The role of Innovation Hubs in supporting collaborative innovation: A case study of user-led healthcare innovation.

Thesis submitted in accordance with the requirements of the University of Liverpool for the degree of Doctor of Philosophy by Katherine Rose Neary

September 2022

Acknowledgements

In memory of Jack Cox

Firstly I would like to thank my supervisors Dr. Paul Ellwood and Professor Robert Blackburn for their continued support and excellent supervision that has enabled me to complete this thesis. Their guidance, experience and attention to detail has provided many opportunities for me to learn and improve my academic writing skills, for which I am most grateful.

This thesis would not have been possible without the CASE studentship funding that I received. I would like to thank the funders and those who contributed to the research proposal, funding application and the North West Social Science Doctoral Training Partnership.

I would like to thank the case study organisation and research participants for the generous amount of time they made available to participate in this study. The insights I gained were important in helping me understand the complexity of the healthcare context, and provide focus to my research.

During the PhD I have received much support from family and friends who have helped me to work through the challenges I have faced. Thank you to those who have encouraged and supported me emotionally and financially – you know who you are! Thanks are also extended to academic colleagues who have enabled me to have opportunities to develop my transferable academic teaching and research skills.

The COVID pandemic has undoubtedly impacted my PhD journey, and I would like to take this opportunity to remember PhD colleagues who were not able to continue with their research.

It is humbling to think of dear family and friends who have supported my education and personal development, and sadly are not able to see me complete this thesis. You are in my thoughts, and I hope that I have made you proud.

Abstract

The role of Innovation Hubs in supporting collaborative innovation: A case study of user-led healthcare innovation

Innovation Hubs have become a popular vehicle for the promotion of innovation in specific settings. This thesis critically explores the development of Hubs in a healthcare setting. Empirically, the thesis presents a detailed case study of a Hub in a public sector paediatric hospital. It critically analyses how effectively Hubs enable hospitals to provide dedicated innovation space where user knowledge can direct the development of healthcare innovations. The research examines how a user-led Hub serves multiple stakeholders, as part of a collaborative innovation process. By using a case study methodology and thematic analysis, the findings provide an understanding of the relationship between the Hub and the main hospital, and the particular challenges of locating a Hub in this context.

A case study approach facilitates an understanding of the roles of space, process and stakeholders in Hub development. The effectiveness of the Hub's location in supporting stakeholders' contributions are critically analysed. In addressing its objectives, the thesis presents a chronology of a Hub's development, the changes to Hub management and process as operational requirements emerge. This includes an examination of how the use of Hub space changes over time, and the impact this has on supporting a collaborative innovation process. The contribution of clinicians, as representatives of healthcare user needs are analysed, highlighting areas of strength and limitation. The thesis also examines user-led demands to increase access to digital products to improve patient experience. Specifically, challenges associated with balancing stakeholder expectations during the development of digital products are explored. Stakeholder tensions regarding conflicting anticipated innovation outcomes raise questions about the place of 'commercialisation' within a paediatric care setting. The thesis examines the role of Hub staff, working as intermediaries, to improve and stabilise the innovation process. The findings contribute to identifying the role of Hub staff in supporting Hub development.

This thesis makes a significant contribution to understanding the challenges of managing a collaborative healthcare innovation process. The analysis highlights the complexity associated with implementing an innovation process to sustain multiple stakeholder collaborations. Changes to how process is used to support concept development and efforts to become a self-sustaining facility are presented. The research finds that generic, or generalised, models of Hub development are inappropriate in a healthcare setting. This derives from the wider job responsibilities of clinicians and how their limited time and dedication to improving patient experience impacts the innovation process. Practically, healthcare innovation has a number of challenges, not least navigating differing stakeholder attitudes to risk, operational pace and preferred innovation outcomes. Overall, this thesis suggests that innovation can be achieved through the vehicle of a Hub, but this is not without its specific challenges. The thesis concludes with suggestions for future research on this crucial subject, including the development of policy to guide digital healthcare innovation and a comparison of user-led hospital hubs with distinct objectives or at differing stages of maturity.

Contents

Chapter 3   Methodology

Chapter 4   Findings - Case History

Chapter 5   Findings

Chapter 6　　　Discussion

Chapter 7　　　Conclusions and Recommendations

Appendices

List of tables

List of Figures

Chapter 1 - Introduction

1.1 Background to the research

Innovation is used as one way to respond to challenges faced by organisations working within constantly evolving environments. The term innovation has multiple definitions, and is highly context dependent. What is meant by innovation differs, but is influenced by the scale and scope of the innovation, and the focus of innovation activity (Tidd, 2001). The objectives of organisational innovation can also differ, but typically involve a change to products or processes as a reaction to changes within the operational environment (Lawson, 2001) alongside a need to generate value for stakeholders (Vargo, Wieland et al., 2015). Studies into the management of innovation explore approaches to manage the complex, uncertain nature of the development process of innovations (Crossan and Apaydin, 2010). This thesis studies how innovation can be undertaken at an organisational level, by examining the development of Innovation Hubs (Hubs). The thesis explores how the environment of a Hub facilitates collaborative multi-stakeholder innovation.

Previous studies have demonstrated potential positive opportunities for organisations that arise from having a dedicated and accessible space for innovation, like an Innovation Hub (Berger and Brem 2016, Mohalajeng and Kroon 2016, van Geenhuizen 2016, Jiménez and Zheng 2018, Leminen, Nyström et al. 2019, Fecher, Winding et al., 2020). Hubs are typically linked to a parent organisation, but function as a separate environment for collaborative working. The distinction of this space enables the Hub to operate outside the confines of the organisational setting (Dzau, Yoediono et al. 2013, Kelley, Ali et al. 2013, Samet, 2016). This is particularly valuable where there are concerns over preserving tightly enforced security, hygiene and risk processes within the parent organisation which is an operational necessity in some sectors (Barlow, 2017, Geiger et al., 2015).

Hubs potentially create a neutral space and a distinct operational culture away from wider organisational restrictions (Diez-Vial and Montoro-Sanchez 2017, Saidi, de Villiers et al., 2017). This creates a safe area for stakeholders to meet and exchange ideas and experiences drawn from their background and existing skills (Diez-Vial and Montoro-

Sanchez, 2017). Hubs orientated to operate in this manner are found in a number of sectors including telecommunications, publishing, energy, biotechnology and manufacturing; demonstrating the extent to which common features of collaborative working generates benefits in many industries (Berger and Brem, 2016).

Increasingly a collaborative approach, involving internal and external stakeholders, is used by organisations seeking to strengthen their innovation (Prahalad and Ramaswamy 2004, Mahr, Lievens et al., 2014). Collaborative working enables innovative projects to be enriched by the resources and perspectives drawn from broad stakeholder groups, through the formation of an innovation network (Dhanaraj and Parke 2006, Cinelli, Ferraro et al., 2019). Yet, existing research on the contingencies of innovation management acknowledge that involving additional stakeholder groups complicates the management of organisational innovation processes (Tidd, 2001).

The diversity of stakeholders who participate during the innovation process introduce additional complexities for innovation management. Stakeholders have different motivations, approaches, levels of knowledge and priorities which can create tension, and adds complexity to the management of innovation (Miller and French 2016, Stossel, 2017). Organisations are tasked with creating an innovation strategy which balances stakeholder requirements, minimises conflict and encourages co-creativity (Chatterji, Fabrizio et al., 2008, Schwartz 2014, Gesing, Antons et al., 2015).

1.2 Exploring the research problem – focus of the research

This thesis examines how technologically-focused innovations are pursued through using multi-sector collaborative working at an organisational level (Nambisan, Lyytinen et al., 2017). Working collaboratively enables the diverse skills and experiences of stakeholders to be connected through establishing multi-disciplinary teams. This can be of particular valuable in fast moving industries, such as those reliant upon technology and digitalisation. Currently organisations are pursuing ways to increase the use of technology within organisation settings. Thus, increasingly technology is a focal point of innovative efforts across a range of sectors (Dimitri, 2019). Organisations need to constantly review their

performance and therefore, are keen to explore innovative ways to respond to changes impacting their organisation. Product and process innovations hold the potential to maintain the quality of service provided and increase effectiveness for stakeholders (Salge and Vera, 2012).

Increasingly organisations are recognising the innovative gains which arise from engaging with users of their product or service users during the innovation process (Von Hippel, 1976, von Hippel and Katz, 2002, Brem, Bilgram et al., 2018). Users are becoming a valued stakeholder group within multi-stakeholder innovation projects. The rapid expansion of the use of technology within society has created a demand from users for organisations to be responsive to their technologically driven needs.

Yet the particular needs of Hubs are sector specific, and reflect broader sectoral differences in organisational culture and operational requirements (van Geenhuizen, 2016). Therefore, closely studying the environment of Innovation Hubs, and their development has the potential to contribute to academic debates on collaborative innovation. Furthermore, the in depth study of a specific Hubs provides an opportunity to collect rich data. This can be used to build an understanding of how Hubs are organised for innovation in different contexts.

1.3 Positioning study within the Innovation Hub Literature

This research seeks to understand the organisation and management of Innovation Hubs. By focusing on Innovation Hubs as an example of an innovative environment, this thesis seeks to contribution to the literatures which explore collaborative innovation, and understand the innovation processes used to manage stakeholders. The thesis focuses on understanding how the hub environment supports collaborative working, and the role of user-led innovation within this setting. The research studies activities within a Hub, to understand the role of a hub as a place for innovation. This study helps to build an understanding of the characteristics of this environment, and the contribution of Hubs to enabling innovation. The data collected illustrates approaches used to manage stakeholders

during the innovation process, as challenges arise (Besharov and Smith, 2014, Miller, McAdam et al., 2014).

Within the Innovation literature, a number of terms are used to describe organisations which co-ordinate multi-stakeholder collaborative innovation. Although each of the terms has a specific definition, often terminology is used to describe a variety of innovative settings, in some cases straying from the intended boundaries of the original definition. Terms used include 'Living Labs' (van Geenhuizen 2016, Leminen, Nyström et al., 2019), 'Incubators' (Diez-Vial and Montoro-Sanchez, 2017), 'Accelerators' (Mohalajeng and Kroon, 2016), 'Tech Hubs' (Jiménez and Zheng, 2018) and approaches in line with 'openness' (Salge, Farchi et al., 2013, Savory and Fortune ,2015) and 'Open Innovation' (Reinhardt, Bullinger et al., 2015, Chesbrough, 2017, Davies, Roderick et al., 2019). The range of terminology used reflects the variations within organisational settings to create environments which fulfil stakeholder requirements and appropriately support the stage of innovative development needed (Salge, Farchi et al., 2013). Certain innovative environments pursue a needs-led strategy to respond to innovation needs identified by internal users. (Zuckerman, Margolis et al., 2013, Miller and French, 2016).

The literature on Hubs has begun to explore the importance of the location and environment as a contributory factor needed to facilitate collaborative innovation (Gryszkiewicz and Friederici, 2014, Berger and Brem, 2017, Jiménez and Zheng, 2018, Leminen, Nyström et al., 2019). Hubs often are located near to supporting stakeholder industries including universities and related commercial businesses (Dzau, Yoediono et al., 2013, Kelley, Ali et al., 2013). These authors argue that it is beneficial for Hubs to be located in close proximity to key stakeholders. This encourages and supports multi-sector collaborative working and enables the Hub to benefit from key resources found within these sectors (Samet, 2016, Davies, Roderick et al., 2019).

Furthermore, previous studies have found that provision of a dedicated innovation space, like a Hub is necessary to enable an innovation culture to develop and thrive. Provision of a dedicated space helps organisations to overcome barriers to innovation present within the working environment of the parent organisation. For example, some organisations have

strict health and safety policies, restricted access for visitors or a low tolerance to risk (Saidi, de Villiers et al., 2017). Such restrictions are understandably present within healthcare settings, and therefore are particularly significant factors for health innovation hubs to consider. A dedicated healthcare innovation hub overcomes the risk posed by the presence of external stakeholders within the restricted environment of a hospital (Todt and Lujan, 2014, Dimitri, 2019). The creation of a dedicated innovation space enables different stakeholders to safely access a shared space where the external organisational culture and aptitude for risk taking are reduced (Burns, 2005, Bason, 2010).

The accessibility of the Hub location is a significant factor to enable stakeholders to interact effectively, particularly for users who either work or are accessing services at the parent organisation (Kelley, Ali et al., 2013, Samet, 2016, Barlow, 2017, Batayeh, Artzberger et al., 2018). In the empirical setting used in this research, the proximity of the Hub to the main hospital is designed to increase accessibility for users to support their participation. Considerations of barriers to access are important, to ensure that multi-stakeholder working is feasible and sustainable. Within sectors such as healthcare, the demanding working schedules of many staff members result in a lack of opportunity to engage in additional activities like innovation. Therefore, the location of the innovative environment and the responsiveness to their needs are important factors in encouraging and sustaining a productive innovative environment (DeWolf, 2009, Barnett, Vasileiou et al., 2011, Fleuren, Wiefferink et al., 2014, Clark, Dean et al., 2019). Researching the Hub environment is valuable to understand how stakeholders from a range of backgrounds access the space, share requirements, and contribute to the culture of the innovation space (Balicer and Afek, 2017, Jiménez and Zheng, 2018, Leminen, Nyström et al. 2019, Fecher, Winding et al., 2020).

Increasingly the voice of users contributes to, and in some cases leads the direction of innovation projects which emerge from existing user needs (O'Hare, Hansen et al., 2008, Bachmann, 2014, Gryszkiewicz and Friederici, 2014, Berger and Brem, 2016).

In seeking a theoretical explanation of collaboration between stakeholders within Hubs a number concepts from the wider innovation literature may be instructive. For example the

literature on user-led innovation can be traced back to the seminal works of Von Hippel (1976) and Urban and Von Hippel (1988). Subsequently the role and importance of users has been the focus of many other academic studies, as the theoretical, commercial and practical importance of user contributions as part of the innovation process became better understood (Herstatt and Von Hippel, 1992, Olson and Bakke, 2001, Lilien, Morrison et al., 2002, Franke, Von Hippel et al., 2006, Brem, Bilgram et al., 2018).

Over time the innovation process has evolved to become more open, this can be seen through the wider distribution of power, and the roles played by stakeholders who form innovation networks. Much research has been undertaken to develop models of innovation which explore and demonstrate the merits of openness and co-creative working (Senker, 1995, Moulaert and Sekia, 2003, Bason, 2010, Crossan and Apaydin, 2010, Savory and Fortune, 2015, Cinelli, Ferraro et al., 2019, Davies, Roderick et al., 2019). As organisations have become more open to working with one another, working relationships and organisational boundaries have become more relaxed to accommodate this reorganisation and redistribution of power. This strategic change is also evident when examining the extent of willingness within multi-stakeholder teams to share knowledge and reconsider their approach to the management of risk as part of the innovation process (Rothwell, 1994, Djellal, 2007, Salge, Farchi et al., 2013, Samet, 2016, Chesbrough, 2017).

When considering collaborative models of innovation two main groups emerge, those that are responsive to external market forces, and those maintaining looser or tighter network ties (Rothwell, 1992, Barlow, 2017). The first group of models, closely linked to the external market are collectively termed front end, or technology push/market pull models. They commonly show the business opportunity which influences the activities of research and development teams, and their management of risk whilst seeking to produce new product (Brem and Voigt, 2009). Characteristically these models are linear and process based, example of is the innovation product develop model 'The Stage Gate Model' (Cooper, 2008).

A second group of models of collaborative innovation have been developed to show a greater or lesser reliance on a wider network of stakeholders. An example of a model which uses the wider stakeholder network as a core strength is 'The Orchestration Model' which

features a lead organisation seeking to create and extract value, through 'orchestrating the interactions of stakeholders within the network (Dhanaraj and Parke, 2006). There are also models which combine the collaborative openness of a network of stakeholders, but with a more diffused approach to structure and management processes. This can is seen in models like the Choreography Model (Ferraro and Iovanella, 2015). Within this model interactions between stakeholders are on a peer to peer basis rather than led by a lead stakeholder. When reviewing the literature there has been a clear progression in the development of collaborative models of innovation. Changes in models developed over time reflect an increasingly open innovation activity, involving stakeholders from multiple organisational backgrounds.

Currently there are calls for further research to better understand the role of users, and how their inclusion within collaboration contributes to multi-stakeholder innovation teams. (Howells, 2006, Guinan et al, 2019). Additionally, there are calls for additional studies on collaborative working at an organisational level and within specific sectors (Dhanaraj and Parke, 2006, Longo and Giaccone, 2017). This research responds to these calls, by focusing on understanding a Hub operating in the UK health sector, at an organisational level, (Sørensen and Torfing, 2011, De Vries, Bekkers et al., 2016). The position of the Hub studied within this thesis provides an opportunity to explore differences in the capacity for risk within a dedicated Innovation setting, and the wider context of the traditionally risk averse public sector (Bason, 2010, De Vries, Bekkers et al., 2016).

1.4 Research Context

The healthcare sector provides a rich empirical setting with which to study the formation of collaborative multi-stakeholder teams within complex organisational settings (Hertzlinger, 2006, Batayeh, Artzberger et al., 2018) whilst contributing to debates within the literature on Innovation Hubs (Farchi and Salge, 2017). The design of this study provides the opportunity to explore the extent to which external organisational influences impacts the collaborative environment of the Hub, and its innovation culture (Savory, 2009, Batayeh, Artzberger et al., 2018, Vespestad and Clancy, 2019).

The National Health Service (NHS) is part of the public sector within the United Kingdom. In 2018 it celebrated its 70th anniversary having originally been established in 1948 within a post war society. The founding objective of the National Health Service was to provide universal healthcare which was free at the point of access for all UK citizens (Doran, 2019, Klein, 2019). Nationally the NHS employs 1.5 million people and provides care through a range of access points including acute, primary health and community care settings. The development of the service has seen it rise to one of the world's largest employers, compared to initial staffing levels of 144,000 employees when it began in 1948 (Rolewicz and Palmer, 2019). Maintaining the operational requirements of this service, has been complicated by frequent updates to governance structures, policies and processes (Farchi and Salge 2017, Klein, 2019).

The NHS is facing a number of challenges arising from a sustained increase in demand for its services amid operating within austere financial conditions (Doran, 2019). The nature of the current demands on the NHS include an increase in patients with complex medical issues, a national shortage of staff at all levels and numerous financial pressures (Alderwick and Dixon, 2019, Proksch, Busch-Casler et al., 2019). These challenging circumstances have created a limited capacity for the NHS to keep abreast of technological advances at the same pace as mainstream society, and resulted in a lag in available technology for staff and patient use (Davies, Roderick et al., 2019, Dimitri, 2019).

Throughout the history of the NHS, innovation can be seen as a consistent feature which has supported development and advances in medical provision and patient care (Farchi and Salge, 2017). As the needs of society have changed, so have the demands on the NHS to respond to the increasingly complex chronic healthcare needs of its patient users, and the needs of its users as healthcare staff and clinicians. Alongside the changing health needs of the patients, are the complexity of its organisational structure (Plesk and Trisha, 2001, Singh, Amini et al., 2015, Samet, 2016, Alderwick and Dixon, 2019). As such process and product innovation are integral to helping the NHS to meet the diverse demands placed in its service. Innovation is detailed as a national strategic priority within the NHS strategy 'The Long term plan', as well as featuring prominently in the previous strategy (NHS England, 2019).

The Hub studied in this research provides a setting to focus on understanding the complexity of managing collaborative healthcare innovation. By studying a Hub, at an organisational level it is possible to explore the way in which multiple perspectives, priorities and working styles are combined to jointly focus on innovation projects (Ferreira, Raposo et al., 2013, Beirão, Patrício et al., 2017) Within this thesis the activities of the Hub, and how they are shaped by the collaborative nature of working and innovation are explored.

In the rapidly evolving sector of healthcare, Innovation activity is increasingly open to incorporating the resources and skills of multiple external stakeholder groups (Bason, 2010, Gesing, Antons et al., 2015, van Geenhuizen, 2016). These external partners can contribute specialised resource, in addition to what is available within the public sector and a hospital setting (McAdam, Miller et al., 2016, Swain, Sharma et al., 2017, Cinelli, Ferraro et al., 2019, Proksch, Busch-Casler et al., 2019). This in turn enables stakeholders to extend their area of contribution by extending the traditional function of their sector. For example, traditionally Universities contribute valued research findings and further resource for analysis and evaluation. Whereas Commercial organisations have the potential to contribution finance, testing and production facilities and latterly distribution networks. Yet both could become involved in product design as an extension to their core function (Carayannis and Campbell, 2009).

The term stakeholders in this setting encompasses groups of stakeholders found both within and outside of the hospital environment. Externally these include government departments, research institutions and the commercial sector. Internal stakeholders refer to groups from within the wider parent hospital organisation who are likely to use or benefit from innovations. In a healthcare setting internal stakeholders, termed users, or end users (Von Hippel, 1976, Bogers, Afuah et al., 2010, Thune and Mina, 2016) within the literature include staff and patients and their carers (Savory and Fortune, 2015, Miller and French, 2016). All stakeholder groups are connected through a common interest in the current and future direction of the NHS, as commonly they impact and are impacted by the decisions made at an organisational level within the hospital setting. However differences in expectations from innovation can raise issues between stakeholder groups (Vespestad and Clancy, 2019).

Within the National Health Service, the voices of its user groups are important and gaining both the attention of NHS decision makers and stakeholders within other sectors. Users within a healthcare setting can influence the innovation process by sharing personal insights and experiences (Greenhalgh, Robert et al., 2004, Dimitri, 2019). This knowledge is valued as organisations like the NHS seek to improve patient experience and healthcare delivery (Savory and Fortune, 2015, Vespestad and Clancy, 2019). The contribution of user knowledge and feedback is recognised as valuable within the design process of innovations seeking to address operational requirements and patient needs (Savory, 2009, Batayeh, Artzberger et al., 2018). Users are well placed to contribute incremental feedback to help revise innovations throughout their development to best meet user needs (Savory, 2009, Bogers, Afuah et al., 2010) whilst creating an end product which is commercially valuable . Including the perspective of users as a contributory group within collaborative innovation adds further support to innovation designed in an open, agile and robust manner (Ciasullo, Cosimato et al., 2017). This is an important step, as previously innovations developed without the input of users have faced compatibility issues with internal systems and organisational culture within the health service (Greenhalgh, 2004, Barnett, Vasileiou et al., 2011).

Within the health sector the potential gains from utilising user-led innovation are particularly valuable as a way to respond to clinical staff challenges, and as a way to engage with patient groups (Chatterji, Fabrizio et al., 2008, Page, 2014, Shapiro and Angelo, 2014, Lukoschek, 2019). Furthermore, acknowledging and considering the experiential requirements of users' needs maintains a line of connectivity with operational service based needs (Batayeh, Artzberger et al., 2018). Conversely, overlooking the needs of these core user groups, can be financially costly (Fleuren, Wiefferink et al., 2014) and create unnecessary anxiety amongst patients and families by not addressing areas of the healthcare journey which are negatively impacting their wellbeing (Berwick, 2003, Lacy, 2016, Tettegah and Garcia, 2016).

Moreover, innovations developed with a lack of consultation with users have been difficult to integrate into the health service because of a lack of synergy with organisational requirements (Doebbeling and Flanagan, 2011). If innovations do not fit with the needs of

healthcare staff they can be under-utilised and thus be a poor investment for the NHS or create additional complexity within established work patterns of staff (Hertzlinger, 2006, Barnett, Vasileiou et al., 2011, Dzau, Yoediono et al., 2013, Dimitri, 2019).

Additionally, as technology becomes an integral part of healthcare treatment processes and the wider patient experience, subgroups of users are recognised as well placed to inform the direction of specialist innovations. This is evident in the area of paediatric healthcare where the physical and emotional needs of users, and the design of suitable healthcare is understandably distinct from adult medicine (Werder, 2015, Wolf, 2019). There is a need to innovate the processes and products available within the care and treatment of patients, and respond to growing interest from users who are keen to participate in innovation activity (Burchardta and Maisch, 2019, Schütz, Heidingsfelder et al., 2019, Secundo, Del Vecchio et al., 2019).

The technological focus of the Hub studied in this research is topical given the current academic and policy based focus on increasing digital innovation in the UK healthcare sector (Hertzlinger, 2006, DeWolf ,2009, Thakur, Hsu et al., 2012, Clark, Dean et al., 2019, Secundo, Del Vecchio et al., 2019).

As technology has become an integral part of public life, the NHS is increasingly under pressure to explore how advances in product and process innovation could increase the capacity, accessibility and scope of healthcare delivery (Savory and Fortune, 2015, Farchi and Salge, 2017, Davies, Roderick et al., 2019). As such, the benefits of collaborative approach to innovation, that provides access to additional expertise and additional resources is currently encouraged within NHS innovation strategy (NHS England, 2019, Vespestad and Clancy, 2019). In addition, this empirical setting studied in this thesis provides an environment to understand the how user focused technological innovation are developed within the context of the NHS, and in respond to stakeholder needs (Farchi and Salge, 2017, Proksch, Busch-Casler et al., 2019)

Evidence of challenges arising from the multi-stakeholder innovation can be seen within the context of the healthcare innovation. Positioning a study within the context of NHS

innovation provides a rich organisational environment to conduct further research (Thune and Mina, 2016). This is timely given calls for studies to understand how collaborative teams are contributing to increasing the number of technologically focused innovations for use in healthcare (Thimbleby, 2013, Werder, 2015, Tettegah and Garcia, 2016, Barlow, 2017, Wolf, 2019). Further work is also needed to contribute to the understanding of how the multiple needs of stakeholders are managed within innovation partnerships (Antons, Gesing et al., 2015, Lauritzen, 2017). This is a complex issue as teams comprise of stakeholders who reflect differing perspectives and priorities of their sector (Conway and Steward, 2009, Salge, Farchi et al., 2013).

1.5 Research Aim, Objective and Research Questions

This thesis is informed by the specific needs of healthcare innovators, with access granted for empirical research to a newly-created Innovation Hub. Drawing on the forgoing introductory sections the Research Aim, Objectives and overarching Research Questions for the study are set out below.

Research Aim

To explain the development of user-led Innovation Hubs that serve multiple stakeholders.

Research Objectives

1) To document the development of a newly-created healthcare Innovation Hub.
2) To explain the ways in which users inform the development of healthcare Innovation Hubs.
3) To explore the ways in which collaborative innovation between multiple stakeholders is enabled.

Research Questions

1) How are Innovation Hubs developed in a healthcare context?
2) How do users inform innovation within an Innovation Hub environment?
3) How is multi-stakeholder collaboration enabled in a healthcare context?

1.6 Thesis Outline

The thesis is structured into 7 chapters. Chapter one introduces the research aim and research questions in relation to gaps in the literature. The empirical healthcare setting is presented. An in-depth review of the literatures informing this thesis are explored in Chapter two. Subjects reviewed include types of innovation space, innovation process and the role of users as part of a collaborative Innovation Hub (Hub) process.

Chapter three presents the research methodology used in this thesis. The chapter outlines the research design, research methods and how the research was conducted. Chapter four and five contain a presentation of findings. In chapter four a chronology of the innovation Hub is presented. The chapter documents a detailed case history of the Hub facility, core actors and spaces. The chapter ends with a series of tables showing results from the thematic analysis process. These themes are used to structure the main findings that follows. Thus, chapter five is structured into five sub-sections: Management of Hub, Collaborative Space, Collaborative Process, Impact of NHS Culture and Climate on Hub Innovation, and Innovation Outcomes. A discussion of findings in relation to the literature is given in chapter six, to answer the research questions. The thesis concludes in chapter seven where the key contributions of the thesis are identified. Recommendations are offered for areas of further study, and implications for innovation management practice.

Chapter 2 Literature Review

2.0 Introduction

The purpose of this chapter is to consider key concepts which inform the health innovation literature, and recognise the evolution within this topical area of research to help shape the agenda of the thesis. The chapter is structured into four main sections, each reviewing literature that contributes to the core themes within this research. The first section introduces and explores the challenges of innovation management, before exploring the notion of innovation spaces, with a focus on Innovation Hubs (Hub). The second section focuses on Users as a distinct group of Innovation actors, before the processes of collaborative innovation are discussed in section three. The chapter concludes with a critical summary, which combines the main discussions from across the chapter. The exploratory consideration of key literature within this chapter is used to help guide the development of a research agenda and approach to structuring the research design of the thesis.

2.1 An introduction to challenges of Innovation Management

When seeking to explain innovation, the literature contains many attempts within existing studies to the capture and define what has become an ambiguous term. Seminal work by Van der Ven (1986:590) suggests that innovation can be defined as 'the development and implementation of new ideas by people who over time engage in transactions with others within an institutional order'. Van der Ven (1986:590) outlined the challenges of managing people, process, multi-stakeholder relationships and innovation context. Although this view is still relevant, the contemporary use of the term innovation has complicated how it has come to be understood. Increasingly, recent publications acknowledge that no fixed definition of innovation exists (Toivonen and Friederici, 2015, Kimble and Massoud, 2017, Osorio et al., 2019).

The process of Innovation can be described as 'an expression of human creativity' which aims to create 'blend creativity and improvisation to produce a new and unique functional and economic value for people' (Sharma and Meyer, 2019a:4). As such, Innovation has

become a popular term in organisational contexts to describe a range of new and revised actions and processes . The difficulty of articulating what innovation means has given rise to phrases like 'the innovation jungle' (Prange and Schlegelmilch, 2018:309-310) to illustrate the complexity and diversity of innovation spaces where attempts to define innovation originate.

It is important to acknowledge that the parameters of what constitutes innovation continue to evolve. Of particular significance is the rapid increase in technological components of innovation projects, in conjunction with the decentralised nature of the innovation process (Von Hippel, 2009, Tiwari and Buse, 2020a, Kostkova, 2015). As a result, innovation projects typically involve expertise and resources from actors in multiple organisational settings, particularly where technology is a central component of the innovation process (Thakur et al., 2012:563, Nambisan et al., 2017, Dimitri, 2019). Thus the environmental elements, motivations and social interactions between innovation actors are recognised as important (Portales, 2019) within the democratization of the innovation process (Von Hippel, 2005, De Jong, 2016). Innovation has developed to become a co-created process involving knowledge, resources and experience from multiple actors (Garud et al., 2013, Wolf, 2019). The purpose motivating innovation has extended from an economic aim, first acknowledged in the seminal work of Schumpeter beginning in 1912, explored by Śledzik (2013) to include socially motivated innovation (Westley and Mcconnell, 2010, Batayeh et al., 2018, Portales, 2019).

The term social innovation itself is not new, but has received increased use as the innovation process has decentralised and opportunities for socially driven innovations have increased (Beausoleil, 2018:76-79, Nicolopoulou et al., 2017). The core motivation of social innovation is to resolve an existing need within society, by mobilising the knowledge of multiple actors. The innovative output can create impactful change to processes, systems and structures resulting in the fulfilment of existing needs in wider society (Edwards-Schachter and Wallace, 2017:73) through effectively designed products and process pathways (Thomke, 2016:469-470).

In response to the ambiguous use of the term innovation, and an increased need to explain complex innovation strategy to stakeholders Prange and Schlegelmilch (2018) developed a visualisation which combines the innovation type with the anticipated impact. The Innovation Cube model, figure 2.1 uses a 3D design, and peripheral axis' which demonstrates how different stakeholder groups can understand types of impact. The model is useful when seeking to plan and explain decisions linked to innovation strategy, and connect the type of innovation with levels of impactful changes to the organisation, its strategy or market dynamics.
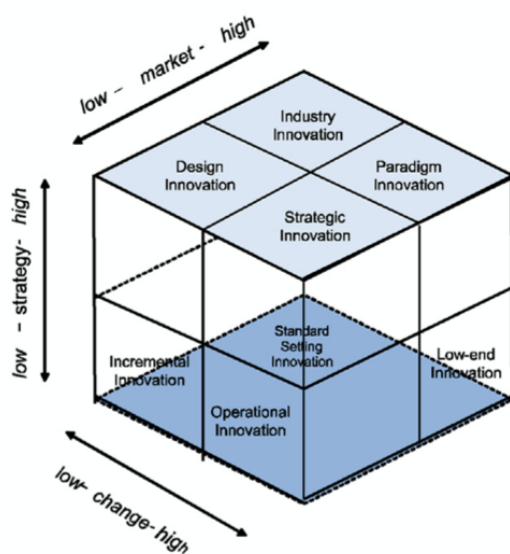
Figure 2.1: 'The Innovation Cube' (Prange and Schlegelmilch, 2018:313)

An alternative approach to defining innovation is proposed by (Sawnhey et al., 2006:76) who suggest innovation can be understood as 'the creation of substantial new value for customers and the firm by creatively changing one or more dimensions of the business system'. Prange and Schlegelmilch (2018) agree that focusing on value created from innovation is a progressive way to understand what has become a complex term.

Seeking to find alternative definitions of innovation seems fitting given the fast moving pace of change in society, which is closely linked to growth in technological innovations. This has led (Kumaraswamy et al., 2018:1026) to suggest we are living in a state of 'continual disruption' due to the fast moving pace of change impacting stakeholder expectations. Consequently organisations are innovating to develop their systems and processes to meet

the technological expectations and operational requirements of their core stakeholders (Lacy, 2016, Konrad et al., 2019, Tettegah and Garcia, 2016).

When defining innovation, it is important to understand the intended output and nature of desired impact, along with the type of innovation process used. This approach enabled a conceptualisation of innovation that is focused and aligned to the context in question. Therefore, as a prelude to a discussion of Innovation Hubs (Section 2.2), the following sub-sections summarise types of innovation, and its drivers before considering the implications for doing innovation with others.

2.1.1 Categorising types of Innovation

Innovation can be categorised in terms of the degree of marketplace impact and the nature of the change created, namely product or process based. Innovation is related to levels of novelty (Bason, 2010a:41, Bessant and Francis, 2005). The table 2.1 summarises the main types of innovation, and shows how the process of innovation differs accordingly.

Table 2.1: Types of Innovation

Innovation Type	Key Characteristic	Key Studies
Product Innovation	Creation of new products within an existing marketplace.	(Lilien et al., 2002, Page, 2014, Engmann et al., 2016, Dimitri, 2019) (Bessant et al., 2019a, Lettl, 2005, Tettegah and Garcia, 2016)
Process Innovation	Change to the way in which systems and processes are organised.	(Ashcroft, 2016, Von Hippel, 1976, Salaman and Storey, 2002, Ham et al., 2003, Chatterji et al., 2008, Savory, 2009a, Nicolini, 2010, Dzau et al., 2013, Salge et al., 2013, Hyysalo and Johnson, 2013, Garud et al., 2013, Schwartz, 2014, Singh et al., 2015, Van Geenhuizen, 2016, Mohalajeng and Kroon, 2016, Edwards-Schachter and Wallace, 2017, Aakhus et al., 2018, Leminen et al., 2019, Secundo et al., 2019, Iakovleva et al., 2019a, Kim et al., 2019, Kimble and Massoud, 2017)
Operational Innovation	Business model or process innovation.	(Hwang and Christensen, 2008, Von Hippel, 1976, Akrich et al., 2002a, Akrich et al., 2002b, Cooper, 2008, Savory, 2009a, Consoli and Mina,

Innovation Type	Key Characteristic	Key Studies
		2009, Bason, 2010d, Omachonu and Einspruch, 2010, Sheffield, 2012, Garud et al., 2013, Russo-Spena et al., 2017, Edwards-Schachter and Wallace, 2017, Mcgann et al., 2018, Leminen et al., 2019)
Services Innovation	Innovation in how services (e.g. healthcare) are managed and delivered.	(Greenhalgh et al., 2004b, Hipp and Grupp, 2005, Damanpour et al., 2009, Savory, 2009b, Schuhmacher and Kuester, 2012, Durst and Mention, 2013, Lusch and Nambisan, 2015, Snyder et al., 2016, Ciasullo et al., 2017, Vespestad and Clancy, 2019, Davies et al., 2019)
Incremental Innovation	Small changes to existing products or processes used within a sector or marketplace.	(Cooper, 1998, Kobarg et al., 2019, Greenhalgh et al., 2004a, Savory and Fortune, 2015, Honeyman et al., 2016, Samuelsson et al., 2019)
Radical Innovation	Completely new, large changes which create a substantial impact for a sector or marketplace.	(Lettl, 2005, O'Hare et al., 2008, Bers and Dismukes, 2012, Gryszkiewicz et al., 2016, Kobarg et al., 2019)
Disruptive Innovation	Innovation which when introduced fundamentally changes existing markets, processes or behaviour patterns.	(Kumaraswamy et al., 2018, Christensen, 2000, Hwang and Christensen, 2008, Bioethics., 2017)

In Table 2.1 shows how broadly the term innovation is used and the approaches that can be used to bring about innovative change. As the term innovation is applied to describe a range of processes and organisational strategies, it is important to identify the characteristics which differentiate types of innovation activity. Thus, the classification of terminology can be used to help clarify and explain the objective and process of the intended innovation. It is important to recognise that innovation activity differs in aim, scale and level of novelty. The approach taken is guided by multiple factors driving the innovation activity.

2.1.2 Drivers of Innovation

Drivers of organisational innovation typically reflect organisational strategy (Burns and Sammut, 2005, Mohalajeng and Kroon, 2016, Sharma and Meyer, 2019a) and the internal and external pressures they are facing (Kyratsis et al., 2014, Hartley, 2015). Organisations are driven to innovate in response to the concerns and often disparate requirements of their stakeholders (Miller et al., 2014, Liedtka, 2020, Komatsu Cipriani et al., 2020). Changes in the external organisational environment can prompt innovation to remedy impacts on the efficiency of organisational processes and effectiveness of communication within the organisational network (Samet, 2016, Consoli and Mina, 2009, Kim et al., 2016). The current expanding role of technology in society, referred to as the 4th Industrial Revolution in academic literature, (Osorio et al., 2019, Pitsis et al., 2020) has driven product and process based innovation, as digitalisation become an organisational necessity.

Furthermore, embracing the inclusion of technology within organisational processes helps maintain operational efficiency (Savory and Fortune, 2015, Swain et al., 2017) and service quality (Batayeh et al., 2018, Kim et al., 2016). This can involve the development of new processes (Cinelli et al., 2019, Leminen et al., 2019), and incremental improvements to existing processes (Kobarg et al., 2019, Samuelsson et al., 2019). Increasingly organisations seek to respond to stakeholder expectations to have access to newly emerging technologies that support their healthcare journey along with digitalised service pathways e.g. (Tettegah and Garcia, 2016, Nambisan et al., 2017, Oliveira et al., 2019, Laudal and Iakovleva, 2019). This requires organisations to use both product and process innovation methods to explore how to incorporate, adopt (Robert et al., 2009, Savory and Fortune, 2013, Clark et al., 2019) and disseminate technologically driven innovations into their existing organisational structure (Greenhalgh et al., 2004a, Glasgow and Emmons, 2007, Neta et al., 2014, Gorman, 2015).

As organisations operate in competitive and challenging (Shemtob and Littlewood, 2019, Sharma and Meyer, 2019b, Kostkova, 2015) organisational environments, sustaining competitiveness in terms of service effectiveness and meeting stakeholder expectations admit continued disruption (Kumaraswamy et al., 2018) present a continuous need for

innovative solutions (Dimitri, 2019, Hartley, 2015, Barlow, 2017). New technologies can create benefits for organisations by reducing pressure on staff by using scalability digital software to support customer needs. This evolution of service provision also increases overall organisational capacity, which in turn can benefit service users and improve their customer experience (Bason, 2010a, Osorio et al., 2019, Lacy, 2016).

The innovation development process can generate multiple beneficial outcomes for stakeholder groups including research data (Shafique, 2013, Maglio et al., 2015, Giannopoulou et al., 2019), improved user experience (Werder, 2015, Sieck et al., 2019, Wolf, 2019), enhanced service quality (Giannopoulou et al., 2013, Dimitri, 2019), and operational efficiency (Leminen et al., 2019, Swain et al., 2017, Samuelson, 2016), the generation of intellectual property (Gassmann et al., 2010, Strandburg, 2016, Teece, 2018) and commercial sales revenue (Naughton and Foss, 2019, Mohalajeng and Kroon, 2016).

2.1.3 Innovation with others – introducing the notion of stakeholders

The innovation process (Van Der Ven, 1986, Von Hippel, 1976) is increasingly influenced by the collaborative involvement of multiple types of organisation (Windrum et al., 2016, Mcadam et al., 2016, Thomas and Maines Da Silva, 2019, Belloso, 2020). This approach to innovation is a modification from previously dominant method of organisations innovating in a closed manner and is part of the broader decentralisation of the innovation process (Salge et al., 2013, Benkler, 2016).

Innovating with increased openness enables the involvement of stakeholders from different backgrounds, and demonstrates how organisations have come to appreciate the benefits of innovating co-creatively (Secundo et al., 2019, Consoli and Mina, 2009). Organisations innovating in a collaborative manner gain access to the experiential tacit knowledge and experiences of collaborating participants (Thomas and Maines Da Silva, 2019, Tietze et al., 2020). Additionally, these participants often have access to different resources within their organisations (Miller et al., 2016, Swan et al., 2016, Schütz et al., 2019) which can be used within the collaborative process to extend capabilities available to address innovation challenges (Bason, 2010d:97, Mahr et al., 2014, Beirão et al., 2017).

2.2 Dedicated spaces for Innovation

In addition to the value found from working collaboratively within a Hub, the concept of Hub space holds great significance when qualifying how Hub facilities support collaborative innovation. This section studies the importance of different types of space used for collaborative innovation by problematizing the literature in this area. This section begins by setting out the key terminology that is used to help understand these multiple innovation spaces. Subsequently their design, operational processes, staff and internal culture are critically explored. The section aims to demonstrate how specialist spaces for collaboration innovation have been set up and studied.

2.2.1 Specialist Spaces: Understanding the function of space

In order to explore and discuss findings from literature on Innovation spaces, at the outset of this section, it is important to define how key terminology is used to describe innovation spaces within this thesis. This ensures that the following discussion consistently uses four key words, space, environment, location and facility which are commonly found within research on innovation spaces.

After a search of the literature it was found that there is no commonly agreed existing innovation space definition in use, and that terminology was broadly applied. This guided the development of working definitions of key terms used in this research. Thus, within this thesis the term location is used at a geographic level to describe proximity in relation to other industries e.g. the innovation hub was located in the city centre, near to the university. The term facility is used to convey the totality of spaces within a building e.g. the innovation hub contains two seminar rooms, a hot desk area and two break out zones. The use of space, and environment have subtly important differences. The term space is used a type specific of room, and the physical and material attributes of that room, e.g. the innovation hub space was 50 square metres and contained modern office furniture, large tables for shared working space and a mini exhibition area showing current projects. The term environment is used to add feelings about the culture and organisational climate of the innovation space, e.g. collaborative and relaxed approach to multi-stakeholder working.

The importance of innovation spaces is evident by the rise in the provision of dedicated innovation environments (Caccamo, 2020, Moultrie et al., 2007). Bason (2010d:100) asserts that 'innovation needs a home it lives in places.' The importance of a defined innovation space is grounded in earlier work by (Kao 2002 cited Bason 2010:100) who compares,

> '…innovation labs with the atelier of an artist. Organisations, just like artists' homes, need a place where the creative process is at the centre… where the innovation process is a professional discipline and not a rare, singular event, and where people can meet, interact, experiment, ideate and prototype new solutions.' This view introduces the concept of an innovation space, and the idea that it has a predetermined function, performs identifiable actions and thus requires suitable environmental conditions (Dzau et al., 2013:1426).

To enable innovation to be appropriately resourced and supported, distinct areas for innovation have been created onsite within organisations, and offsite near to complementary organisations. To describe these innovation spaces new terminology has emerged to convey the purpose and processes which occur in these settings. However, within the literature it is acknowledged that ambiguous usage of terms has caused some complexity in defining named innovation spaces (Osorio et al., 2019, Gryszkiewicz and Friederici, 2014a).

Furthermore, as the innovation space terminology has been acknowledged as often being inaccurately applied, some misunderstandings occur regarding the characteristics of innovation spaces, and the differences between them (Veeckman et al., 2013, Page, 2014). Table 2.2 consolidates the varied terminology used to describe innovation spaces, and presents the distinctive characteristics between them.

Table 2.2: Innovation Space Terminology

Label	Espoused Aim	Key Studies	Main Activities	Participants
Innovation Hub	Provides accessible space for stakeholders to develop innovations by integrating valuable skills, resources and tacit knowledge. Acts as a central nexus within wider innovation eco-system. Encourages diverse stakeholder participation through providing environmental conditions which support creative needs-led innovation.	(Hattori and Wycoff, 2002, Toivonen and Friederici, 2015, Berger and Brem, 2016, Sharma and Meyer, 2019b, Crupi et al., 2020)	Events to promote stakeholder interaction e.g. hackathons. Active external communication through social media threads. Co-working office space and meeting rooms for use by innovators. Training, Commercial and strategic support provided by Hub staff. Knowledge Brokering, Knowledge Sharing, Leverage of knowledge to enable robust multi-stakeholder collaboration. Ongoing relationship, risk and project management.	Multi-stakeholder: citizens, business, and government

Label	Espoused Aim	Key Studies	Main Activities	Participants
Innovation Lab	Purpose built venue shaped by local context/needs, designed to support collaborative innovation and knowledge sharing.	(Magadley and Birdi, 2009, Carstensen and Bason, 2012, Veeckman et al., 2013, Gryszkiewicz et al., 2016, Osorio et al., 2019)	Provides neutral space, facilities and events to support multi-stakeholder innovation. Hub staff facilitate knowledge transfer between stakeholders and support project development.	Multi-stakeholder: citizens, business, university/research institutes and government.
Living Lab	Purpose built user-led innovation space situated within an active work setting e.g. hospital. Champions user-led innovation by enabling experiential user knowledge to inform multi-stakeholder collaborations.	(Hossain et al., 2019, Garcia Guzman et al., 2013:633, Hyysalo and Hakkarainen, 2014:627, Leminen et al., 2019:158, Van Geenhuizen, 2016:241, Kim et al., 2019:636, Haukipuro et al., 2019:702, NyströM et al., 2014:635)	Living labs provide space for users to work on addressing existing social needs by offering support for idea creation, proto-typing, validation and testing within a real life setting. Oversees product development to meet social and commercial needs to aid adoption.	Multi-stakeholder: citizens, business, university/research institute government.
Public Sector Innovation	Encourages increased participation in the policy making process by using the environment of an Innovation Hub.	(Bason, 2010d, Bason, 2010c, Carstensen and Bason, 2012, Mcgann et al., 2018, Björklund et al., 2019)	Facilitates involvement by members of the public in Public Sector policy development and service design.	Government and members of the public

Label	Espoused Aim	Key Studies	Main Activities	Participants
Maker Space	Supports staff to develop creative ideas which impact their workplace (e.g. hospital) often using principles of Design Thinking. Enables external organisations to gain input into products designed for specialised/highly regulated organisational environments.	(Svensson and Hartmann, 2018, Liedtka et al., 2017c)	Promotes learning by doing/peer learning. Provides access to resources and equipment that develop and refine innovative ideas.	Predominantly hospital staff, some support for external innovators.
Innovation Incubator	Nurtures the development of early stage SME innovation, often in hi-tech industries by providing a link between innovation and entrepreneurship. Supports the creation of new businesses, often located in Business Parks.	(Etzkowitz, 2002, Beausoleil, 2012, Diez-Vial and Montoro-Sanchez, 2017, Nicolopoulou et al., 2017, Haukipuro et al., 2019, Sharma and Meyer, 2019b)	Provides business support and innovation resources for SMEs through shared office space and access to assistance from staff to address project specific needs.	SME

Label	Espoused Aim	Key Studies	Main Activities	Participants
Innovation Accelerator	Advertises innovation needs, termed 'challenges' and invites participation from stakeholders. The aim is to generate quantifiable innovation outputs e.g. successful proposal outcomes, income generation and intellectual property.	(Mohalajeng and Kroon, 2016, Liedtka et al., 2017d, Haukipuro et al., 2019)	Accelerator staff use marketing skills to generate proposal entries and negotiate with stakeholders to develop contractual arrangements and provide financial support. Mentorship Support is provided using Accelerator Alumni.	Multi-stakeholder – usually with a commercial focus.

The Innovation Space terminology listed in table 2.2 summarises how the multiple innovation spaces are described within the innovation literature. Although it is possible to note some unique characteristics, the use of different terms and their definition within research papers show much similarity, which confirms existing findings that terminology is often used ambiguously (Barlow, 2017, Osorio et al., 2019). Table 2.2 shows that there is some overlap between the terms used by authors, and therefore the same terminology can be used to mean different things. As such, when reading papers about innovation spaces, the initial specifics of the term become increasing indistinct, due to the way they are used. Therefore, the reader can benefit from recognising that these terms are often applied loosely in practice. Developing Table 2.2 was useful in helping to decide, what and how innovation space terminology will be used in this thesis. Table 2.2 conveys that consistent visibility of users as an important stakeholder group in multiple innovation spaces. They provide an important role in guiding the innovation process by sharing their experiential knowledge. Additionally, the importance of the innovation space, to support creatively led multi-stakeholder collaboration with is also a consistent feature. This approach is explored further in section 2.2.2.

An important contribution to the discussion on clarifying innovation spaces can be seen through the creation of a model which recognises the overlap between characteristics of innovation spaces. By reflecting on the complexity of the multiple aims, roles and types of actors within innovation spaces a new innovation space model has been designed. Sharma and Meyer (2019b:189) produced a modified construct of a Hub space, which takes into consideration the strengths and weaknesses of previous approaches. Entitled a 'Full Service Design Incubator' shown in Figure 2.2. This model amalgamates key strengths which are characteristics of innovation spaces including Innovation Hubs, Accelerators and Incubators along with the current popularity of a holistic approach to innovation concept development. However, the authors acknowledge that further elements should be added to this model. Particularly if these additions contribute to understanding the interactions between government, universities and commercial organisations working together within a Hub organisational environment (Sharma and Meyer, 2019b:189).

Space
•Shared work space
•Space for prototyping
•Space for activities and events

Visibility
•Build visiiblity of Innovation activities to attract participation innovation actors, including existing small business owners.

Financial Support
•Seed funding for ideas
•Funding for development of ideas
•Build committed financial sources for projects (Angel Investors, Philanthropists, Debt Financing.

Collaborative Partners
•Establish working relationship with Universities
•Estabilsh working relationsihps with commericial organisations
•Build links with government agencies and departments
•Create pathways to access key skilled workers like grant writers, funders, technical experts

Learning Curriculum
•Provision of courses to support innovation development stages
•Grounding in business and design skills

Figure 2.2: 'A Full Service Design Incubator' (Sharma and Meyer, 2019b:93)

Figure 2.2 is useful in setting out the overlap between the main areas of operational purpose and activity within most innovation spaces. This model provides a useful alternative model to help understand innovation spaces, and move the complexity commonly associated the definitional conditions of innovation space terminology.

One area which is not included in figure 2.2 is the specific beneficial outcomes for internal staff who become involved in innovation spaces. Hub environments provide a number of direct and indirect benefits for internal staff (Naughton and Foss, 2019) including improved job satisfaction, organisational performance (Tatarinov and Ambos, 2019, Salzman et al., 2017) and opportunities resulting from access to external actors involved in multi-stakeholder collaboration (Miller et al., 2018). Inclusion of this is a potential way to extend this model, subject to further empirical research.

This section has helped inform the use of innovation terminology for the thesis, and has aided the conclusion that in studying innovation spaces, terminology can cause a distraction away from the importance of the purpose and action of the space, as shown in table 2.2. Thus, reflecting on the contents of Table 2.2, there is the implication that sets of innovation

activities can be designed to meet the distinctive purposes. Different innovation spaces can arise as a way to host activities which have a different aim. The Full Service Design Incubator model (Sharma and Meyer, 2019a:93) shows how the overlap in characteristics of innovation spaces can be combined, and ordered to convey the multiple activities and aims of innovation spaces.

Therefore, as this thesis studies collaborative innovation within a dedicated space, there is the need to understand the actions which take place in innovation spaces. In order to do this is it necessary to understand what a designated space for innovation looks like, what happens in it, who is involved and what are the outcomes. These questions are elaborated on in the rest of the thesis.

To begin addressing these questions, the literature review chapter continues to explore what is known about dedicated innovation spaces, the people who work in them, and their roles. The next section explores the importance of space for innovation environments and subdivides this concept to study key areas in turn.

2.2.2 Exploring the significance of Space for innovation environments

In order to support innovation activity, it is important that sufficient spaces are available to meet the requirements of an innovative facility. Hubs require a 'common space' (Saidi et al., 2017:42) that is conducive to the creative and experimental processes within the early stages of innovative developments. Typically, Hubs use dedicated built spaces for a variety of purposes which all support the innovation process including networking, idea creation, and the creation and development of innovation concepts (Jiménez and Zheng, 2018:95) and fostering the collaborative creativity of participating stakeholders (Fecher et al., 2020). It has been claimed that Hubs enable different types of people to 'connect, collaborate and be inspired in a conducive environment' (Jiménez, 2019:43). It has been found that the use of space within Hubs has been intentionally designed to cultivate creativity through an unstructured layout and semi-industrial, minimalistic style of décor. This can be seen through intentional design elements used to contribute to the development of a distinctive different workspace which encourages creativity, flexible working e.g. 'wooden furniture,

large desks, brick walls, whiteboards, a football table, at least some artwork, shared kitchen spaces, a coffee bar, meeting rooms, and bean bags' (Toivonen and Friederici, 2015:3) and promote stakeholder interaction (Gryszkiewicz and Friederici, 2014a). Typical spaces within a Hub include, individual and co-working areas, a brainstorming/meeting room, quick check-in areas, a communal planning/prototyping area, a reading and relaxation area, and space for presentations' (Saidi et al., 2017:40, Crupi et al., 2020).

The social importance of the use and design of space has been reviewed by Saidi et al. (2017) who explore the importance of design and space to support social interaction and the flow of knowledge and creativity between those using the space. The characteristic design elements of Hubs create 'attractive and novel environments' (Saidi et al., 2017:38). However, the configuration of these spaces is strategically intentional and extends beyond providing a safe space for innovators (Bason, 2010a:97) and an environment to stimulate innovation (Dzau et al., 2013, Kim et al., 2019, Caccamo, 2020). Magadley and Birdi (2009:315) emphasise how the Hub is designed to create, 'a certain ambience that allows creativity to flourish in a space that is stimulating and non- threatening.'

The provision of such a facility is particularly important in the Public Sector where there is a recognised lack of opportunity to become involved in the innovation process, and explore innovation with actors outside immediate Public Sector colleagues (Bason, 2010d:97-98). Moultrie et al. (2007) produced a process model to demonstrate how stages of Hub creation support the use of an innovation space, within a particular operational and strategic context. The model is useful as it connects the aspirational intent of the innovation space to specific action and outcomes, whilst acknowledging the importance of continuous evaluation and physical space. This model helps to demonstrate the complexity of the use and design of the innovation space, and how this impacts the resources and support available to support collaborative innovation. The four stages of the model lead to the 'realised intent' of the innovation space, showing a recognition that stakeholder anticipate the achievement of aims and the production of innovation outcomes (Moultrie et al., 2007:62).

Given the lack of agreement on defining innovation spaces, for the purpose of this study, Hubs are used as an example of a collaborative and dedicated innovation space. Within this

thesis the term Hub is used to portray a physical space with particular environmental conditions, which functions as a location for multiple stakeholder groups to meet and work collaboratively. The Hub has a distinct organisational culture, which embraces creative experimentation, and provides a range of support services and activities to develop and sustain needs-led innovation projects which respond existing healthcare needs identified by healthcare Users. The Hub connects with internal and external stakeholders and as such forms a central point between a number of different organisations and innovation actors (Bachmann, 2014, Jiménez and Zheng, 2018, Cinelli et al., 2019).

2.2.3 Exploring the location of Innovation spaces

As Hubs function within a wider innovation network of stakeholders, there has been some debate about how best to understand the inner and outer boundaries of the innovation space (Adner and Kapoor, 2016). This has given rise to the concept of an Innovation Eco-system, which illustrates the connectivity between innovation actors and organisations (Carayannis and Campbell, 2009:206) with the Hub as 'the nexus' (Sharma and Meyer, 2019a:641) forming central point of connectivity (Longo and Giaccone, 2017:881-882).

As exploratory studies into innovation eco-systems have developed, the use of this construct has also become ambiguous and ill-defined, prompting studies seeking to review and redefine the term and better understand the component parts (Gomes et al., 2018, Sharma and Meyer, 2019a, Suresh and Karl, 2019). Importantly, the objective of Innovation Eco-systems remains the creation of value outputs, which satisfy the diverse needs of the innovation actors informing the innovation process (Nicolopoulou et al., 2017, Portales, 2019).

Despite some contradicting definitions, commonly there is agreement that an Innovation Eco-system is, 'composed of interconnected and interdependent networked actors, which includes the focal firm, customers, suppliers, complementary innovators and other agents as regulators…. members face cooperation and competition in the innovation ecosystem; and an innovation ecosystem has a lifecycle, which follows a co-evolution process' (Gomes et al., 2018:45).

Within the innovation eco-system, the Hub has a distinct role in providing a space, a built facility and range of activities to bring together and support innovation actors located with the multiple environments participating in the innovation process. The next section introduces and explores the function and characteristics of Hubs.

2.2.4 The importance of location for Innovation Spaces

The placement of a Hub is significant, as the innovation process relies on multiple stakeholders being able to easily access the Hub geographic location (Svensson and Hartmann, 2018), to collaborate (Diez-Vial and Montoro-Sanchez, 2017:1253,1259) and benefit from the facilities available within the space. Consequently 'metropolitan areas' (Toivonen and Friederici, 2015:3) are popular locations for Hubs, given their proximity to key organisations including Universities and commercial organisations (Nicolopoulou et al., 2017:370, Vespestad and Clancy, 2019:134) which have relevance for innovation activity. Areas of America including Boston (Lawton Smith et al., 2016:1422,1434) and Silicon Valley (Berger and Brem, 2016, Berger and Brem, 2017, Liedtka et al., 2017b) as well as Oxford in England (Lawton Smith et al., 2019) are researched to understand the connection between their location and successful innovations (Swain et al., 2017, Berger and Brem, 2016, Berger and Brem, 2017). Similarly, studies are underway to explores factors underpinning the rapid growth of Hubs in developing countries (Sharma and Meyer, 2019a:155-160, Jiménez, 2019).

The geographic placement of a Hub is a significant factor in terms of maximising accessibility to knowledge held within organisations, termed 'institutional anchors' (Owen-Smith and Powell, 2004:17) including universities and other research facilities and commercial organisations with active research and development departments. This enables actors to easily access the space and increases the likelihood of important 'collisions of ideas' (Dzau et al., 2013:1426) and have the opportunity to interact (Vespestad and Clancy, 2019:132-134) . Enabling access for internal stakeholders is significant given the often under used tacit knowledge they possess. Therefore, the ability of innovation spaces to successfully support innovation has been found to correlate with a closeness proximity to the core organisation (Sharma and Meyer, 2019a:87). Where a close proximity exists, accessibility is increased,

particularly for internal stakeholders working within the setting of the parent organisation (Lawton Smith et al., 2016:1426).

2.2.5 Innovation Operations

Hubs do not conform to a consistent structure. The Hub literature identifies some recurrent characteristics which also demonstrate a Hub's purpose, functions and main components. The focus of Hub activities is highly context dependent, but over time commonly evolve their purpose and activities to become increasingly focused, measured and output driven as shown in table 2.3.

Table 2.3 'The Innovation Shift' (Hattori and Wycoff, 2002:27)

First generation (creative platform)	Second generation (creative platform)
Physical creativity centre	Innovation resources part of business units
Focus on ideation	Focus on strategy and value-creation
Employee-oriented	User-centred
Training and facilitation	Team-oriented innovation culture
Individual and monetary rewards	Coaching and involvement of project teams
Individual/small group	Recognition of teams
Creativity tools	Tools scalable to entire organisation
Management passively supportive	Management actively involved

The broad composition of Hub activities can be summarised as the provision of physical space, services and resources to support and shape innovation. An important element of operational work within Hubs seeks to 'refine the process' of innovation through 'social interaction' and 'transactional relationships' with innovation actors who bring different knowledge and resources into the Hub, whilst using the collaborative space to learn and be creative (Sharma and Meyer, 2019a:184). These actions support the development of the innovation environment and spread of innovation capabilities, dynamics and culture (Fecher et al., 2020) through Hub activities which aim to use facilitation and development of

creativity to support Innovation actors to develop innovative ideas (Magadley and Birdi, 2009, Gryszkiewicz and Friederici, 2014a).

As Sharma and Meyer (2019a:89) illustrate in figure 2.3, the core functions of a Hubs can be categorised as the provision of support, management processes and resources which enable the Hub to make connections with and between a range of stakeholders. Figure 2.3 is useful in understanding the complexity of the function of Hubs and the diversity of functions provided within the Hub space. Furthermore, the diagram demonstrates the potential diversity of stakeholder groups who can become involved in or be impacted by the Hub's activities.

Figure 2.3: 'The Hub' (Sharma and Meyer, 2019a:89)

As discussed, the ambiguous and inconsistent use of terminology to describe innovation spaces makes it difficult categorise Innovation spaces. Therefore, when seeking to understand Hubs it is important to seek clarity where possible. Sharma and Meyer (2019b:87-111) construct a diagram of a Hub in relation to the wider Innovation Eco-system activities. This provides an important distinction between other spaces for collaborative innovation and Hubs. 'The Hub is a collection of components that work together with the other elements of the innovation ecosystem in order to help a start-up to adapt and succeed or fail as quickly as possible' (Sharma and Meyer, 2019b:98).

A key operational contribution of Hubs is to use their position as a nexus within a wider Innovation network (Gomes et al., 2018:40-44) to 'enable connectivity' between stakeholders and actors (employees, suppliers, partners and customers) involved Innovation collaborators (Longo and Giaccone, 2017:881). The significance of enabling connection is described by (Gryszkiewicz and Friederici, 2014a) as 'convening groups of people that usually would not "run into" one another, while they are likely to form teams and innovate together once they have found each other'.

A core function of Hubs is the method used to manage stakeholder interaction. This can be understood through a 'Network Orchestration' model of Innovation networks, whereby the Hub 'orchestrates network activities to ensure the creation of and extraction of value without the benefit of hierarchical authority (Dhanaraj and Parkhe, 2006:661). The conceptualisation of the role of Hub shown in this model presents the role of a Hub as managing three core processes with the aim of creating value from stakeholder interactions overseen by Hub staff. The key resource used to achieve this is the tacit knowledge held by network actors (Senker, 1995, Herstatt et al., 2016). This knowledge has the potential to create value when combined in new ways through co-creative innovation. Consequently, the Hub has an important role in managing the mobility of knowledge between actors, whilst ensuring that the individual motives of actors do not create tension or instability within the broader collaborative innovation process (Dhanaraj and Parke, 2006:665-666). The management of Stakeholder tension is explored in section 2.4.1.

Studies into understanding the contribution of Hubs in managing the relationship between stakeholders is ongoing. Hubs have a role in creating and sustaining 'socialisation' between Hub actors through 'community building' (Jiménez and Zheng, 2018). This is achieved through the hosting of events in particular open style hackathons and pitch-nights (Toivonen and Friederici, 2015:5, Boudreau et al., 2011, Liedtka et al., 2017c), the creation of forums and communication mechanisms with a view to cultivating an open and motivated group of people who develop a shared sense of identity (Dhanaraj and Parkhe, 2006:662). The sense of loyalty that can be created through repeated opportunities to interact is important for the effective functioning of a Hub.

Furthermore, efforts by Hubs to create 'relational ties' between core network actors increases trust and confidence (Brockman et al., 2018) aims to increase actors' willingness to share valuable tacit knowledge (Dhanaraj and Parkhe, 2006:665, Senker, 1995). Additionally, as the innovation community becomes more strongly interconnected there are less occurrences stakeholders demonstrating self-interested behaviours like 'free-riding' and 'opportunism' (Dhanaraj and Parkhe, 2006:662) which are destabilising co-creative process and innovation culture. The Hub also has a challenging role in managing hierarchical behaviours which are customary within the typical work environment, but are not conducive to collaborative innovation. The Hub mission in this sense can be described as seeking to 'temporarily unfreeze organisational embedded practices' (Carstensen and Bason, 2012:7). This links to the importance of creating a trusting environment conducive to fostering creativity and experimentation outlined in section 2.2.6.

2.2.6 Innovation Hub staff roles

A vital component of Hub infrastructure are the staff who are employed to form a managerial and administration team based within Hubs. They have a key role in enabling the increasingly popular socially motivated innovation process (Nicolopoulou et al., 2017:375,380). Guinan et al. (2019) respond to a call for additional research in this area of understanding Hub staff roles. There are additional calls for further research to understand the core roles of Hub staff (Garibyan et al., 2020, Dedehayir et al., 2018) and to understand the nature of their relationships with stakeholders (Howells, 2006:725). Staff working within Innovation spaces have a number of duties which can be broadly grouped into areas of project and relationship management (Vallo Hult and Hansson, 2019), fostering opportunities for collaboration and processes to sustain an innovation culture (Guinan et al., 2019:719, Caccamo, 2020:181, 188-189).

Oversight by Hub staff provides structured guidance whilst working to sustain a positive environment for innovation. Staff perform varied roles within Hubs to support collaborative innovation. Strategically their objective is to maximise potential outputs from project teams through creating and managing the dynamics of teams and divergent needs of multiple innovation actors (Liedtka et al., 2017e:3-5, Sharma and Meyer, 2019b:106). Staff have a

broad range of duties within their role which include negotiation, the financing and managing innovation partnerships, relationship management for multi-stakeholder teams where objectives for innovation can differ. This requires a range of business knowledge and experience, and the need to communicate effectively with stakeholder who have competing needs (Salge and Vera, 2012). Additionally, (Höyssä and Hyysalo, 2009:991-992) found that during the innovation process, particularly in the early stages, is a need for the purpose, progress and process of innovation projects to be clarified. The innovation process is often viewed as unclear and 'foggy' by stakeholders who are unfamiliar with the uncertainty within the innovation process.

2.2.7 Aligning Host Organisational Culture within the Innovation Space

The innovation literature makes a distinction between what is needed for innovation to develop and to be sustained, and contrasts this with characteristics of mainstream organisational culture (Büschgens et al., 2013). Hansen and Jakobsen (2006:246) articulate this by differentiating between the 'swamp' of typical work life activities, and the 'creative process' underpinning the innovation culture of innovation spaces. The need to curate an environment with a culture that is conducive to innovation is centred around an accepted tolerance of risk and appetite for creativity. These characteristics do not fit well within mainstream corporations, especially in the public service organisations and therefore limit the potential for innovation to occur (Giannopoulou et al., 2013). Sharma and Meyer (2019a:26) capture a key section of innovation management literature which explores organisational risk tolerance and how this relates to the management of innovation by stating, 'what risk is to corporations, fear is to the people in them.' Within the Public Sector the lack of appetite for risk taking has created a culture of risk aversion, this has impeded using innovation as a way to overcome existing challenges (Torugsa and Arundel, 2017:900).

The conventional management structures are designed to manage and minimise risk through bureaucratic processes and a culture of adherence to routines and rules (Longo and Giaccone, 2017, Hertzlinger, 2006). This creates a fear of failure amongst leadership teams, which filters through to impact employees. Consequently, opportunities for employees innovative are connected to adherence to complex bureaucratic processes (Bason,

2010e:102). This can create 'analysis paralysis' where leadership teams sense a need to innovate, but fear making wrong decisions, causing no action to be taken (Sharma and Meyer, 2019a:27, Liedtka et al., 2017b:14). In mainstream organisational decision making management are judged on the success of the outcomes of their decisions. This causes fear when making decisions around unknown outcomes like in the case of technologically driven innovation (Van Der Ven et al., 1999). Friction often develops within organisations that are seeking to innovation, but are constrained by feelings of risk, fear and potential disruption from innovation which is incompatible with existing organisational processes (Sharma and Meyer, 2019a:28, Dewolf, 2009, Barkun et al., 2009).

Therefore, access to dedicated internal innovation facilities, like Hubs are important to facilitating innovation, by creating a 'benign environment' for innovative risk taking (Ryan et al., 2018:18-22). The importance of the environmental conditions as a core component of enabling and supporting innovative development in healthcare are outlined in the literature e.g. (Dzau et al., 2013). Within Hubs risk is managed differently, beginning with the provision of space which forms an identifiable facility for innovation activities. The motivation for this is to fee internal innovation actors from the restrictions found in the main organisational environment. The espoused aim is to create an environment, a separate Innovation Culture, where different expectations become normalised, and actors to feel reassured that these differences are accepted as part of the innovation environment. Hansen and Jakobsen (2006) suggest that four key cultural areas characterise what is described as 'The Creative Platform' to support Innovation Culture. Their model shown in figure 2.4 outlines 'the 4 Pillars of Trust' needed to separate innovation spaces from 'the daily swamp' of mainstream organisational culture. It is important to create the conditions needed to support key innovation processes including collaboration, free thinking, creativity and experimentation which are often considered in inconsistent with mainstream organisational culture (Carlgren et al., 2016, Sheffield, 2012, Samuelson, 2016, Secundo et al., 2019, Locke et al., 2019).

- Overcome reluctance to share ideas due to prior fears of failure, being ridiculed and accused of wasting time and resources.

- Encourage feelings of security to motivate and inspire participation and ambition for co-created change.

Confidence | Motivation

Knowledge and Experience | Concentration

- Diversity, knowledge and experience removes traditional social patterns built on fear to create a climate for spontaneity of thought.

- Provide an environment where collaborators can focus, without outside distraction enabling free thinking and creativity.

Figure 2.4: 'The Creative Platform' (Hansen and Jakobsen, 2006:246-248)

Without the separation of innovation work from the main organisation it is often challenging for innovators to focus and modify their patterns of thinking away from conventional work-based norms (Magadley and Birdi, 2009:320,322).

2.2.8 Approaches to developing an Innovation Culture

The innovation culture as introduced in section 2.2.7 is an important element of Hubs, and contributes to overcoming the inhospitable conditions for innovation found within mainstream organisational culture (Mohalajeng and Kroon, 2016, Oftedal and Foss, 2019). In addition to the management of risk, a key element of the incompatibility between organisational and innovation culture is the process of idea development, refinement and evaluation. Within the innovation environment Wrigley et al. (2020:176) describe the importance of the innovation environment as a place where there is a design led balance between 'human need, technical feasibility and business viability'. Within healthcare organisations Evidence Based Decision Making (Fitzgerald et al., 2003:219,222, Barnett et al., 2011:5) is the dominant method used to guide and assess decisions taken. This approach requires the provision of detailed data driven information prior to the start of the project,

and at regular intervals during the development process to measure success. This information is then used to assess the success of the innovation by using the data to track and measure effectiveness and costs associated with the innovative venture (McGann et al., 2018).

The benefits of providing access to an innovation facility, with environmental conditions designed to foster innovation is increasingly being encouraged within public sector Hubs (McGann et al., 2018, Björklund et al., 2019:554) and healthcare settings (Salzman et al., 2017, Liedtka and Maclaren, 2018). There is recognition that dedicated innovation spaces can be successful in addressing and resolving complex social problems which involve the priorities of multiple stakeholders, and this is not possible within the environment of the main organisation (Baker and Moukhliss, 2020, Pitsis et al., 2020, Wrigley et al., 2020).

An additional area of literature of potential relevance to this thesis is that on corporate entrepreneurship. This continues to evolve and explores the types of internal initiatives which strategically use internal resources to respond to changes in the needs of stakeholders and the wider organisation (Birkinshaw 1998, Stopforth and Baden-Fuller, 1994) with the aim of achieving increased organisational growth, performance and profitability (Sakhdain, 2016, Zahra et al 2019). Examples include the creation of a new business within an existing organisation and characterises another type of creative microclimate, with different cultural norms than what exists within a large organisation. Markapoulos et al. (2019) study the importance of space, process and strategy in effectively achieving these aims as part of an innovation strategy which seeks to explore the value of shared knowledge. This is achieved by enabling staff to engage in creative experimentation leading to entrepreneurship or intrapreneurship in a distinctly different manner to the dominant culture of the organisation.

Whilst the literature on corporate entrepreneurship is useful in a broader sense, the literature on innovation hubs was chosen because of its focus and relevance on innovation in healthcare. The innovation hub explored in the thesis involved people outside the newly created hub as well as existing hospital staff continuing to perform their roles.

2.2.9 Section Summary

This section has introduced the concept of innovation, and how it is used at an organisational level to support and sustain the delivery of evolving economic and social service requirements. The importance of dedicated innovation spaces, to facilitate and cultivate innovation are found to encourage collaborative between internal and external organisations.

Innovation facilities, like Hubs have distinct characteristics which can support the creation an innovation culture. The features of Innovation facilities are conducive to the development of innovation, and are not commonly found within mainstream organisational settings. These include an accessible location, with an environment designed to support creativity and collaboration. Furthermore, the innovation space provides access to innovation resources, within an innovation environment providing opportunities to for innovation actors to share their perspectives and experiential knowledge. Furthermore, Hub staff are acknowledged as important in supporting innovation project development.

The correlation between Social Innovation, and co-created innovation is introduced in relation to understanding the core the functions of Hubs. Innovation actors who are motivated to innovate to solve societal issues, and organisations seeking to respond to stakeholder requirements benefit from feature of the Innovation space and the environment it provides to support innovators. The suitability of Hubs as a collaborative space for Innovation is explored through focusing on central aspects of innovation environments like innovation culture. These areas will continue to be discussed in the next section which focuses on the role of users as stakeholders, and their contribution to the innovation process.

2.3 Users and Innovation

This section continues to builds on key areas needed to understand collaborative innovation spaces, by exploring the role and contribution of particular group of innovation stakeholders, called here users. This section studies the contribution users they make to collaborative innovation, with particular reference to the context of hospitals. At the outset of this section, it is important to differentiate between stakeholders more broadly and the specific stakeholder category of stakeholders who are also current or potential users of innovations in development.

Section 2.3 begins by exploring how users participate in collaborative innovation, to provide an understanding the role of Users in multi-stakeholder innovation projects. This is followed in 2.3.2 and 2.3.3 with a focus on the context of healthcare innovation. The research focus of the thesis is then studied in greater detail by outlining the significance of users within healthcare innovation. The section concludes by considering the complexity of the collaborative innovation process and how to manage the differing needs and priorities of stakeholders. The differing needs of subcategories of user are explored.

The roles and value contributed by users is an area of growing interest in the literature, where recent studies have focused on the contribution users make collaborative innovation through sharing their tacit knowledge and expectations. Furthermore, users are in a unique position to draw upon their personal insights to assist the development of innovations, ensuring relevance and suitability (Windrum et al., 2016, Shah and Tripsas, 2016, Oliveira and Canhão, 2016).

Recent publications have made a series of interesting contributions to understanding user involvement in innovation within specific sectors, including banking (Harhoff and Lakhani, 2016:15), IT and computing (Garcia Guzman et al., 2013:29) healthcare (Kim et al., 2019:62, Lacy, 2016, Miller and French, 2016:1537, Svensson and Hartmann, 2018:277,285, Vespestad and Clancy, 2019, Ciasullo et al., 2017, Kickul et al., 2019) Transport Security Administration (Liedtka et al., 2017a) social robotics (Hasche et al., 2019:16) and civic government departments (Claudel, 2018:62). These studies have focused on the roles

undertaken by users within collaborative innovation. This has led to the introduction of new user terminology which outline sub-categories of user, and the elements of their innovation roles. These categories reflect the diversity of stakeholders who are classified as users (Schweisfurth and Raasch, 2015). This evolution in understanding the importance of users extends the seminal work of (Von Hippel, 1976) who initially introduced the importance of users' experiential knowledge for innovation efforts. Hyysalo and Johnson (2013:51) encourage the role of users to be viewed conceptually, and define the role of users in collaboration as, '…bridges between people out there and renditions of them relevant for design.'

For the context of this study, the value found within healthcare user's knowledge holds great significance for collaborative innovation in the healthcare sector. The inclusion of the experiential knowledge of users creates many benefits for collaborative healthcare innovation projects. The section will continue to explore this concept by focusing on the sub-categories of user within the healthcare sector.

2.3.1 Exploring the participation of Users in collaborative innovation.

Von Hippel (1986) introduced the term 'Lead User' to convey the necessary level of experience needed to successfully develop and launch 'high technology' products through 'user-led innovation' (Von Hippel, 2005). The market place familiarity of lead users enables them to make experientially based contributions, and provide unique and valuable insight not present within traditional external research and development settings (Von Hippel, 1986:791-792). The role of lead users has been particularly important in informing the development of product and process innovations (Schuhmacher and Kuester, 2012) in the National Health service, and elsewhere in the health sector e.g. (Savory, 2009b, Engström, 2014, Graffigna, 2015, Konrad et al., 2019).

Lüthje and Herstatt (2004:565) address a lack of congruence in research on the importance of Lead Users through publication of the Lead User method process diagram shown in Figure 2.5. The diagram outlines the ways that Lead Users can contribute to the innovation process, at various stages of design and development. The development of 'the Lead User

method' demonstrates how lead users can use their tacit knowledge to support the development of innovation concepts (Nonaka and Von Krogh, 2009) which respond to the societal needs of consumer in otherwise underserved marketplaces (Lüthje and Herstatt, 2004:564).

Step One Start of the Lead User Process	Step Two Identification of Needs and Trends	Step Three Identification of Lead Users	Step Four Concept Design
Building an interdisciplinary team.

Defining the target market

Defining the goals of the Lead User involvement. | Interviews with experts (market/technology)

Scanning of literature, internet, databanks.

Selection of the most attractive trends. | Networking based search for Lead Users.

Investigation of analogous markets.

Screening of first ideas and solutions generated by Lead Users. | Workshop with Lead Users to generate or to improve product concepts.

Evaluation and documentation of the concepts. |

Figure 2.5 'The process of the Lead User method' (Lüthje and Herstatt, 2004:561)

The benefits of including user insights in the innovation process extend beyond enhancing innovation quality, creating competitive advantage for the organisation (Schuhmacher and Kuester, 2012). Organisational staff who are involved as a group of Lead users can also benefit personally from their participation. Extrinsic and intrinsic areas of motivation include intellectual challenge, financial compensation along with satisfaction gained participation in the co-creative process (Lettl et al., 2016:429). Broadly user motivation is centred around satisfying a curiosity and desire to learn or an enthusiasm to creation their idea (Schütz et al., 2019:138, Samuelson, 2016). However, issues can arise when collaborating with users, including the process of how users are chosen, and the management of any intellectual property generated from their involvement (Brem et al., 2018:18, Torrance, 2016, Strandburg, 2016).

The importance of lead users has given rise to research which considers the relative merits of internal and external lead users (Schweisfurth, 2017:239-240). For healthcare the value of the knowledge of internal users, including employees is highly significant for healthcare innovation (Haukipuro et al., 2019:12). Therefore, the development of research into users

who are located within the context of the organisation or sector is significant. Herstatt et al. (2016) explore the role of staff as users, and introduces the term 'Embedded Lead User' (ELU), for users employed within innovating organisation, who are fluent in intricacies of organisational culture and the context of intended use (Herstatt et al., 2016:397,400, Schweisfurth and Raasch, 2015). Additionally, their position between the internal organisational culture and the interaction with external customers creates opportunity for a multi-perspective analysis the impact of design and development decisions. Their position as Boundary Spanners (Herstatt et al., 2016:409-410) generates access to the contextually dependent 'sticky knowledge', (Savory and Fortune, 2015, Von Hippel, 1994) of multiple stakeholder mindsets and their organisational environments (Herstatt et al., 2016:414, Liedtka et al., 2017e, Schweisfurth and Raasch, 2015:176). Within the literature there are calls for additional studies on ELU (Herstatt et al., 2016, Lettl et al., 2016, Hienerth and Lettl, 2017, Brem et al., 2018), their role and the motivations behind their involvement. ELU been identified as a currently are underserved sub-group of users, despite a growing recognition of their importance to collaborative innovation projects.

The following section will focus on the role of users as innovators in the context of UK healthcare. Within the healthcare literature users are divided into two groups, patients and their families and healthcare staff, in particular those with a clinical role. These users are able to convey existing needs-led opportunities for socially motivated innovation (Batayeh et al., 2018, Aakhus et al., 2018, Zuckerman et al., 2013, Savory and Fortune, 2015).

2.3.2 Innovating in response to changing user expectations of Healthcare.

This thesis is set within the context of the United Kingdom and its healthcare system. The British National Health Service (NHS) is the largest publicly funded health system, which has stayed true to its founding objective of offering every UK resident tax funded healthcare, which is free at the point of access (Farchi and Salge, 2017:145). In 2018 the NHS celebrated its 70th birthday (Klein, 2019). This milestone prompted reflections on how the health needs of the population have changed the from post war emergency medicine in 1948 to the continuous, complex and diverse health needs of the 21st century Britain (Dimitri, 2019:185).

It has been suggested that the healthcare system is on the edge of 'crisis' (Doran, 2019:19) due to increased demand and a lack of capacity (time, employee numbers, resources) (Alderwick and Dixon, 2019) within the organisational systems to deliver care and enable staff to have the time and resources needed to meets patient need (Doran, 2019:23). This is situation has been exacerbated by a lack investment into the modernisation of services (Bessant et al., 2019b:232, Klein, 2019:3, Proksch et al., 2019). Health systems, especially in the public sector (Bason, 2010b, Bason, 2010d) operate within complex operational conditions which create constant pressure to change, as a result of 21st Century conditions known as 'VUCA – volatility, uncertainty, complexity and ambiguity' (Burchardta and Maisch, 2019:113).

In addition, organisations are under pressure to respond innovate to meet the technological expectations of society who are accustomed to the increased speed of service, interactivity of emerging digital businesses known as FAANG companies (Facebook, Apple, Amazon, Netflix and Google) which have altered expectations of service delivery (Burchardta and Maisch, 2019:113-114). Increases in the use of technology in daily life has created a desire from patients to access information about their health and treatment pathways. The term patient-facing health information technology (PFHIT), describes products which align user expectation and innovations. For example, digital interactive portals (Kildea et al., 2019) which have the ability to self-report health data as part of remote health monitoring (Sieck and Huerta, 2019, Finch et al., 2006, Barlow, 2017:76). The potential benefits of creating interactive health technologies are vital to create capacity in healthcare processes and contribute to creating a human centred health service, where the patients are empowered through increased interactivity and access to information (Sieck and Huerta, 2019, Wolf, 2019).

Innovation can create changes to healthcare processes and products to better align the needs of the organisation, and its users (Barlow, 2017, Hertzlinger, 2006, Vespestad and Clancy, 2019, Page, 2014). Health innovation has no single fixed definition, but commonly refers to the creation of value arising from improvements to efficiency, safety, quality effectiveness or affordability of healthcare services (Kimble and Massoud, 2017:89, Dewolf, 2009:3). Health innovations can take the form of pharmaceuticals, medical procedures,

surgical devices (Demonaco et al., 2020, Chatterji et al., 2008, Geiger and Hirschl, 2015, Schiavone, 2020:40). Product and service innovations focus on improving the patient wellbeing (Batayeh et al., 2018:15,77, Schiavone, 2020), and patient experience, increasingly through the use of technology (Lacy, 2016, Werder, 2015, Wolf, 2019, Sieck and Huerta, 2019).

A growth in research in this area reflects a shift to a more holistic (Diderich, 2020) healthcare system, which recognises the importance of patient wellbeing (Mittelmark et al., 2017, Bauer et al., 2019, Samuelsson et al., 2019), how to manage the impact of health care on emotional health (Lacy, 2016, Zuckerman, 2016), and improve and support their patient understanding of health processes, referred to as their health literacy (Tones, 2002, Palumbo and Annarumma, 2018, Palumbo et al., 2019). Therefore, health innovation can be defined as 'an evolving system of institutionally bound interactions and pathways of innovation… emerging from the stakeholder interactions, where knowledge and experiences are shared' (Consoli and Mina, 2009:297).

The evolution in health innovation can be seen within the context of the NHS. Studies of NHS policy (Savory and Fortune, 2013, Savory, 2009b) have tracked evolution to the current point of increasingly being 'needs led' decisions (Demers-Payette et al., 2016, Claudel, 2018, Demonaco et al., 2020). In the health service the innovation process is increasingly open to involving multiple stakeholders, broadly termed 'collective endeavours', including internal users like healthcare staff (Farchi and Salge, 2017:148). This shift has modified the job expectations on healthcare staff, who are able to become involved in innovation, and shared collective responsibility by informing and refining the design of innovations (Wrigley et al., 2020:125) and advancing service delivery (Farchi and Salge, 2017:149-150). This has given rise to the term 'user-led' innovation and studies exploring how user knowledge and expectations stimulate innovation projects (Liedtka and Maclaren, 2018, Bogers et al., 2010:62). The socially constructed nature of innovation (Beausoleil, 2018:73), supported by the contribution of users (Liedtka et al., 2017b:12) have been recognised as an important innovation mechanisms within the complex organisational setting of health innovation (Savory and Fortune, 2015:216, Windrum and Garcia-Goni, 2008, Consoli and Mina, 2009).

Furthermore, the central role of innovation in creating capacity to sustain healthcare provision (Clark et al., 2019, Schütz et al., 2019, Hossain et al., 2019, Tiwari and Buse, 2020b) demonstrates the importance of resolving existing issues within the healthcare delivery, to meet care expectations in terms of efficiency, quality of person centredness (Doyle et al., 2013, Adams et al., 2016, Tiwari and Buse, 2020b, Thakur et al., 2012).

2.3.3 Digital Healthcare Innovation

In response to capacity issues, healthcare innovation research is currently exploring how technology can be used to digitalise aspects of healthcare processes and service delivery by using technologically based innovation (Vargo et al., 2015:65, Engmann et al., 2016:5, Iyawa et al., 2016). Technology can be used to address existing issues within the healthcare sector, which are impacting stakeholders. E-health, the umbrella term to describe digital health innovations often referred to as MedTech (Nylén and Holmström, 2015, Kostkova, 2015) using different forms of technology, hold the potential to impact clinical and patient healthcare service pathways and organisational processes (Konrad et al., 2019:162, Kolling et al., 2016).

The promise of Innovation which seeks to integrate technology into the wider health system is anticipated to contribute to ease existing challenges and weaknesses in service provision (Hertzlinger, 2006, Liedtka, 2020). A lack of investment in technology has resulted in an NHS infrastructure has not modernised in line with the 'technological revolution' past 20 years (Tiwari and Buse, 2020b:1). The NHS is therefore facing issues in meeting the diverse needs of users who seek interactive and digitally based communication options. It is anticipated that the development of new devices, tools and processes which use advancements in technology will enable faster, smarter, high quality and more cost effective innovation (Ciasullo et al., 2017:4, Miller and French, 2016) and ease organisational pressures, whilst creating value for the service provider and the user in their role as a staff member or service beneficiary (Lusch and Nambisan, 2015).

Investment into scalable technological healthcare innovations improves the quality of healthcare by increasing access to information for users through addressing gaps digital

patient services which can empower patients and create capacity by reducing dependency healthcare staff (Thune and Mina, 2016, Sieck et al., 2019, Diderich, 2020).

Clinical staff users require technological improvements to enable confidential digitally based communication (Sureshkumar et al., 2019, Tang et al., 2018) which is in line with patient data ethics, safety and risk management processes (Demers-Payette et al., 2016). Clinicians increasingly seek to explore how technology can improve treatment processes through the use of more advanced technology (Geiger and Hirschl, 2015, Dimitri, 2019, Clark et al., 2019) and using technology to reduce patient anxiety through distraction and personal development (Wilson et al., 2016:12-14, Newman, 2017:212).

The importance of increased digitalisation has been identified as an existing need by healthcare staff and patients (Tang et al., 2018, Aakhus et al., 2018, Nambisan et al., 2017). Research has acknowledged that improved digital care pathways can contribute improved patient wellbeing by reducing anxiety caused by a lack of interactivity and accessible information (Proudfoot et al., 2010, Tettegah and Garcia, 2016, Lacy, 2016), especially in the treatment of paediatric patients (Newman, 2017, Dimitri, 2019).

Technology can also be used to enhance and develop medically processes and create and improve products (Samuelsson et al., 2019, Liedtka and Kaplan, 2019). Healthcare managers seek ways of increasing capacity within the healthcare system to treat patients more quickly (Lawton Smith et al., 2016, Kleeman et al., 2017, Diderich, 2020), efficiently (Swain et al., 2017) and cost effectively (Tettegah and Garcia, 2016:17). Patients seek developments in how information is communicated and accessed. Innovation is responding by developing through digital communication processes, alongside methods to access healthcare remotely using e-consultations (Nicolini, 2010, Balicer and Afek, 2017, Liedtka and Maclaren, 2018), and through interactive health products (Schiavone, 2020:30-31) and gadgets (Iakovleva et al., 2019b, Kostkova, 2015, Demonaco et al., 2020).

Technologies that are being integrated into healthcare services include 3D printing, augmented reality (Dimitri, 2019), social robotics (Kolling et al., 2016, Riva and Riva, 2019) and artificial intelligence (Thimbleby, 2013, Liedtka, 2020, Babic et al., 2020). Healthcare innovation projects seek to identify ways to integrate the best use of these advancements

to deliver patient experience and surgical benefits, whilst easing existing organisational capacity pressures by increasing efficiency (Thakur et al., 2012, Swain et al., 2017:160), service quality (Liedtka and Maclaren, 2018) and productivity (Clark et al., 2019). The stages involved in this process are termed digital transformation, reflecting the potentially radical impact that the adoption of these innovations would create for health service processes, structure (Hinings et al., 2018) and key user groups. The following section will consider the involvement of users within a hospital context, and the motivations for their participation.

2.3.4 Hospital based User-led Health Innovation: challenges and key considerations

Hospitals have the potential to perform an important role in user-led innovation, but as organisations, and groups of users, are often unable to embrace collaborative innovation (Thune and Mina, 2016:1545). The healthcare sector is a complex context for innovation (Adams et al., 2011:359, Gulbrandsen et al., 2016:1493) and as such there are many barriers to innovation (Hertzlinger, 2006, Gorman, 2015, Kimble and Massoud, 2017). Stakeholders from companies, universities, government agencies and alongside multiple users are involved in and impacted by outcomes of the co-creative multi-stakeholder innovation process (Windrum and Garcia-Goni, 2008:650). This creates a complex interplay between stakeholders during a process which must balance interdependent needs and priorities (Garud et al., 2013).

It can be argued that Hospitals provide a location and an environment which is suitable to mobilize stakeholder knowledge, alongside the potential to develop, test and revise innovation (Gulbrandsen et al., 2016:1493-1494). The organisational structure of the healthcare systems are complex due to the fragmented multi-level organisational structure of the health services which deliver acute, primary, outpatient, and palliative care in a range of care settings (Doebbeling and Flanagan, 2011, Djellal, 2007:181-182). In the case of the NHS the vast scale and complex organisational structure adds further levels of complexity for collaborative innovation (Vespestad and Clancy, 2019). The NHS comprises of hundreds of healthcare delivery organisations who act semi-autonomously whilst adhering to national standards of the healthcare system (Barlow, 2017, Plesk and Trisha, 2001, Sheffield, 2012,

Klein, 2019). This study contributes to the development of innovation hubs operating within healthcare settings by exploring their structure, purpose, processes and management.

The complexity of the hospital organisational environment and the connection to the ways in which users can inform health innovation is of interest to innovation scholars. Specifically, the factors needed to enable users to contribute to the innovation process by applying their experiential knowledge of healthcare processes and services (Swain et al., 2017, Zuckerman et al., 2013:1113). This insightful knowledge is highly valued, and enables users to contribute to multiple stages of the innovation process (Farchi and Salge, 2017:148, Savory and Fortune, 2015:208,213). These roles include idea generation, product development, testing and user adaption (Thune and Mina, 2016:1546, Djellal, 2007).

There is growing interest from healthcare staff and patient users in using their knowledge and experience to collaborate with external stakeholders to address a historical lack of innovation into the specialized needs of paediatric care (Engmann et al., 2016, Dimitri, 2019). However, a challenge emerges when seeking to manage the digital expectations of users, who seek use of digital pathways previously unused within the hospital environment. The primary purpose of hospitals is the provision of healthcare treatment delivered through a highly regulated (Todt and Lujan, 2014) bureaucratic structure which seeks to uphold quality (Kim et al., 2016), minimise risk (Barlow, 2017) and show compliance with ethical standards (Riskin et al., 2006, Broekman et al., 2016). Therefore, the integration of user knowledge in shaping digitally led healthcare innovations must also seek to comply with ethical considerations informing the healthcare sector whilst maintaining collaborative stakeholder participation.

2.3.5 Healthcare innovation and the evolution of the patient – clinician relationship.

The dynamic between healthcare professionals and patients has shifted to a point of 'mutual accountability' where healthcare organisations respond to patient needs alongside providing diagnostics and treatment (Schiavone, 2020:52) . Healthcare processes have changed to enable open communication with patients as part of a democratization process of the patient and clinician relationship (McNichol, 2012). It has been suggested that the

power balance has shifted from a place of largely one way communication from clinician to patient, where the role of a patient is as a recipient of care, to a point of increased openness where patients can communicate with and be listened to by medical staff (Laudal and Iakovleva, 2019:57). There is recognition that combining clinician and patient knowledge creates value for the innovation process stemming from needs-led novel designs embedded in the local organisational context. This can create multiple stakeholder benefits including improvements to patient experience and sales, revenue and improvements to organisational quality (Thapa and Iakovleva, 2019:111).

The centrality of user needs and patient wellbeing are influencing the development of health innovation. Innovations which are informed by patient users enable innovations to be developed in alignment with their existing needs. This design of user-led technology aims to empower and enable users (Oftedal et al., 2019) to access generic information independently online. This is currently a focus within healthcare innovation projects (Werder, 2015, Tettegah and Garcia, 2016, Dimitri, 2019, Clark et al., 2019, Iakovleva et al., 2019b, Liedtka, 2020).

The way in which patients and their families experience healthcare treatment is an important indicator of the quality of service they receive, and therefore important for organisational reputation (Dewolf, 2009, Kim et al., 2016, Batayeh et al., 2018, Alderwick and Dixon, 2019, Vespestad and Clancy, 2019). In recognition of this, there is a growing body of literature on patient centred care (Engström, 2014, Aakhus et al., 2018, Laudal and Iakovleva, 2019).

2.3.6 The contribution of Healthcare users to the innovation process.

Within healthcare innovation, users can be grouped into two main categories, patients and their families and clinicians. This section will explore the contributions made by these user groups, to understand how their involvement and knowledge is used to influence the development of innovative products.

2.3.6.1 Patient-led Innovation

The tacit knowledge of patients who have lived experience of hospital processes and treatments is increasingly included within user-led innovation projects (Engström, 2014, Oftedal et al., 2019, Oliveira et al., 2019, Laudal and Iakovleva, 2019, Palumbo et al., 2019, Demonaco et al., 2020). McNichol (2012:220) describes key aspects of innovation informed from the perspective of the user, and outlines why their knowledge has value for innovation. Organisations increasingly need to provide a response to changing patient needs and expectations (Ward et al., 2006:97-100.) An interesting study by Oftedal et al. (2019:30-34) researched how the increase and breadth of patient engagement (Schiavone, 2020:63) in the innovation process has given rise to sub categorisations of patient involvement.

Table 2.4: 'Types of patient user' (Oftedal et al., 2019:29)

Type of patient	Description
The Informed Patient	User is actively using sources of information to understand own circumstances.
The Involved Patient	Patient is actively involved in the healthcare sector.
The Innovative Patient	Patient is actively innovating to find new solutions for the problems.

An increase in access to information as a result of digitalisation has enabled 'informed patient' (Oftedal et al., 2019:30-31,62) users to increase their health literacy. As shown in table 2.4, this is enabled by being able to independently access digital information resources which educate patients on aspects of their health condition and treatment process. Through seeking information, patients have been able to give feedback as they become more 'informed' (Oftedal et al., 2019:30-31) to the usefulness of existing information sources and where their expectations were not met (Iakovleva et al., 2019b, Oftedal et al., 2019).

Increasingly, patients are becoming 'expert patients' who give feedback to healthcare staff on aspects of their care (Vallo Hult and Hansson, 2019:593). Furthermore, they have suggestions to resolve the issue they gave faced, in some cases suggesting initial designs for

new products (Demonaco et al., 2020:124) and providing feedback on emerging healthcare treatments for wellness, like social robotics (Kolling et al., 2016:85-86) person centred patient care portals (Kildea et al., 2019) and patient education technology (Lacy, 2016).

Part of the actions shown by, 'innovative patients' (Oftedal et al., 2019:33) is participation in problem solving, which can be seen by involvement in human centred design led projects (Maglio et al., 2015, Van Der Bijl Brouwer and Dorst, 2014, Liedtka et al., 2017b) within Hubs and similar collaborative spaces (Oliveira and Canhão, 2016, Demonaco et al., 2020). These categories demonstrate developments in patient user-led innovation, and the user knowledge can contribution to innovation projects.

This section has shown how the contribution of patients as a group of users has begun to develop and as such, has created an opportunity for patient users to impact the development of health innovations. The experiential knowledge of patients is valuable in informing the development of innovations, and ensuring patient needs are responded to as part of this process. In conjunction with this, the next section considers the role and contribution of clinicians as users in the innovation process, and the connection between patient and clinician knowledge in healthcare innovation.

2.3.6.2 Clinician-led Innovation

Clinician-led innovation also seeks to challenge existing societal and clinical barriers in providing healthcare treatment (Svensson and Hartmann, 2018:281). Clinical staff users, drawn from a number of patient care roles in healthcare, can contribute novel product design concepts (Chatterji et al., 2008) through their ability to recognise and initiate concepts to address existing healthcare needs (Garibyan et al., 2020) in a role which has been termed a 'clinical engineer' (Clark et al., 2019:538). Notable examples include the Doctor who invented the artificial heart, and the 2 Doctors who collaborated to create the Nobel Prize winning MRI scanner (Schiavone, 2020:39). Clinician's knowledge is frequently used to create incremental modifications based on needs identified within their work context (Aakhus et al., 2018:4599, Savory and Fortune, 2013:18, Svensson and Hartmann, 2018:283) this 'intent' to innovate act as a key motivator (Clark et al., 2019:538). Within the

literature Clinicians are cited as the longest recognised and most active group of users. The first instance of recorded clinician-led innovation is from the invention of the stethoscope by a French Doctor Renè Laennec (Schiavone, 2020:38). By transferring an observation from children playing with a stick and a pin in a park, Laennec used the same principle to transfer sound, and give increased privacy to a patient. This method of transfer sound generated an amplification and lead to the creation of a new medical device (Fayssoil, 2009:744). The focus of Nurses in user-led innovation is commonly found in process improvement to benefit the patient experience (Thomas et al., 2016). (Schiavone, 2020:43) found that nurses typically focus on the softer, socially based forms of innovation, whereas innovation led by doctors generally is in the area of medical devices.

Increasingly clinicians are involved in helping redesign healthcare processes to increase predictive and preventative medicine (Dimitri, 2019) whilst increasing digitalisation to support a shift towards patient centred care (Tang et al., 2018, Vallo Hult and Hansson, 2019:588). Clinicians make contributions to this process by sharing detailed experiential knowledge, gained by working within the complex healthcare environment and alongside medical specialists (Savory and Fortune, 2013:76, Aakhus et al., 2018). This insight is valuable given the challenge of meeting the multiple priorities of stakeholders during the innovation design process, alongside the need to be mindful of ethical and regulatory issues (Clark et al., 2019:540, Kluijtmans et al., 2017).

As Embedded Lead Users, Clinicians are well placed to give incremental feedback, using their detailed knowledge of multiple perspectives within the complex healthcare environment. These include clinical medical need (Tang et al., 2018:91), needs linked to the provision of patient care (Newman, 2017), radical medical innovation in emerging areas including sensor technology, artificial intelligence and virtual reality (Schiavone, 2020:28,76). Furthermore, healthcare staff have value tacit knowledge around which can be used to develop innovations which will fit with existing systems and processes (Bessant et al., 2019b:243, Vallo Hult and Hansson, 2019:589) Furthermore, Torugsa and Arundel (2017:905, 908-909) and Claudel (2018:43-44) have initial research findings which suggest that risk in the innovation process can be reduced by the incorporating the vital insight drawn from the experiential knowledge of users like staff.

The value associated with the professional status networks of some Clinical staff present additional value for innovation projects, (Ferlie et al., 2005). This influence as an 'Opinion leader' (Greszczuk et al., 2018:69) can facilitate a number of functions within the innovation process. Greszczuk et al. (2018:71-73) explore the connection between a well-respected clinical position and earn peer recognition as an Opinion Leader. This can be used to educate and generate support amongst peers, which helps overcoming resistance to accepting new innovations (Miller and French, 2016:1542).

Although clinicians have valuable knowledge, not all will want to share ideas, or the skills necessary to think innovatively (Lettl, 2005:170) or creatively (Amabile, 1998:79-82). To encourage users to share their knowledge some organisations have created a role of healthcare staff acting as 'Innovation Champions' (Miech et al., 2018). This involves them using their role and personal motivation to influence attitudes and spread key messages within the organisational and their peer network.

Within literature about clinician-led innovation a few studies explore the link between clinicians as opinion leaders (Greszczuk et al., 2018, Miech et al., 2018) alongside and a creatively driven motivation to be involved in innovation. As described in section 2.2.6 the innovation culture within Hubs creates an environment where innovation actors are encouraged to feel comfortable to experiment creatively. Thus, within a Hub space clinicians have the potential to combine their experiential knowledge with their desire to overcome existing issues affecting healthcare through problem solve in a creative manner (Amabile, 1998, Samuelson, 2016).

The ability for clinicians to introduce novel and creative ideas is further supported by the increasing use of Human Centred Design within Hub strategies. Thus, Clinicians can use their existing knowledge of medical processes, patient needs and the desire to overcome existing societal health challenges by innovating to improve processes and patient experience (Zuckerman, 2016:2). Within the health service, the lack of scope for innovation within mainstream Public Sector organisational culture has led to staff often feeling that their creativity will not be rewarded (Locke et al., 2019:99). Therefore, user-led design is commonly found where there is access to an innovation facility which provides an

environment where creative problem solving is welcomed to address improving health outcomes and as a way to motivate staff (Locke et al., 2019:102).

Previous studies have found that a main aim of the clinicians is to develop technologically driven innovations to enable healthcare services to be delivered in a more efficient and scalable (Vallo Hult and Hansson, 2019:592). This is made possible by using a collaborative stakeholder approach, to maximise available knowledge and resources (Tang et al., 2018). This enables innovation projects to be developed with a view to incorporating novel emerging sources of innovation including Apps, Artificial Intelligence and Virtual Reality. It is important that the design elements of new and modified processes and products for use in the healthcare sector are developed to be compatible with existing system requirements and established organisational culture. Therefore, the involvement of user driven knowledge, ideas and iterative feedback within the innovation process is critical to inform and direct prospective innovations and ensure their suitability for use in the health service. Bullinger et al. (2012:173) calls for future studies which explore innovation that is created from the transfer of clinician and patient experiential knowledge to develop our understanding of the contribution of user-led innovation.

2.3.7 Recognising user needs within Collaborative Innovation Projects.

Differing requirements of user groups can create additional complexity during the innovation process (Barlow, 2017, Cinelli et al., 2019). Within collaborative innovation projects, stakeholders from public sector background including Government bodies and University Research settings, alongside commercial organisations and users all can bring different perspectives, priorities and desired outcomes from innovation projects (Trischler and Charles, 2019). This potential lack of congruence can create practical challenges when seeking to satisfy such diverse objectives and expectations (Ashcroft, 2016, Tietze et al., 2020). The differing expectations of innovation outcomes is a contributory factor in the emergence of stakeholder tension (Liedtka, 2020). However collaborative innovation involves successfully managing complex stakeholder relationships (Stossel, 2017, Ashcroft, 2016).

The next section explores the role of collaboration, and the processes which can support multi-stakeholder working. Section 2.4.1 focuses on how tensions arising from different stakeholder expectations of innovation are managed.

This thesis is focused on dedicated innovation spaces in healthcare and the connected processes, actors and interactions, with a focus on hospitals. Figure 2.6 outlines the roles that hospitals and their stakeholders can have during the multiple stages of innovation. This diagram also demonstrates entanglement of the types of involvement key stakeholder groups have within collaborative innovation, without being users of innovation themselves (Thune and Mina, 2016:1547). This diagram is helpful presenting the scope of the involvement of hospitals as part of the collaborative innovation process, and connecting this to stages of the innovation process, which as this section has shown, in informed by a number of stakeholders including groups of Users.
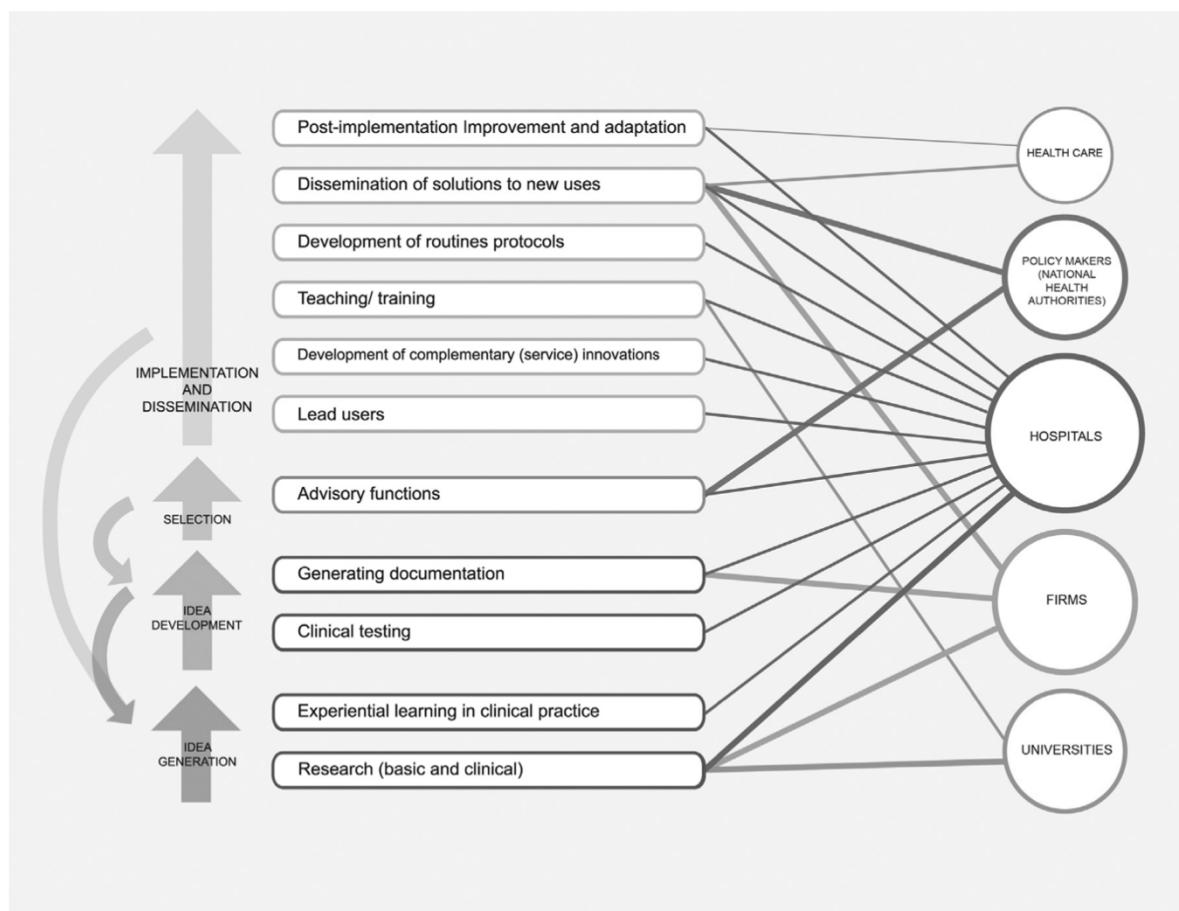
Figure 2.6 'The roles of hospitals in Innovation' (Thune and Mina, 2016:1547)

2.3.8. Section Summary

This section has explored the literature on users, and their roles and contribution to innovation, with a focus on the healthcare sector. The knowledge and experience of users as a way to inform and guide innovation is discussed through the two main categories of user in healthcare innovation, patients and clinicians. The literature outlining the drivers of clinician and patient involvement in innovation are presented, which include the desire for change, stemming from a motivation to extend medical treatment options, to create a more person-centred patient experience and to increase digitalisation of the healthcare journey. The expectations of clinical and patient users for a modernisation of service within the healthcare sector has given rise to a steep rise in digital innovation projects. The integral role of technology and the need to increase digitalisation within the healthcare service is outlined. The section closes by introducing the literature on stakeholder tension, and the complexity of managing multi-stakeholder relationships. These areas form the focus of the following section on collaborative innovation, and the processes and innovation environments which support this.

2.4 Collaborative Innovation: Environment and Processes

This section explores literature that seeks to understand how innovation culture, strategy and processes support collaborative innovation. The previous sections have introduced factors which contribute to collaborative innovation thus demonstrating the potential value generated from effectively combining human and environmental factors. Consequently, the creation of specialised facilities for innovation, of which Hubs are one such manifestation, require suitable processes and supportive management. By managing innovation spaces by providing appropriate environmental conditions for innovation, organisations can facilitate a processes which support stakeholder collaboration (Ollila and Yström, 2016). This provides a position from which organisations can use stakeholder knowledge as a means to innovate and resolve existing challenges (Cinelli et al., 2019:430).

This section will explore Hub processes which support multi-stakeholder collaborative working, and healthcare innovation strategy. Managing the potential value outcomes of the collaborative process is central to the success of Hubs. Therefore, this section will introduce strategic responses to managing issues arising from multi-stakeholder collaborative working. This is an important consideration in this thesis which seeks to understand the contribution of a Hub as a space which provides a suitable environment to enabling collaborative innovation within the complexity of the healthcare sector. Thus, in this section of the chapter literature is explored to present key considerations related to the complexity managing organisational processes which support collaborative healthcare innovation. This is followed by a discussion of the literature on stakeholder tension which can emerge from collaborative working. The section closes by introducing models which seek to make sense of collaborative innovation, whilst considering stakeholder objectives and methods of contribution.

2.4.1 The complexity of managing multi-stakeholder collaboration.

Increasingly key stakeholders and researchers are both focusing on the seeking to improve their understanding of impactful outcomes from innovation projects to understand their value (Kickul et al., 2019, Komatsu Cipriani et al., 2020, Coccia, 2009). Broadly impact can be identified through changes to organisational performance, e.g. improved competitiveness, efficiency and the creation of capacity (Crossan and Apaydin, 2010, Osorio et al., 2019:2), economic indicators e.g. reduced costs and the opportunity to create income from the innovation (Searles et al., 2016) or social factors e.g. improved patient experience and satisfaction with the service quality (Sieck and Huerta, 2019). Stakeholder group often have differing priorities, and desired outcomes from innovation projects (Miller and French, 2016). Therefore, the management of the innovation environment and the processes within it have an important role in supporting collaborative innovation activity (Shapiro and Angelo, 2014, Cinelli et al., 2019).

Herrera (2016:1727) capture the complexity of the organisational elements related to the development of impactful innovation. Figure 2.7 is useful in illustrating how the strategy, purpose and stakeholder engagement have to function as interrelated factors all influenced

by the contextual/institutional drivers. However, to be considered in line with the needs of healthcare Hub, modifications to be model would be needed to acknowledge the healthcare sector and Hub challenges as explored within this review.
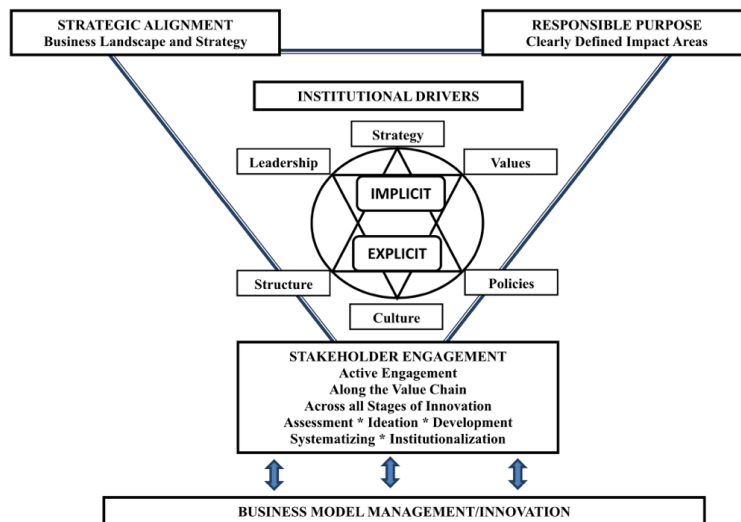
Figure 2.7 Innovation for impact: organisational elements' (Herrera, 2016:1727)

For example, an important additional factor needed on this model is the management of knowledge. For impactful innovation to be created, stakeholder insight and tacit knowledge is needed to develop novel and relevant products and processes. This is particularly important within the public health system of the NHS where the complexity of the institution often results in barriers integrate new innovations. Thus, knowledge of internal users during the development process can be invaluable with a view to overcoming this (Berwick, 2003, Greenhalgh et al., 2004a, Barnett et al., 2011, Parris et al., 2016). A collaborative innovation process is one way that stakeholders can be brought together within team structures to co-create innovation. In this form or organising, a Hub acts as the central point of coordination for stakeholders coming together to collaborate. The different organisational experiences and knowledge of stakeholders can be a cause of tension (Björklund et al., 2019:554,560). Although having a breadth of expertise can positively contribute to innovation projects, the differing working styles, motivations and desired outcomes from the project can cause tension between stakeholders (Besharov and Smith, 2014, De Vries et al., 2016, Longo and Giaccone, 2017). Therefore, the Hub has an important role in seeking to develop shared goals, and common purpose between stakeholders as a

form of 'short term strategy' (Ashcroft, 2016:125). This can be done by Hub staff working to create and manage processes to helping stakeholders articulate their motivations and goals, and encourage stakeholders to align their thinking to accommodate arising differences within a broader shared purpose (Ashcroft, 2016:147-149, Wrigley et al., 2020:176).

2.4.2 The function of Hub staff in supporting Collaborative Innovation

Building on the introduction of staff roles covered in section 2.2.6, this section considers how their role supports collaboration. (Howells, 2006) explored the idea of a core staff function being 'intermediaries' holding a key process and relationship building function, by acting as a 'bridge' to work with and between stakeholder groups, 'transforming' knowledge and ideas, by drawing on prior knowledge. Thus, the role of Staff employed to work within the Hub team can be understood as comprising of a diverse range of duties which support the innovation culture, collaboration of stakeholders and sustainability of innovation projects. Their approach is suggested to be one which recognises the strategic benefits which can arise from design-led collaborative innovation, and therefore approaches the management of innovation projects with a balance of empathy, creativity and rationality (Wrigley et al., 2020:126). Aspects of their role can be categorised broadly as spanning relationship and knowledge management, commercialisation and monitoring of regulatory and data concerns (Howells, 2006).

When looking more broadly in the literature, it is evident that the way that the staff member role is subdivided and categorised differs by study e.g. (Björklund et al., 2019, Dedehayir et al., 2018, Miller and French, 2016). Despite the importance of these roles, studies exploring this aspect the collaborative innovation process are scarce (Guinan et al., 2019:717). The existing literature in this area seems to lack clarity, and would benefit from additional more focused research which contributes additional detail in a similar manner to work done by (Nyström et al., 2014) on roles within Living Labs. Therefore, this thesis seeks to respond to calls for additional studies on staff roles (Howells, 2006, Dedehayir et al., 2018), including those which focus on the strategic role of staff working to support Hubs, within complex organisational settings e.g. (Nambisan and Sawhney, 2011:54, Garud et al., 2013) like healthcare e.g. (Gulbrandsen et al., 2016:149, Thune and Mina, 2016).

A useful overview of key tasks of Hub staff to create processes which provide structure and support for collaborators is captured by Nambisan and Sawhney (2011:43) in their Orchestra model of network-centric innovation. In an attempt to make sense of the complexity of multi-stakeholder innovation many research papers produce new models. When researching this area, the number of models can create confusion and a lack of consistency which impacts research and practical coherence. Thus, models which seek to bring clarity are useful in understanding this subject area. Nambisan and Sawhney (2011:43) suggest that a Hub organisation has two main roles as orchestrator of the wider innovation network. Firstly, Hub staff work to integrate stakeholder expertise to co-creatively innovate, by building on early stage innovation concepts. The Hub staff build processes and structures to support relationship building and successful collaborative working. This includes the creation of processes and policies to support the management of knowledge and fair distribution of intellectual property and innovation value (Nambisan and Sawhney, 2011, Cinelli et al., 2019). Secondly, the Hub has a role as a Platform leader, which involves holding activities to promote knowledge sharing and value creation and coherence within the project teams. As Platform Leader the Hub staff seek to extending innovation concepts and maximising outcomes by enabling stakeholders to participate and enhance the basic idea, through using their skills and knowledge within a co-creative team. The Hub staff lead activities which help generate understanding of the diverse needs of stakeholders and provide an opportunity to develop processes to ensure these are considered. The external commercial and organisational marketplace requirements for the innovation dissemination are also a particular consideration within these activities (Nambisan and Sawhney, 2011:45-46).

More recent research acknowledges the evolution of innovation spaces and the processes within them, including a response to a rapid increase in digitalization within innovation settings and strategies (Nambisan et al., 2017, Tiwari and Buse, 2020b, Kostkova, 2015). Therefore, the core ideas of how Hub staff roles support collaborative innovation have evolved. Crupi et al. (2020) explored how Hubs can use exploit opportunities by using stakeholder skills and knowledge to respond to increased expectation for digital technology in society. Although the paper focused on how Hubs can support SME's, but much of the paper is relevant in a broader multi-stakeholder Hub context. Crupi et al. (2020) introduced

the idea of the Digital Innovation Hub (DIH) and the core role of Hub staff in managing a knowledge driven approach to Innovation, which is supported by the openness of Hub culture and innovative opportunities this produces (Crupi et al., 2020:1272). The DIH team utilised stakeholder skills, resources and knowledge to create collaborative multi-stakeholder teams who employed their skills through a process of digital transformation of products and processes . The co-creative teams enabled stakeholders to share and employ their knowledge by using the mechanism of digital technologies to meet changing operational and customer expectations through their innovation outputs (Crupi et al., 2020:1264). The Hub staff were responsible for working as project managers, seeking to capture any generated Intellectual Property, which supported the Hub by providing a sustainable competitive advantage (Crupi et al., 2020).

Crupi et al. (2020) suggested that the role of DIH staff can be understood by appreciating the processes employed in managing the 'physical collaborative environment' of the Hub alongside their role as Knowledge Brokers. This role encompassed the 'transfer and translation' of knowledge amongst stakeholders as 'unconnected actors', to support the sharing and integration of ideas and experiential knowledge. Hub staff developed and managed a number of strategic processes which targeted valuable stakeholder knowledge for innovative creative development. Through 'knowledge brokering', stakeholder relationship management, and strategic visioning Hub staff actively fostered connections between stakeholders with the objective of developing sustainable working collaboration and promoting knowledge sharing. The overall objective was to 'create sustainable competitive advantage' by 'sharing and transforming' the knowledge of stakeholders, to innovate and meet their digital expectations. This was achieved by strategically managing stakeholders as sources of knowledge, and using the collaborative model and environment of a Hub to support the collaborative development of innovation. The processes created and actioned by Hub staff commonly required the use of management and interpersonal skills to successfully supervise Hub processes and policies which seek to influence, facilitate, negotiate and mediate between stakeholder as connections are developed.

Furthermore, Hub staff had a strategic role in leveraging partnerships with external actors, to extend opportunities for creating innovation value. Their competency as knowledge

brokers and 'fluency' in the language, processes and priorities of multiple stakeholder groups informed their role as key decision makers of complex project based decisions. The strategic oversight this knowledge informed the main services and activities offered within the DIH by the Hub staff to support collaborative innovation (Crupi et al., 2020:1272).

Crupi et al. (2020) introduced the idea that the environment of a Hub provided the opportunities for Hub staff to implement a process called 'Digital Imprinting', whereby the unique founding characteristics of the Hubs were used to add value to innovation activities. Hub staff had the strategic objective of designing and managing processes which used the skills, knowledge and professional credibility of founding Hub members, along with the reputational integrity of the parent organisation to 'imprint' and influence innovation activities. Where Digital Imprinting existed Hub staff supported the Innovation process by working both as Knowledge Brokers between stakeholders to leverage and sustain co-creation, and to manage the value arising from the Hub as a Knowledge Source. This extends the importance of their role to include responsibility for raising funds, conducting market intelligence, managing the innovation project development and raising internal and external awareness of the Hub as a valuable source of, and space for person centred collaborative innovation.

The extent to which a Hub environment was successful in facilitating positive outcomes from these key tasks was linked to the style and methods of leadership used by the Hub staff. To sustain the innovation culture of a Hub, Hub staff needed to balance arising opportunities arising for impactful innovation with the inherent risks of a collaborative innovation process (Sharma and Meyer, 2019a:96). The breadth of responsibilities for Hub staff are extensive and can become 'overwhelming and exhausting' (Sharma and Meyer, 2019a:97). Findings from Crupi (2020) outlined in this section provide justification to support this finding. Therefore, a Hub team usually appointed, managed by an Executive Director who was responsible for the financial stability of the Hub projects. Elsewhere in the literature this role is termed the 'Eco-system leader' with key responsibilities for governance, managing the innovation space, building partnerships and capturing value created (Dedehayir et al., 2018:22). The Eco-system leader role is supported by staff in operational and supportive roles within the category of 'expert', 'champion', 'entrepreneur',

'sponsor' and 'regulator' who use and develop policies and processes to support aspects of the collaborative innovation process (Dedehayir et al., 2018:25-26).

It is asserted that Hub staff create and implement policies to stabilise and sustain collaborative innovation projects (Howells, 2006:720). Effective communication and project management are necessary to strategically manage innovation project teams. Guinan et al. (2019:719-722) found that staff who approached managing co-creative teams by focusing on a culture of continuous learning were often successful. For example, using the Hub as a 'psychological safe zone' where staff could create an environment that encouraged stakeholders to change their perceptions, embrace design led thinking and embrace a continuous learning involving cycles of risk taking and reflection (Guinan et al., 2019:722-723). However, the extent to which this is made possible is likely to be influenced by competing agendas amongst stakeholders within the Hub, this will be explored within the empirical work.

A fundamental objective for Hub staff was to build strength and purpose amongst stakeholders who originate from different organisational backgrounds and held differing priorities for innovation outcomes (Kickul et al., 2019:223). This approach involved Hub staff working to generate a sense of shared responsibility amongst stakeholders to demonstrate a responsible and ethical approach to the sensitive knowledge they are exposed to during the collaborative process (Riskin et al., 2006, Von Schomberg, 2013, Schwartz, 2014). This required Hub Staff to understand the ethical and regulatory constraints within the healthcare sector, and use this knowledge to guide the innovation process (Todt and Lujan, 2014). The culture of health innovation, particularly where emerging new technologies (see section 2.3.3) are used required Hub staff to provide support through the implementation of processes. The aim of this involvement was to implement a guiding structure to underpin the exploratory innovation process (Wrigley et al., 2020:176). This was necessary to balance the behavioural norms within different stakeholder groups, potential risks factors of innovating using new knowledge along with the benefits of using 'science for society' to develop 'challenge led science and innovation (Owen et al., 2012:778). Therefore, key role of Hub staff was to support innovation, to ensure that the innovation process was able to develop whilst being conducted in a responsible way. Howells (2006:725) called for future

research which explored the range of functions carried out by intermediaries, like staff, to understand the nature of their relationships with stakeholders, and their place within collaborative stakeholder innovation.

2.4.3 Managing collaborative innovation projects in a responsible manner

Within the health sector, efforts to encourage innovation projects which take into consideration ethical and responsible decision making align with changes in attitudes towards what constitutes effective healthcare provision (Samuelsson et al., 2019, Fecher et al., 2020, Laudal and Iakovleva, 2019, Demonaco et al., 2020). Currently, the UK healthcare service seeks to operate a patient centred model of care, whilst remaining mindful of an active need to increase operational and financial efficiency (Kickul et al., 2019:221). Thus, the notion of socially responsible healthcare reflects efforts to strengthen the sustainability of the healthcare system which is under increasing operational pressures (Owen et al., 2013). The financial challenges of meeting rising levels of demand and expectations for increasingly sophisticated healthcare treatments is exacerbated by limited organisational capacity and resource (Bessant et al., 2019b:232, Demers-Payette et al., 2016:189). Furthermore, the notion of what constitutes providing quality healthcare has evolved to the current more holistic focus on patient centred treatment. This includes growing medical consensus that healthcare involves supporting factors influencing achieving patient long-term wellness as opposed to purely treating medical symptoms (Batayeh et al., 2018:15).

Pressures in the healthcare system create opportunities for Hub users to respond with innovative approaches design and support new models of healthcare. As part of this innovative process hub staff need to voluntarily consider ethical and regulatory risk factors (Demers-Payette et al., 2016:189). The overall objective is to develop innovations that address the needs of healthcare stakeholders and manage stakeholder behaviours linked to unethically pursuing financial reward (Thapa and Iakovleva, 2019:110, Naughton and Foss, 2019:198-199, 211,214).

2.4.4 Understanding the drive for increased sustainability in healthcare innovation

The importance of sustainably designed innovations includes foresight and planning during the design phase to enable future modifications. This contributes to increasing the sustainability of the innovation and aligns with efforts to prolong the relevance of the innovation in light of continually evolving societal and organisational needs (Fischer, 2014, Braithwaite et al., 2017, Pereno and Eriksson, 2020). Health Innovations which demonstrate these principles of sustainability are increasingly valued as they reflect a respect for person centred healthcare, and indicate responsible design and development practices (Schütz et al., 2019, Hossain et al., 2019). The management of innovation projects, to ensure cohesion with the longer term strategy of sustainable healthcare provision is an emerging area of responsibility for hub staff. The way in which the innovation environment is managed, and the processes and policies developed within a Hub are of integral importance to supporting the delivery of healthcare in a sustainable manner (Fischer, 2014:299,301, Coccia, 2009, Palumbo et al., 2017). The notion of sustainability brings together a number of key elements impacting the healthcare sector and the importance of innovation discussed in previous sections.

In summary, the rising demands on healthcare organisations to meet the increasingly complex and diverse needs of a growing population, alongside developments in technology and user expectation for access to digital health services are influencing the healthcare service (Braithwaite et al., 2017:1) and methods of collaborative design (Jones and Kijima, 2018). Increasingly healthcare is being designed more holistically to reflect the importance of addressing the wellbeing needs of patients, rather than a sole focus on treatment of their medical condition. To achieve this, health innovation is central to the development of suitable processes and products, within the restrictions of available healthcare budgets and organisational resources (Pereno and Eriksson, 2020:2).

Consequently, research is ongoing to better understand and connect the necessary components which enable collaborative healthcare to achieve its objectives. The emerging appreciation of outcomes resulting from sustainable healthcare strategy is aligned with how stakeholders working on collaborative innovation projects are managed. Furthermore,

understanding how to responsibly manage stakeholders working within a co-creative innovation space has been recognised as integral to the development of an economically, socially and environmentally sustainable healthcare system (Diderich, 2020, Palumbo et al., 2017, Pereno and Eriksson, 2020). For example, understanding stages of developing a strategy which will support collaboration should understand how to sustain balanced networks of stakeholders. This is a prerequisite to forming collaborative teams who can participate in human centred design innovation projects (Bühring and Liedtka, 2018). The environment of a Hub provides a suitable space to experiment, test and pilot ideas and products whilst raising awareness of sustainability issues effecting stakeholder groups. Figure 2.8 demonstrates how Hub processes developed can be used to strategically support the development of sustainable healthcare practices (Pereno and Eriksson, 2020:16).
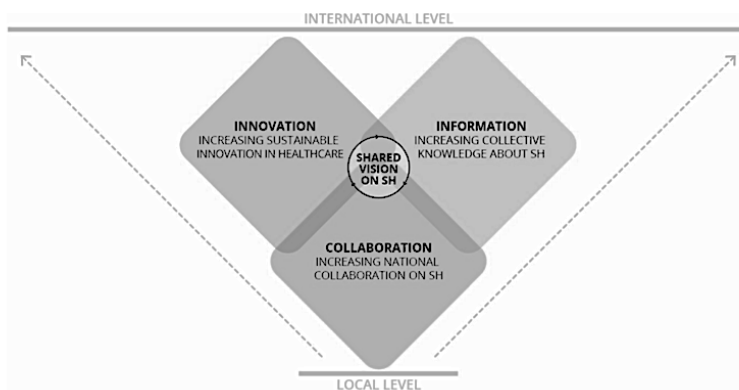
Figure 2.8: 'Visualisation for the three strategic areas of enhancing the transition towards the long term model of sustainable healthcare' (Pereno and Eriksson, 2020:16)

For collaborations to be successful it is important that stakeholders have opportunities to share and discuss their priorities during the innovation development and design process (Robert and Macdonald, 2017:127). This approach is evident within the patient centred model of sustainable healthcare provision (Jones, 2013). Thus, the processes and characteristics of innovation environments are important in supporting and sustaining collaborative innovation. The collaborative and needs-led design methods currently popular within innovation environments enable a holistic innovation processes, which is open to recognising diverse stakeholder priorities.

The healthcare sector has become receptive to working collaboratively with external stakeholder groups. This increased openness has required a change in process to enable collaborative processes to become possible in what is traditionally a complex, bureaucratic top-down organisational structure. The emergence of dedicated spaces for innovation has introduced new processes which support multi-stakeholder collaboration.

2.4.5 The ways in which collaborative processes are changing

As collaborative innovation becomes more commonplace in healthcare innovation, studies seek to understand the roles undertaken by stakeholders working in multi-disciplinary teams, and how knowledge is shared and created. Savory and Fortune (2015) and Windrum and Garcia-Goni (2008) explored the interrelated nature of stakeholder relationships and how these inform innovative change in healthcare environments. The suitability of Hospitals as locations for innovation spaces which in turn, develop and diffuse innovations have also been researched to explore how organisational structure and behaviours effect the implementation of person centred needs led innovation (Salge and Vera, 2012, Djellal, 2007). As innovation in healthcare has become decentralised, a more user-led, 'bottom up' (Savory and Fortune, 2015:215, Thapa and Iakovleva, 2019:109) way of working has begun to emerge. This can enable internal stakeholders, like users, to have opportunities to apply their knowledge to inform the development of technologically driven healthcare services and products (Consoli and Mina, 2009) supported by input from key external stakeholder groups (Savory and Fortune, 2015:203-204).

Studies have researched and classified the way in which knowledge to inform innovation is generated. Initially knowledge generation within the NHS was typically Mode 1, meaning that knowledge came from a top down approach, and a purely scientific research source (Savory and Fortune, 2015:208). As collaboration has become more commonplace, the ideas and knowledge of internal and external stakeholders have contributed to the continued development of the process of multi-stakeholder working in conjunction with the broader decentralised of the innovation process (Carayannis et al., 2018:151). Thus, knowledge generation has shifted from being purely research based, to incorporate a practice based elements in alignment with Mode 2 knowledge production processes (Savory, 2009a:150).

Research studies have documented the increased involvement of university and industry innovation actors as stakeholders in the innovation process, and how the interactions between them and government enabled collaborative innovation. The connectivity between these three stakeholder groups was termed 'The Triple Helix' model of innovation (Etzkowitz and Leydesdorff, 2000, Etzkowitz and Leydesdorff, 1995, Etzkowitz, 2002, Etzkowitz, 2003). The role of innovation spaces, like Hubs as 'boundary spanners' between organisations in the Triple Helix model became of increased interest in understanding the dynamics of collaborative stakeholder relationships. (Van Geenhuizen, 2016:80) Stakeholders began to contributing to innovation more broadly, extending the application of their knowledge by undertaking new roles.

Universities and other research organisations became increasingly more entrepreneurial by becoming involved in activities other than research which had a benefit to innovation (Tuunainen and Knuuttila, 2009, Giannopoulou et al., 2019). These included the training of students, and the ways in which research knowledge could be applied in practical contexts, supported by the creation of Technology Transfer Offices (Etzkowitz, 2003:301,319,333). As the collaborative ties continued to develop, Universities began researching problems in conjunction with an industry partner (Etzkowitz, 2003:321). As a result a number of new types of intangible value outcomes began to be recognised as holding research and organisational impact (Ryan et al., 2018:16). In some Universities and Hospitals this broadening of tasks led to organisations becoming known as hybrid organisations as a way to recognise that their function and nature of tasks had evolved from its initial focus (Miller and French, 2016). Consoli and Mina (2009) also refer to the changes in the process of innovation in healthcare, suggesting that the combination of stakeholder interactions are creating a complex, yet valuable system of interactions which drive cycles of health innovation. This process, termed a 'Health Innovation System' in their research paper has evolved to enable iterative contributions of stakeholder knowledge and feedback to be incorporated into the innovation process. This is suggested to be an example of an evolution in medical processes which reflects an appreciation of the competencies of stakeholders, and the potential value found in using these contributions to inform developments in healthcare innovation research and eventually impact clinical practice (Consoli and Mina, 2009).

2.4.6 Section Summary

This section has explored how process is used within Hubs to support collaborative innovation. The complexity of ethical and regulatory considerations and the competing agendas of stakeholders are used as examples to justify the implementation of processes to stabilise and sustain innovation projects. To manage these processes effectively, the role of hub staff are studied. This outlined how management processes and policies were used to manage stakeholder interactions and bring alignment to disparate stakeholder aims. Hub staff used a number of processes to influence stakeholders into developing shared goals for innovation. This was particularly important as collaborative processes within healthcare innovation are changing as a result of the decentralisation of Innovation process. This has led to additional stakeholder perspectives being included within the innovation process. An example of this can be seen through changes to collaborative innovation processes which seek to enable a direct response to existing needs, stakeholder expectations and unmet operational demands. Hub staff performed an important role as Knowledge Brokers to manage processes which support knowledge led innovation by accessing, transferring and using valuable stakeholder knowledge to drive collaborative innovation. Hub staff can support innovation by using leveraging processes to increase the sustainability of healthcare services, and produce valuable competitive advantage through the generation of intellectual property.

Although there are many advantages to working collaboratively with stakeholders, tensions can emerge related to responsible use of sensitive knowledge and conflicting priorities for innovation outcomes. Therefore, Hub staff have an important role in supporting and resolving arising challenges as part of their management of innovation projects. As acknowledged in the literature, there is currently a lack of research which explores the outcomes of Hub staff involvement in Hub co-created innovation. As such there are calls for further research, particularly in complex organisational contexts where innovations carry a high potential risk factors (Savory and Fortune, 2015, Kim et al., 2016, Ciasullo et al., 2017, Höglund and Linton, 2018). Conducting focused research in this area would contribute to answering the research question which seeks to understand how multi-stakeholder collaboration is enabled as Hub staff have a core role in all aspects of this process.

Furthermore, this research provides an opportunity to understand findings of Crupi et al. (2020) within a Healthcare Hub that is also prioritising the advancement of person centred digital innovations.

2.5 Chapter Summary

This chapter analysed key concepts within the health innovation literature, to shape the subsequent agenda of the thesis. The chapter critically reviewed the decentralisation of Innovation process, and role of collaborative innovation within the context of healthcare Hubs. Currently in this context, innovation efforts are used to combine new technology and stakeholder knowledge to address complex organisational demands. Therefore, the potential benefits of using emerging technologies are being explored. Furthermore, innovation efforts seek to influence healthcare pathways and increase person centred healthcare. The overall objective of this holistic approach to healthcare delivery seeks to create good health. Thus, health innovation projects aim to address the broader emotional wellness needs of the patient. The use of a multi-stakeholder approach provides new types of resource to use in addressing current gaps in digital technology products. Through including a user voice in the healthcare innovation process patient expectations and wellbeing issues connected to a lack of digital resources have become better understood at an organisation level. Increasingly patients expect access to digital resources. Therefore addressing changing patient expectations has emerged as a main needs-led driver of healthcare innovation projects.

In support of this, the decentralisation of innovation has opened up the innovation process, encouraging stakeholder collaboration and sharing of knowledge and resources. This adds complexity to the innovation process, and opportunities for research to understand how collaborative healthcare innovation is managed. Exploring the contributions of end users as important healthcare stakeholders is a current area of research interest. In specialised fields like paediatric medicine, user knowledge has an essential role in conveying distinct surgical and wellbeing requirements of patients and staff.

The highly regulated and risk averse organisational culture within healthcare organisations are not conducive to collaborative innovation. One approach to overcoming these barriers is the use of dedicated facilities. One such example are Innovation Hubs, which provide dedicated space, where an innovation culture can develop. The Hub's experimental environment provides a space to share ideas and appreciate stakeholder motivations. The formation of multi-disciplinary teams enables stakeholders to address existing needs through a user-led innovation process. The flexiblity within the Hub's innovation culture accommodates multiple stakeholder needs, supporting users socially focused expectations alongside organisational pressures to increase efficiency (Miller and French, 2016) and increased sustainability of the health service (Coccia, 2009, Fischer, 2014, Braithwaite et al., 2017).

The emerging literatures within this thesis span a number of research areas, each presenting opportunity for further contribution. Therefore, the research agenda of this thesis draws motivation from an ability to respond to calls for research in a number of areas. First, the complexity of the Healthcare sector provide an opportunity to understand the importance of dedicated innovation space in this context. Second, the environment of a hospital based Hub provides a suitable facility to explore Hub development in a focused manner, contributing to research on user-led innovation and the role of Hub staff. Third, the roles, motivations and contributions of clincians in a co-creative Healthcare Hub will be explored. Finally, this study will critically examine the use of innovation process used within a dedicated innovation space.

Chapter 3 Methodology

3.0 Introduction

This chapter presents the research methodology used to generate new empirical data for use in the thesis. The aim of the chapter is to explain the research design, and provide justification for methods used to gather and analyse data collected.

The chapter begins by considering the literatures and theories that informed the research, and influenced the focus of the research aim. This is followed by section 3.2 which outlines my epistemological and ontological positions and how they impacted research design. The research design is outlined and justified in section 3.3. In section 3.3.5 the process of data analysis is presented. Section 3.4 considers research ethics obligations. In section 3.5 challenges faced during data collection, and limitations of the methodology are outlined. Section 3.6 presents a reflection of the use of participant observation as part of the methodology. The chapter concludes in section 3.7 with a chapter summary.

3.1 Informing theory from the literature review process

I began the thesis process by spending time reading peer reviewed three and four star journals to ground my research approach. To establish an initial understanding of academic debates informing the thesis, I undertook an extensive search of peer reviewed academic journals. Using the Discover database and Google Scholar a number of keywords were used to search existing literature, to find relevant journal articles and recently published books. Initial search terms were broad and included 'Innovation Hub', 'Innovation Management', 'Health Innovation' and 'Collaboration and Innovation'. Reading the papers generated a second, more specific group of search terms. These were used to conducted a focused review of the literature and included: 'digital innovation and healthcare', 'user-led innovation', 'collaborative innovation models' and 'stakeholder knowledge and innovation'.

The search produced a large number of results due to the breadth of the keywords. To maintain an orderly approach, journal articles and book references were organised using Endnote referencing software. This software helped to create a searchable library of papers

with key information. Additionally I used the EndNote software to create sub-groups of papers, and add notes during the reading and review process. I then used Endnote software to help select the most relevant papers for crafting the direction of the thesis. By considering keywords, publication date and the ranking of the journal and the contents of the abstract 671 papers were selected for further detailed reading. A thorough review of these papers was undertaken, during this process I made notes on each paper and highlighted core themes using a colour code system. This helped to identify themes that emerged across studies within different literatures, alongside areas identified as needing further study or an additional search of the literature. Once I was satisfied that a comprehensive literature review had been conducted, papers were grouped into themes using keywords, and a list of core themes emerging from the papers was produced. This information was used to inform the first draft of research questions to frame the research focus of thesis.

3.1.1 Introduction to data collection site

During the process of conducting the literature review, I began immersing myself in the data collection site. The research had been funded to support the study of a pre-identified case study site. I spent one day a week for six months at this data collection site (a hospital innovation hub) to fulfil the funding requirements of the study and begin to understand the research setting.

I observed the day to day activities of the innovation hub. I spoke informally to core staff and visiting stakeholders and attended staff internal meetings. These activities provided opportunity to build initial rapport and gain an insight into staff and stakeholder roles in the Hub. This contact provided insight into the structure, processes, innovation culture and broad work areas within the Hub facility. Over time I was able to observe internal meetings that focused on addressing arising management issues. Detailed notes were kept during each visit to the Hub as a way of recording observations and my subsequent reflections on Hub activity.

3.2 Research Philosophy

The research was guided by social constructivist perspective, I agreed with the philosophical view that there are multiple interpretations of reality, and no one single truth. This research aimed to understand and build knowledge of the innovation hub being studied, through talking to key stakeholders and conducting observation in the hub facility. This philosophical position acknowledges that the process of gaining this knowledge would be a constructed process informed by the interpretations of individuals; my interactions within the case study setting, and the experiences of stakeholders working within it. Therefore, by adhering to the principles of social constructivism I recognised my qualitative data would be influenced by multiple interpretations of reality; my own perceptions, and the opinions of interviewees working within the specific social context of the research setting. This process of interpretation of the Hub case study setting was abductive in nature in that it entailed moving between concepts derived from the literature review (Chapter 2) and a thematic analysis of the data (cf. Van de Ven, 2007).

Consistent with this epistemological position, the analytical process used in this study was that of Template Analysis (King, 2012). To the extent that this process starts with a priori themes (the "Initial Template") derived from a reading of relevant literature then it has a deductive character. However, as the analysis proceeds then inductive reasoning is evident as observational and interview data are coded in order to extract and identify patterns and connected meaning. This inductive reasoning process supports the generation of new theories to explain the social processes within the Hub. Thus, this research approach guided me in how to integrate extant research with the interpretations and experiences of interviewees along with my own subjective observations and notes. A detail statement of the analytical process is explained in section 3.3.5.

3.3 Research Design

This section will explain the research design and incorporate the methods of data collection and analysis. The research questions outlined in chapter one were informed by outcomes of the literature review, which provided a focus for the study and data collection plan. I was

able to decide on key stakeholder groups from the Hub environment to interview and formulate a semi-structured interview protocol of what to ask them. Interviewing multiple individuals participating in the Hub enabled me to generate a case history. Empirical data was analysed thematically so I could discern patterns of activity related to Hub management.

3.3.1 Case Study Methodology

I used a qualitative case study methodology in this research as this was an appropriate method to support the exploratory nature of my research questions. In the absence of existing empirical case studies on paediatric public sector Hub. I adopted a case study methodology which is suitable when exploring new phenomena and the generation of associated constructs and their inter-relationships (Eisenhardt, 1989). I collected data from a variety of Hub stakeholders in order to build up a rich picture of the creation and operationalisation of a healthcare Innovation Hub. This approach enabled me to capture and document innovation management practices as they emerged in the Hub facility (Stake, 2005).

3.3.2 Data collection methods

The purpose of data collection was to capture the perspectives of key stakeholder groups working in and with the Hub at the centre of this research. Data was collected using two qualitative research approaches (semi-structured interviews and observation) which are outlined below.

3.3.3 Data collection – semi-structured interviews

Using key themes that emerged from the literature review, I constructed a semi-structured protocol of open questions to encourage stakeholders to share their opinions and experiences on themes relating to innovation management in a healthcare context. This generated rich descriptive data comprising of personal insights and perspectives of Hub stakeholders. Each interview question was crafted to connect to a theme identified in the

literature as being significant. Some questions were based on exploring the a priori theme of hospital based innovation hubs, that were important to understanding to fulfil the initial funded research brief. The semi-structured nature of the interview process enabled research participants to contribute additional thoughts which they felt were relevant and connected to the questions. The diverse background and priorities of research participants enabled the inclusion of a wide variety of innovation agendas that connected them to the Hub and which was of value to the theory building nature of the research.

The full list of potential interviewees was compiled based upon my introductory visits to the Hub. The intended research participants included hospital board members, hospital staff, innovation hub staff collaborating organisations and innovation project participants.
I complied an anonymised list of those invited to participate, indicating their stakeholder background to ensure that a representative sample of stakeholders was maintained. Focusing on hospital employees provided the opportunity gather data from a number sub-groups, namely senior clinicians, junior clinicians, nurses, Hospital Board members, and non-clinical staff referred to as Professional staff in this study. The professional category of stakeholders includes hospital staff working in administrative, fundraising, educational and holistic care programme management roles as well as the range of roles undertaken by Hub based staff outlined in section 4.3. In addition to these participants, a Hub staff member recommended that I included some participants and organisational collaborators from their SME focused development programme. This presented the opportunity to speak to NHS staff working at a regional level and participants of one of the Hub projects. Due to the sensitive nature of the healthcare setting, it was not appropriate to enter the hospital wards or speak to patients and their families. Therefore, as the research focuses on users, research participants in a direct patient-facing role within the hospital were also identified as prospective interviewees. I conducted twenty five interviews lasting 40 – 60 minutes that I transcribed verbatim. Each interviewee was given a pseudonym to maintain anonymity.

The interview questions used are shown below:

1. Can you briefly describe your role and its link to innovation?

2. Do you feel as though innovation is well thought through and implemented within the NHS? Can you give me some examples of this?

3. How do you feel recent digital innovations within your work environment have impacted the service you can provide?

4. Thinking about the provision of healthcare within this hospital, can you give me an example of how patient experience or wellbeing maybe supported through the use of a recent innovation?

5. Much effort is currently focused on digital health applications and tools which can be as part of their patient experience, how do you feel about this ?

6. Do you feel that there are any obstacles present when implementing innovations in the hospital that resulted in reduced impact, uptake or success?

7. The NHS has been criticised for being organisationally difficult to impact, given its complex structure. From your perspective, how would you support the dissemination of innovations within an NHS hospital?

8. Including the ideas and experiences of people outside the hospital is an increasingly popular. How can the Hub best balance multiple perspectives when striving to improve healthcare through being innovative?

9. What capacity for innovation do you feel there is within the hospital? Is it an environment that reacts well to new technology and changes to core processes?

10. Increasingly innovation requires a team of people from different organisations work together towards an innovative goal. How do you feel that culture of the NHS will be understood external organisations and will this collaborative working?

11. What should the role of innovation be within an NHS healthcare setting?

12. What do you feel are the most important considerations before embarking on a collaboratively led innovation project?

13. In your opinion, how do broader NHS strategies and funding schemes to encourage and facilitate innovation activity across the NHS?

14. In your experience how could the uptake of innovations be improved, and a reduction in the failure rate of launched products be achieved?

15. Thinking about recent innovations you have experienced can you explain why a particular innovation that has been successful in integrating itself into your working environment?

3.3.4 Data collection – observation

As a secondary method of data collection I employed participant observation. As outlined in section 3.1.1 I attended the Hub regularly which provided opportunities to observe innovation-related activities taking place in the Hub facility (Bogdewic 1999). I was able to record data from a number of informal Hub gathering attended by Hub staff and clinicians. I kept a research diary of my observations and notes which were included as part of the thematic analysis of findings. I was able to attend Hub staff meetings where I observed discussions on operational and management issues which gave insight into issues of stakeholder tension and approaches to project management. I was also invited to attend informal Hub staff meetings where staff shared problems they were experiencing with colleagues.

3.3.5 Data Analysis Process

This section explains the methodological steps used to conduct a thematic analysis of the empirical data. Template analysis was chosen as a way to approach thematically analysing the data as this method allows the researcher to examine large volumes of detailed textual data to inform the development of codes to be used during the analysis process (King 2012). I used interview transcripts and written fieldnotes as the main data sources. The final thematic categories provided a structure for the presentation of the empirical findings and a discussion of the same. The steps followed to conduct the template analysis will now be outlined.

3.3.5.1 Data handling

The first stage of the analysis process required the transcription of interview audio files. I transcribed the tapes to help immerse and familiarise myself with the data. Each transcription was saved as a word document, using a pseudonym to preserve the anonymity of the interviewee. A total of 25 interviews were transcribed, generating 356 pages and 216,598 words of data.

The literature review examined general concepts in Innovation Management to guide the search for data. The empirical strategy was to collect data on how innovation was managed using an interview protocol constructed from core innovation concepts. These concepts were also used in the analysis process as *a priori* codes: Organisational Culture, Policy and Strategy, People, Process, Purpose, Product, Performance, Promotion and Partnerships and Collaboration.

The analysis process began by printing out the transcripts, which were then closely read to identify where the a priori codes linked to content in the text. Relevant quotations in the text were highlighted on the transcript using a colour coding system, one for each priori code. I also made annotations in the margin of the transcript to record additional emerging themes. This approach, referred to as memoing was used to inform the crafting summary statements for the 1st order themes (Birks et al, 2008).

NVivo software was used to electronically mark up the transcripts to create a digital version of what had been achieved on paper. This helped to organise all the highlighted material from multiple transcripts and formed the foundation of the thematic analysis process. After using the software for this stage, I realised that I preferred to use a paper based rather than digital process for my analysis, and therefore stopped using NVivo at this point.

3.3.5.2 Stages of the thematic analysis process

Stage One

Template analysis generates patterns in qualitative data by means of an iterative and flexible coding process (King, 1998). The process of template analysis seeks to develop increasingly focused templates to demonstrate the evolving connectivity between core themes in the data (King, 2012). King (1998) recommends breaking the data sample into three groups as a way to make the coding process manageable, and enable clustering of related quotations.

In line with the process stages outlined by King (1998), I selected a representative sample of four transcripts as the first stage of creating a template. The transcripts were selected on the basis of choosing interviewees from different stakeholder groups to provide the widest range of perspectives possible. Using a paper copy of the transcript the data was then methodically interrogated for evidence of *a priori* codes. Relevant quotations linked to *a priori* codes were highlighted on the transcript using a colour based key.

Once this process has been repeated for each of the four transcripts a long list of quotations had been produced. Each quotation was written onto a post-it note, and then the post-it notes were organised into groups of similar ideas and assigned to an appropriate a priori code where possible. The post it notes were then stuck in their clusters onto a large piece of paper around the appropriate priori codes, which had been written onto the paper.

The aim of this stage of the analysis is to develop an initial overview of the data. By using paper and post-it notes, a picture of significant and recurrent patterns in the data from multiple transcripts began to emerge. This helped me to understand and establish connectivity and relationships between disparate perspectives of stakeholder interviewees. I then reviewed the clusters of quotations and crafted summary statements to convey the main idea from the group of quotations. These summary statements are known in the analysis process as a "first-order themes".

In line with the method developed by King (1998) this process was repeated for a further six transcripts. I carefully re-read the transcripts and highlighted quotations were assigned to existing quotation clusters where appropriate. Where ideas differed from those found in the initial stage of this process a new cluster was created and assigned to an a priori code where possible. Any quotations that were not able to be clustered were put to one side and later assigned to a new, additional code. This process was repeated for a third time, to include all remaining transcripts. The outcomes of this process was the identification of first-order themes for use in the analysis process. One additional code, 'Value/Impact Signs and Measurement' was identified as needed to enable quotations that did not fit with the a priori codes to be clustered.

The three stages of the template analysis process are useful when the data set includes complex and lengthy transcripts. Conducting the analysis using a three stage approach makes the coding process more manageable. It also helped me to reflect on the data when organising important quotations into clusters. The three stages of the template analysis process enable the clustering of quotations to be reviewed and regrouped as needed to ensure the template is an accurate reflection of the interpretation of the data collected. This means that the stakeholder perceptions and priorities that emerge from a close analysis are reflected in the crafted summary statements used as first order themes.

To show the outcomes of this stage in the analysis process a summary table named "Template Analysis Stage One" was produced in MS-Word. This table shows the crafted summary statements as first order themes, organised by *a priori* code. One additional code was added as a result of conducting the template analysis process: Value and Impact Signs and Measurement. This code was crafted using the analysis process to provide a suitable way to cluster quotations that did not fit with the existing a priori codes. This code also has summary statements crafted from the transcript quotations. The actual results of the analysis are presented in Appendix One 'Template Analysis Stage One'. Summary statements are marked with one of three icons to indicate at which of the three template analysis stages the summary statement was crafted.

Stage two

The aim of next stage was to reorganise the first-order themes to create alignment with the innovation hub literature review categories: Management of Hub, Collaborative Spaces, Collaborative Processes, Innovation Outcomes and Organisational Context/Climate. This enabled alignment between the empirical data and existing academic areas of innovation hub research and ongoing debates in the literature identified as significant for this research project.

In order to track the elaboration of the data structure between stages in the analysis process the *a priori* codes from Template Analysis Stage One were each given an abbreviation, and all the first-order themes assigned to the code were annotated with this

abbreviation. For example all first order themes from within *a priori code* "Organisational Culture" had the abbreviation 'OC' added at the end, to provide a link back to the previous stage of the analysis process.

Once all codes from the Template Analysis Stage One table were abbreviated and marked up, each first-order theme was considered in turn to see where it fit best under the innovation hub literature categories. The actual results of this stage of the analysis are presented in Appendix Two titled "Template Analysis Stage Two". All the first-order themes from Template Analysis Stage One are in Template Analysis Stage Two, but just organised in thematic categories drawn from the innovation hub literature.

Stage Three

The third stage of the analysis process was to discern the fine structure or "sub-categories" within each of the main categories. Working through each of the main categories in turn, each of the associated first-order themes were reviewed, and those expressing similar ideas were then clustered. These clusters or "sub-categories" were given a label. The result of this clustering process is shown Appendix Three "Template Analysis Stage Three". The left hand column shows output of Stage 2 with the first-order themes grouped into the main categories. The right hand column shows the clustering of first-order themes into sub-categories to provide focus and fine structure within the broader category.

To complete the analysis process a final table was produced, named "Final Template Analysis Summary Table" shown in Appendix Four. The purpose of this table was to present data structure (main analytical categories and sub-categories) from Stage two and three of the analysis process. This table could be used to provide a structure for the contents of the subsequent findings chapters (King, 1998). The final template aims to present how the connections between the empirical findings can be used to support answering the research questions which underpin the thesis.

3.4 Research ethics obligations

I followed the University of Liverpool process to obtain ethical approval for my research design. Once ethical approval was obtained, I began preparing to begin the data collection. In accordance with research ethical procedure prospective interviewees were contacted by email and invited to participate. Information about the research project was provided to enable the potential interviewee to have time to consider if they wanted to participate, and if they agreed, their informed consent was documented.

The majority of interview participants worked within the hospital and therefore, as interviews were arranged during their working day, a meeting room in the Hub provided a private and easily accessible location. Some Hospital Board members, and external research participants preferred to use their own office or a café as this fitted better with their work schedule. I informed my supervisor of the time and location of the interviews to comply with research ethics guidelines.

When the interview time was arranged participants were provided with a participant information sheet and a consent form. Providing time ahead of the interview for participants to review these documents, was an important part of complying with the University of Liverpool Research Ethics process. To ensure that informed consent was obtained, if the interview was arranged in person, hard copies of the documentation were provided, with electronic versions used if initial contact was via email. Where initial contact was via email, the study was introduced, and the voluntary participation of key stakeholders was simply explained to show why the I was interested in meeting with the recipient. If the recipient was agreeable a suitable time was arranged. During correspondence, I asked for agreement for the interviews to be recorded on a voice recorder, with notetaking used where the participant preferred. All participants were assured of that their anonymity would be preserved through the use of pseudonyms. At the end of each interview I debriefed the participant be outlining how the data would be stored and used in the study. I offered to provide a copy of the interview transcript to provide the opportunity for the data collected to be reviewed, and any parts omitted, or the data withdrawn if they were not

comfortable with its inclusion. I was mindful of the need to adhere to University policy on research conduct and integrity at all times.

Some difficulties occurred in meeting with interviewees at the planned times given changing priorities in their diaries. Some senior board members and clinicians due in theatre rearranged or postponed their interviews at short notice which prolonged the data collection period.

3.5 Challenges and Limitations to Research Methodology

The single case study focus of this research and sample size of 25 interviews presents a limitation in terms of generalisability of findings. However, due to the lack of studies of health based innovation hubs, the depth of the insights provided by interview participants does not detract from the contributions made by this research, and provides a valuable contribution of a focused health innovation hub study.

The use of semi-structured interviews enabled data to be gathered on a wide range of innovation themes related to collaborative healthcare innovation in the Hub space. Using this approach enabled varied insights and additional content the participant thought relevant to be captured as part of the interview process. Although this approach was beneficial in collecting data of extensive scope, it meant that the analysis process was time consuming. Furthermore, the variation in content of transcript meant that not all participants gave equal attention by way of contributions to all interview questions. This created some limitations during the analysis process when contributions from different innovation actors were being coded. The challenge of a relatively small sample size could be resolved by extended data collection, or gathering data on a longitudinal basis to enable changes in the Hub collaborative activity to be recorded over time. If a larger sample size was required, additional Hub stakeholders could be recruited, if sufficient time was available to allow for frequent rescheduling of interviews due to arising urgent work commitments.

The healthcare delivery roles of many interview participants provided a challenge in terms of access, as finding suitable times to conduct data collection was highly influenced by their workload. Additionally the schedules of Hospital Board members were often changed at short notice. This impacted both availability of interview participants and the number of attempts undertaken to complete an interview. For these reasons some interviews were rearranged multiple times or did not take place despite confirmed interest in participating in the research. This meant that it was necessary for me to be mindful of maintaining a representative sample of interviewees when changes were made to the interview schedule.

3.6 Reflections on the methodological use of participant observation

Including a participant as observer component to my research design enabled me to use the 'at a glance' (Cunliffe, 2003:998) approach to explore the theme of space within my research through first-hand experience of social interactions in Hub space. By spending time each week in the Hub, I was able to take fieldnotes to record how Hub spaces functioned and build rapport with Hub stakeholders. Becoming an expected visitor each Thursday helped to show myself as a consistent and trustworthy figure. This helped interviewees to be comfortable in sharing their thoughts and experiences during interviews (Waddington, 2004:155,162). Dedicating time to participant observation also provided me with opportunities to take extensive notes and interact informally with Hub stakeholders. This was helpful as I was able to consider my observations alongside narratives from interview participants relating to Hub space and environment gathered during interviews, to build my understanding. I used my fieldnotes when I was critically reflecting on my data, particularly regarding the differences between anticipated and actual use of Hub spaces. The insights I gathered first hand were drawn upon in the analysis to help develop and present an understanding of how people used space to work and interact within the Hub.

As healthcare hubs were under-researched in the literature I wanted to understand if the organisational context influenced space usage. The broader Hub literature characterises them as lively environments for multi-stakeholder interaction. This informed my view of what to expect in the healthcare Hub. Yet, by thinking reflexively, I was able to challenge

these pre-conceptions and ideas through using observational and interview data which suggested that use of hub space was impacted by the context specific factors.

I was advised by Hub staff that there would be most activity (staff in person presence) in the Hub on Thursdays and so I regularly visited on this day. I did not challenge this advice and so it is possible there would have been some merit also visiting on other days of the week.

Given the ethical issues related to the hospital context, I was restricted to collect observational data within the Hub facility. Therefore, I was not able to directly observe changes in clinicians' behaviour between the Hub and hospital settings, as reported by interviewees themselves. The observations I recorded align with the 'narrative' and 'naturalistic' approach often used in exploratory case study research (Simons, 2014:463). Direct observation enabled me to record details of Hub meetings (date, time, place, attendees and overview of discussions) and the use of space by people from different stakeholder groups. I recorded the level of interactions I witnessed in Hub spaces I was able to cross-check participant narratives on space with my notes. Although the observational fieldnotes aimed to add descriptive detail, there will inevitably have been some judgement in how I recorded what I observed, particularly details regarding my perceptions of the Hub environment. As the observation was overt it is possible the behaviours I witnessed were influenced by my presence. I attempted to mitigate this through establishing rapport with Hub staff and being transparent about the purpose and type of data I was collecting.

Thus, the value of the participant observation method in this thesis was both empirical and confidence enhancing. First, I found having access to both observational fieldnotes and interview transcripts helpful when interpreting my empirical data as there was no archival data available with which to triangulate my primary data. Thus having two sources of empirical data was important when writing the discussion chapter as it gave a basis from which to add and challenge existing literature. In this research participant observation was a minor part of the methodology, yet has the potential to be used more substantially in future research depending on the research design. Second, having a presence in the hub allowed me to develop relationships with staff which subsequently enabled a better understanding

of the fieldwork setting and important trust building for face-to-face interviews (Ciesielska et al 2018:45).

The combined collection of empirical data and the relationship building with people in the Hub enabled me to reflect on the data collected from the interviews and develop a more holistic account of innovation hub activity. The observational data was used through chapters 4 and 5. Although the data collected from interviews provided the overwhelming body of evidence used, the observation process and additional evidence helped underpin the validity of the analysis and main results.

3.7 Chapter Summary

This chapter presented the research methodology used to design the collection of data in this thesis. A justification for the approaches used in research design, data collection and data analysis were provided. The chapter explained why a qualitative enquiry and an inductive strategy were a suitable way to collect data and align with the research objectives. The chapter continued by outlining the significance of outcomes from the literature review to provide conceptual themes to inform the creation of research questions and a semi-structured interview protocol. The chapter described factors informing the study design and justified approaches used to gather and analyse data and adhere to ethics procedures.

The results of the analysis process are presented in two findings chapters. In chapter four a case history is presented of the chronological development of the Hub facility, the Hub space and role of Hub staff. The actual results of each stage in the template analysis are then presented. The main findings chapter follows, and is structured in terms of the main themes in the Final Template. A detailed presentation of findings are given in five sub-sections: Management of the Hub, Collaborative Space, Collaborative Process, The impact of NHS culture and climate on Innovation Hub and Innovation Outcomes.

Chapter 4 Case History

4.0 Introduction to the Hub: a case history

This chapter uses data gathered from the empirical research to present a chronology of the Hub's development. The aim of the chapter is to present the Hub facility its history, spaces, and core actors. This chapter shows how the case study site presents a number of operational characteristics that are not commonplace within healthcare facilities. Beginning with the planning stages of the Hub, the chapter introduces the unconventional factors leading to the Hubs creation. The chapter contributes to the thesis by illustrating how the Hub was founded and began to establish processes and design spaces to support collaborative innovation projects. As the Hub became established the operational issues that emerge are outlined. The chapter concludes by introducing these process and space issues, and outlining how this research contributes to understanding factors which could support their resolution.

The chapter is presented in five sections, in section 4.1 the founding elements of the Hub facility are introduced. The location and use of spaces within the Hub facility are described. Section 4.2 explores the vision behind the Hub, and the drivers behind its creation. Section 4.3 presents a descriptive chronology of the Hub team. This continues in section 4.4 which focuses on understanding the intentions of Hub innovation projects, by presenting process development and the three approaches used within projects. A conclusion of the chapters main findings is provided in section 4.5.

4.1 Establishing the Hub Facility

This section will begin by introducing the geographic and physical location of the Hub used to collect empirical data. The Hub is located within the main hospital campus of a NHS Foundation Trust hospital, nationally recognised as leading provider of paediatric care.

In terms of the organisational location, and positioning of the Hub it is important to consider elements of the broader hospital strategy and operational position. The first of these is the openness to commercial strategic principles, '*The Foundation Trust hospitals were*

formulated under the Blair years creating a more business focus, so they understand business, income and expenditure etc. The board tends to operate broadly as a Board of Directors, its slightly different to the private sector but has the intention that you are it, it's not somebody else's job outside to run it' (Clive, Hospital Board).

It is also relevant that the hospital has a clear organisational strategy, implemented throughout the organisation from Board level downwards, '*when we set the vision strategy for this organisation, we aim to become Internationally recognised, world class, leading in paediatric healthcare. To do that you need great facilities, great people, … great research, stable money, but you also need great innovation now we are slowly putting these pillars together* (Clive, Hospital Board).

Innovation is within the hospital's strategic objectives and as such, the centre of the hospital's innovation work has found a location within the creation of an Innovation Hub (the Hub). The Hub therefore can be linked to wider organisation goals, but the physical location of the Hub in terms of its accessibility from the main hospital is also significant. The Hub's position facilitates easy access for hospital staff and external stakeholders. Although the Hub is part of the main building structure, it is accessed through a separate dedicated entrance. This albeit small separation from the main hospital environment maintains easy access for staff, whilst providing a different environment and organisational culture, both of which support innovation activity.

A senior clinician noted, '*…the physical role of the Hub is to give people a little bit of a phase shift it their head. When you are in here you shouldn't be thinking like a clinician, you should be being a bit more experimental…. on a ward I am conditioned to behave differently. I am not in a high risk, let's have a go at this, kind of frame of mind. Whereas down here I am, it's the setup, its rough and ready, very changeable and it is in the hospital but it's not really in the hospital, and it's a place where I can bring people* (Tim, Senior Clinical).
When visiting the Hub as an external visitor its proximity to a hospital adds authenticity. Furthermore, the distinct facility and its environment create a suitable meeting place which is not subject to the strict protocols of the main hospital building. The Hub is accessed by walking through a public external courtyard garden accessible from the main hospital

atrium or via an external gate. The door to re-enter the building, and access the Hub is found directly off the outside courtyard, and is linked to the hospital swipe card system for internal staff use or via a doorbell for external visitors.

In terms of physical space, the Hub is a 1000 square metre single level space. A short metal stairway leads from the entrance down into the Hub facility, a large enclosed area without windows. It has a grey concrete floor, exposed electrical metal work and air-conditioning pipework and a number of concrete support columns. This stark interior has prompted the informal use phrase 'The Bat Cave' to describe the Hub (Tim, Senior Clinician).

On entering the Hub, it is immediately apparent that the space has been divided into zoned areas which each provide a different purpose, and suggests multiple purposes for the space. A display area with proto-types of products and pull-up exhibition display stands provides a showcase of current projects, and shows where there is collaboration with external organisations. A small area is used by an independent firm working with 3D printers to provide medically useful models of complex medical conditions, created from patient scans and data. It houses their printers, desks and IT hardware and a display table of 3D printed models. This equipment adds to the environment of the Hub as a space for creative, technology based innovation. William who works for the firm suggests that their presence also acts as *'a 'showcase' every time a visitor comes (in the Hub) they see our stuff – it is easy to understand. What we do has a machine which makes everything really cool'* (William, External Professional).

The visual interest provided by the 3D printers helps to break up the floor space, a large part of which is occupied by desks, some with PC computers. This is used by a core non-clinical Hub team of 10 staff and by 4 clinical staff who hot desk within the space on a semi-regular basis, subject to the demands of their clinical role within the main hospital. The Hub is also used by a number of other project collaborators on a less regular basis. The Hub is also visited by members of the wider Hospital Board on a regular basis, particularly when they are hosting special visitors. The Hub welcomes internal and external visitors who are attending Hub and wider hospital meetings and events. One area that can be used for events is immediately adjacent to the desk space. This area is used as flexible space, with

furniture to accommodate events and presentation set up as needed. When not used for events, Hub staff use the sofas for informal internal and external meetings.

Around the perimeter of the main Hub floorspace are a number of additional spaces. A small kitchen and access to toilets are close to the Hub entrance. Two meeting rooms are located directly off the main Hub floorspace, furnished with sofa seating and screens for presentations. A smaller room has been set up as a child's bedroom with the help of an external corporate sponsor to enable products in development to be tested in a simulated environment. The two largest rooms are used for their intended purpose and as additional flexible space. At the time of data collection, the first of these rooms was used as a more formal meeting room, with a large table and chairs to seat 10-15 people. At times this room has housed externally loaned interactive technology which has a number of interactive capabilities, including providing a surface for drawing and design and the ability to support multi-stakeholder video conferencing which is an important communication tool to support multi-stakeholder collaboration.

The second large room is used to house sophisticated technology developed by the local University engineering department as part of an ongoing partnership project into the use of virtual reality and pre-operative planning for complex surgery. The room shows prominent branding to demonstrate this partnership for Hub visitors. The room is also used as a flexible space for meetings and events as there are no staff permanently working from this space.

The photos below show the Hub environment and the 3D printing area to showcase types of print possible and what they can be used to show. The glass windows lead into one of the meeting rooms, and the grey doors lead into meeting separate spaces.

Figure 4.1 'Images from Hub space.'

These photos show the hub floor space, and the 3D printing display area.

4.2 Vision and opportunity: Understanding the origins of the Hub facility.

In this section a number of key terms are used to describe people who are working within or connected to the Hub. The table 4.1 defines how these terms are used and provides a differentiation between these groups of people.

Table 4.1 Terminology used to describe groups of people linked to the Hub.

Term	Definition
User	Patients and their families and hospital staff as users of the hospital and healthcare resources, products and processes.
Hub staff team	Staff who work in the Hub as their main job, as opposed to clinical staff who work in the Hub one day a week as a secondary role.
Hub team/team	The collective team when it is not necessary to differentiate between the Hub staff team, clinical and non-clinical staff.
Clinical staff/ Clinician	Staff who have a clinical care role within the main hospital as a Doctor, Surgeon, Nurse or similar.
Non-clinical staff	Staff who work in an administrative, finance or management role.
Stakeholder	Individuals from organisations who have a connect to or are invested in the Hub but do not use the services of the hospital in a practical way.
Interview participant	An individual who answers the researchers semi-structured interview questions.
ERDF participant	A person who participated in the Hub ERDF project for SME innovators.

This section presents how the innovative vision of hospital users, staff and the Hospital board were facilitated by opportunities which arose during the construction of the new hospital building. The origins of the Hub are shown in conjunction with key factors that informed the developmental process of the new hospital and its vision, and the formation of Hub itself.

The origins of the Hub facility are found with the development and construction of a new children's hospital, replacing an older outdated building. In 2016, after years of planning and development, the hospital moved into the new building . The role of user consultation during the planning process of designing the new building is relevant to the Hub as it reflects a desire to meet the needs of users, and therefore was guided by extensive user

consultation. The view of users informed the use of space and design characteristics of the new hospital. The Hospital Board took this approach in recognition of a need to think innovatively about how to satisfy user requirements. A key driver in developing the new hospital was to meet the changing needs of paediatric hospital users, namely patients and their families and hospital staff.

A Board Member reflected, *'This building is a symbol of the fact that a hospital should not look like a hospital. That is what kids said to us, and they were really clear about that, the number one message, and that is how we ended up with this, because we let them design it. Now if we had designed it we would have built at 'hospital' without a shadow of a doubt'* (Christine, Board Member)*.*

Within the hospital two areas which demonstrate how this aim has been achieved can be seen, firstly through the inclusion of new technologies that support paediatric patient experience. Secondly, how patient ideas on design have contributed to create a hospital where users practical and holistic needs are recognised within the building and surrounding green spaces. The new hospital building contains a number of innovative features which are continuing to be updated and added to with additional interactive technologies to support and communicate with hospital users. This demonstrates how important a commitment to recognising user needs is as a part of the organisational culture of the hospital.

A Board member commented, *'I think a lot of our focus is moving towards physical and mental health. I think we like to pride ourselves on thinking that we have always taken a holistic view of children when we are caring for them…. so thinking about the emotional aspects of healthcare and what children experience'* (Christine, Board Member).

The next section will explain how the Hub originated and its early stages of development from within the wider planning and development of the new hospital building. The process behind how the Hub facility began, is again a consequence of arising opportunities and the vision of key Hub actors.

The Hub itself originated from within the developmental stages of the hospital, yet coincidentally not as part of the planned space, as a Hub staff member explained, *'Were we given this Hub because when they designed the hospital they felt that 1000 square metres is exactly what we needed? No, it turns out that we didn't need the air handling space and the person who knew that first was also the person responsible for innovation, bingo, we have a space….'* (Jeremy, Professional Internal).

In fact, the Hub emerged opportunistically, demonstrates an existing interest in innovation, and a desire to create a dedicated space for innovation within the new hospital building rather than use the space for other purposes. This vision for innovation pre-dates the new hospital building, and creation of the Hub facility. The founding members of the Hub team were all clinicians apart from hospital one board member. They had begun work on some initiatives to bring about innovative change within the old hospital building.

Prior to the move into the new hospital building, part of the existing Hospital strategy was to be responsive to user needs. A leading example of this was the creation of Ward Chefs, changing the way meals were provided to patients in the Oncology ward of the old hospital, to better meet their needs and reduce waste. This emerged as a consequence of user consultation with paediatric patients.

A Hospital Board member explains, *'…we used to do something called Investors in Children… sitting down with groups of kids and saying what would make your life better…, they said that central kitchen thing just doesn't work for us, /…/so we said ok, would it be helpful to have something on demand? Oh yes! So we thoughts let's try it, so we just put a couple of chefs on that ward and it started to get legs, it really took off, it was fantastic'* (Christine, Board Member).

Building on the success of this idea, within the new hospital plans, Ward Chefs were incorporated into every hospital ward. This demonstrates the Hospital Board's strategic commitment to meeting user needs and improving their patient experience. The innovative strategic mindset of the Board is evident within the Hospital's long term strategy documentation. Significantly for the development of the Hub, a strategic focus on

innovation is identified as a mechanism to help achieve its vision of being a '*world class centre of paediatric healthcare*' (Clive, Board Member).

Therefore, an advert for an external commercial partner organisation was released to help develop an '*innovation methodology to inform the strategy and culture of the hospital for the next ten years*' (Roger, Board Member). The successful external commercial partner invested time and existing industry expertise in digital technology into a collaborative working arrangement with the hospital. The hospital contributed by recruiting a new member of clinical staff (Tim) who was a skilled surgeon and also had an interest in digital innovation for healthcare. Alongside his clinical duties, part of his role was driving the integration of technologically based innovations into the hospital, to enhance the patient experience and better meet user needs. The initial stages of this visionary work began in the months prior to the move into the new hospital.

A small team of hospital staff began work on innovation projects on a part-time basis using space within an old ward space. When Tim was recruited, he was joined by two clinical nursing colleagues (Peter and Graham) on a part-time basis and the Board Member (Roger) who worked on innovation ideas, linked to the concept of 'service transformation' (Roger, Hospital Board). The visionary ideas of Tim and Roger were influential factors in satisfying Board members that using this space as dedicated facility for the hospital's innovation work would support the hospital's broader strategic objectives. The aspirations for the dedicated innovation space were founded on the objective '*…that you have ideas coming from the hospital, … staff, or patients or parents, and then.. people outside the organisation, companies or individuals or universities that have got things that they are trying to work on, so if you could pair the two things up maybe they could work together?*' (Roger, Hospital Board). This aspiration can be seen as the initial indications of the Hub's approach to innovation; multi-stakeholder, focused on projects originating from user-led ideas or challenges.

The motivation for creating a dedicated innovation space was also needed in setting up the Hub facility. At the outset, the space allocated as the Innovation Hub was totally empty and unfinished apart from the existing utilities within the building's infrastructure. The team of

staff who had been working on innovation projects relocated into the Hub. They were given an initial period of freedom by the Hospital Board to explore what was needed to make the Hub function successfully. This was aided by an unusually relaxed tolerance to allow for creative thinking and experimentation, characteristics not commonly found within NHS organisations.

A Board member explained, *"…we are not a controlling culture, unlikely many … within the NHS, we try to support rather than control, (innovation staff)./…./ here we say, we would like you to play around with those computers and out of that, … we discovered we can get ourselves into spaces (collaborations) which are extraordinary'* (Clive, Hospital Board).

This approach enabled staff to think creatively about how to use the space, how to begin developing processes and seeking collaboration with internal and external stakeholders. Over time, by using existing contacts within local networks the Hub became furnished using donations from external organisations. This made the Hub into a usable workspace, with desks, a board room table, chairs and sofas for informal meetings.
The semi-autonomous freedoms granted to Hub staff in the early stages of the Hub's development further demonstrate a Board Level commitment to benefits arising from supporting informed actors to lead innovative change.

Roger a Board Member explained, *'If you look at the team a lot of our early people they were the sort of people who could stand up and do a talk, look credible in front of a company, could make networks. So we got Tim.. a supreme networker… and we then got Jeremy … what they do is … talk to people very credibly and make connections'* (Roger, Board Member).

This small team has continued to grow over time as shown in figure 4.2. As the number of active projects in the Hub increased, additional staff were recruited to provide the necessary expertise and capacity. In the next section, 4.3 the expansion of the Hub team is presented as a chronology to explain the need for additional the roles. In this section figure 4.3 shows the expansion of the team in detail. Figure 4.3 also demonstrates the connection

between growth in Hub innovation activity and the need for additional team roles to add capacity and specialist skills.

Phase One Pre-Hub	Phase Two - Hub Opens	Phase Three	Phase Four	Phase Five	Phase Six
3 clinical staff work part time on service improvement projects	One staff member juggles Hub set up phase and networking to gain collaborative partners	External firm occupies space in Hub - adding one staff member.	As Hub activity grows, roles added to administer projects and externally promote Hub.	Capacity and expertise needed to oversee creating processes and manage commercial interests of projects.	Additional roles added to support collaborative innovation process and manage stakeholder expectations.

Figure 4.2 – 'Development of Hub team structure'

4.3 A chronology of the expanding Hub team: exploring staff roles and the contribution of their expertise.

This section will provide a chronology of how the Hub team developed, which in turn demonstrates how as the Hub developed, there were emerging needs for additional expertise and knowledge within the staff. This is important as Hub staff formed an important sub-group within wider group of interview participants contributing to this research. At the point data collection started the Hub had been in existence for approaching two years.

In March 2016 the initial innovation team were able to move from a temporary innovation space in the old hospital, which was set to be demolished, into the space which would become the Hub within the new hospital building. At this time an administrator was recruited to join them and provide project support, and the team began the process of turning the empty innovation space into an active facility.

During this early phase the hospital Board members granted the Hub staff some autonomy to experiment with how to use the Hub as an innovation facility.
A Board member explained, *'... it has been important for us to take a backwards step and say we haven't got a clue what this is about really, we want this to be given some air space*

to develop, be given some oxygen so they can do what they think is the right thing to do' (Christine, Hospital Board).

Therefore, the Hub began to develop semi-autonomously, unrestricted by organisational processes found within the main hospital. Tim began his role in a hands-on manner but over time his role moved to work on delivering three key objectives. Firstly, using his clinical and surgical expertise to provide and communicate the innovative vision of the Hub, to help others understand the need and impact of potential innovation projects. Secondly, to network internally and externally, strategically using his '*authenticity as a clinician to engage people with the Hub*' (Tim, Clinical) to promote the Hub and find potential collaborators to contribute to and support innovation projects. Thirdly, to use his specialist paediatric knowledge to review the clinical applicability of potential innovation concepts brought into the Hub.

Tim reflected on his role, *'It used to be that I was answering the phones and making the tea and everything, but now my role, one is to provide the vision behind it, and two the networking element.., so getting out of the hospital and using my authenticity as a clinician to engage with people… Within the Hub's set up, looking at the ideas coming through and their clinical applicability. Beforehand I was literally doing absolutely everything and now there are different (team) functions'* (Tim, Senior Clinical).

The team initially began to expand from the founding members, due to an opportunity to be a partner organisation within a multi-organisational ERDF innovation project to support SME's. This provided an opportunity to access funding to support the Hub and help generate visibility and new contacts. To resource this Jeremy (Professional, Internal) was employed on a fixed term full-time contract to run this project. Yet as the number of projects expanded elsewhere in the Hub, his role evolved to become the operational and strategic manager of the wider Hub. Therefore a project manager, Faye, and two project administrators were recruited on a full-time fixed term basis to work solely on the delivery and the ERDF project.

Also at this time, additional project support was informally requested within the hospital, seeking a staff member to work in the Hub a few days a week. After a conversation with

Jeremy, Margie (Professional, Internal) began work in the Hub part-time. This was then changed to full-time as the number of Hub projects, and the complexity of these required more staff resource. Margie joined the Hub staff to work as an Innovation Associate. Her long service in the NHS in a number of roles enabled her to contribute to aligning innovation project development in a number of ways, including using her foresight in relation to necessary NHS regulatory compliance.

Margie explained, *'So 42 years in the NHS, … I worked across the entire (hospital) Trust so I had a lot of contacts, if I don't know them then I probably know someone who does …/…having done the improvement side of things I know how hard it is, to make change happen!... I can either navigate it, plough through it or find a way around it!... my background in operational and service management, means you have to be aware of what policies are, and that tends to be where I will put the brakes on things, or go 'I'm not sure you can do that'… it is such a huge place and so regulated' (Margie, Professional Internal).*

The appointment of Margie was the first stage in recognising that more resource was needed to manage innovation projects and the various aspects of their development. Over time the Hub workload continued to become more complex as the number of innovation projects grew and matured, and collaboration between different stakeholders became a feature of the multi-stakeholder projects teams. This meant that it became less realistic and beneficial for Tim to lead the multiple elements of the Hub operations.

He reflected, *'in the early phases I had the ability to do the networking but I had absolutely no ability to do any commercial deals or to do any of the delivery, so we just didn't bother with a deal, we let them (the partner organisation) have it all … but we would harvest the positive press off the back of it... We did that because that is all we could do, we didn't have any people, …we just got what we could out of it…. But that is no longer going to fly because that is not going to support this number of people, so you have to change over the model, when money starts to be involved, … have a lot more governance around it, so that is the difficult transition we have to make, and also what is the right structure? Corporately and financially, these are areas I am not an expert in which is why you have to bring in a wide variety of people' (Tim, Senior Clinical).*

In conjunction with these developments in terms of the need for different staff roles within the team, was the emergence of disparate expectations of the Hub activities from within project teams and from the Hospital Board.

A staff member working to manage stakeholder relationships in the Hub stated, *'they (commercial organisations) are looking for as many opportunities as you can deal with, that is the aim of business, to grow…. It is a different game to the NHS and in the public sector, here the game is how well can we deliver that service?/…/ So it is a different mentality, the pace is different and the quantities are different'* (Robert, Professional Internal).

These differing needs prompted the recruitment of a new team member, Joanna (Professional Internal) who had the expertise to manage commercial multi-stakeholder innovation projects. The specialist skills required to manage the areas of stakeholder, relationship and project management grew to require an additional two members of staff. Scott (Professional, Internal) was recruited to support Joanna (Professional, Internal) both working full time, and latterly Robert (Professional Internal) worked part-time to form a team of three. The extensive remit of this team was to help the Hub to operate more sustainability. This included a focus on initiating Hub processes through the development of a Hub innovation strategy, an innovation methodology, formally exploring funding opportunities and providing varied types of support to innovation projects.

Joanna (Professional Internal) summarised the team remit as *'from point of assessing opportunities right the way through to building the business model and an exploitation strategy on the individual product. I (Joanna) am managing a team which is clinical and product delivery from a technical and commercial perspective*.

The team worked together *'to support the innovation team and help them to commercialise some of the ideas that they have got … and then assess is that a big opportunity within the market? … there are two aspects to it, the process of doing that and the content of doing that. So I guess the process really needs to be, how do we identify challenges and problems and needs, how do we validate those, how do we identify solutions, how do we then assess*

those solutions and prioritise them in terms of the impact that we want to achieve?' (Robert, Professional Internal).

This quote implies that the development of processes in the Hub is an ongoing challenge. In part, this is because projects already in progress require additional remedial project management support, due to a lack of process in place when they initially began. Joanna's team works to implement structure through the creation and implementation of processes which seek to resolve existing issues, and protect future project interests.

In addition to the growth of this team, a non-clinical project manager (Joan, Professional Internal) and an administrator were appointed to work part-time on accelerating the development of a specific flagship digital innovation project. The investment and visibility this project within the wider hospital has generated funding to provide resource and expertise to try and support specific project development targets to be reached.

The number of staff within Hub team had expanded rapidly, Figure 4.3 shows a chronology of how the Hub team roles expanded to meet arising needs as the work of the Hub expanded. As the Hub projects run using multi-actor teams, the management of stakeholder expectations and priorities became an increasingly important role within the Hub. In addition, as the projects developed it was necessary to develop new processes to manage project pace and objectives.

Phase one — Pre-Hub
Phase two — Vision for healthcare innovation
Phase three — Profile raising
Phase four — Adding capacity
Phase five — Developing strategy and processes.
Phase six — Delivering own projects

Phase One Activity
Service improvement led by consultation with patient users.

2014/2015 Phase Two Activity
Innovation emerges as strategic goal for hospital
Vision for innovation discussed internally

2016 Phase Three Activity
Hub space opens. Hub Spaces start to be designed
Efforts to find external collaborators and promote Hub

2016/2017 Phase Four Activity
Division of labour in Hub as team expands
First collaborative projects begin

2017 Phase Five Activity
Team capacity and expertise expands through new roles
Physical development of Hub space and processes

2018 Phase Six Activity
Two Hub digital products launch into a test phase
Project and Stakeholder management
Process development

Clinical staff roles
Peter (Nursing)
Graham (Nursing)
Tim (Senior Clinician)

Clinical staff roles

Clinical staff roles

Clinical staff roles
Philip (Junior Clinical)

Clinical staff roles

Clinical staff roles

Additional roles added over time

Professional staff roles
Roger (Board Member)

Professional staff roles

Professional staff roles
William (External 3D printing firm using Hub space)

Professional staff roles
Jeremy reassign to Hub Operations Manager
Faye joins team to take on Jeremy's project role.
2 Support Administrators

Professional staff roles
Joanna - Strategic process management of projects
Margie - Innovation Associate (Project support and troubleshooting)
Administrator to support Faye

Professional staff roles
Scott and latterly Justin to support Joanna on process creation
Steven - IT support
Denise - App Project Manager
Administrator for App project
Administrator to support Faye

Figure 4.3 – Chronology of the Hub team role expansion

In addition to the growth of non-clinical Hub staff, the team also grew to include additional clinical team members including Philip who was an interview participant. The role of Clinical Hub staff is interesting, as they balanced their primary job role within the main hospital with one day per week in the Hub. Their knowledge-led contribution within project teams enabled them to apply their medical skill and organisational experiences to the shape project developments. The Hub provided new opportunities for clinicians to use their knowledge as part of their role. A senior clinician explained, *'You get a lot of inventive and entrepreneurial people in medicine who get a bit crushed by it, because medicine is performing the same thing over and over again really, that is what it is, lots of tasks to be done. Whereas some people want to do a deed, a let's get that dragon, some people like that, and you need to give them the opportunity to do it'* (Tim, Senior Clinical).

Clinical staff joining the Hub team were encouraged by Tim who connected their interest in technology, with the Hub as an environment to explore using technology as part of needs led innovation projects. This prospect appealed to some clinical staff. A junior clinician explained *'...I have got a background and interest in App development, so I got involved ... to do that more, and from interaction with Tim* (Philip, Junior Clinical).

The Hub team continued to work on a growing number of project ideas which progressed at varying rates and levels of successful development. Part of this expansion was supported by the Hub forming working collaborations with a number of external local organisations, who became key actors within the project teams. Within collaborative teams the Hub facility played an important role as a *'facilitator for these types of things (collaborations). When you have someone who has a great idea, who wants to find the right person to work with so they can do it'* (Tim, Senior Clinical).

A number of external organisations were working collaboratively with the Hub, and its internal users within project teams. These organisations included universities with dedicated research expertise, commercial organisations with access to world leading technology, development facilities and commercial markets and public sector organisations with access to dedicated funding and local networks. This has been important in supporting the development of projects as a clinical Hub staff member explained, *'I have a very narrow*

set of skills and in order to make anything happen you need a team to make it happen and a lot of those skills aren't naturally within the NHS' (Graham, Nursing).

The contributions of external innovation stakeholders had also been recognised at Board Level, *'The work with the guys from the University is fantastic…, we would never be able to do that here… the expertise that those guys are bringing to solving the problems, and then it is a way of financing things which I think is another expertise which we haven't got'* Christine, (Board Member.)

However also over time, tension arising from stakeholders working in the Hub began to surface, connected to their varied expectations and priorities. This tension also arose from the differing perspectives of innovation actors, related to how innovation should be managed, and what processes should be followed. *'…we are currently discussing at the moment what should be going into it, and that has been an example of multi-stakeholder inputs making things difficult when you have got lots of different people trying to steer a message, so it is difficult to please all of the people on that front'* (Tim, Senior Clinical).

As figure 4.3 demonstrates, the development of processes and connected supporting structures did not become a focus of innovation activity until a number of projects had begun, and the team had expanded to support them. This meant that there was a retrospective development of processes and decision making procedures. This caused growing confusion and frustration amongst Hub staff and stakeholders. Scott (Professional Internal) commented *'…it is harder trying to do it (process creation) retrospectively than do that from the beginning.'*

The culture within the Hub originated with the motivations of clinical staff to resolve user-led needs. This prompted the creation of an approach which was about, *'not being too prescriptive about what we are trying to achieve and just be opportunistic about what comes up which doesn't sit particularly well with the strategy!'* (Tim, Senior Clinical). The Hub approach developed to focus on addressing current patient needs through attempting to create suitable product and process innovations. This caused tension with

innovation actors who had experienced alternative approaches to innovation management which were not adhered to within the Hub.

The intensity of this quote demonstrates the exasperation felt by an innovation actor, external to the hospital, who communicated her difficulty in working within an approach that differed to her own firm belief about how the innovation process should be, *'I'm sounding very critical aren't, I but I know what good looks like, so I am enormously frustrated, enormously frustrated !... I know it is going to work! If we do this then it will work'* (Denise, Professional, External).

Stakeholder understanding regarding how they saw the role of the Hub in relation to health innovation, and the hub processes needed to enable innovation differed, depending on the lens of the stakeholder interviewed.

An example of this can be seen in the perspective a senior clinician who commented,
> *'Everyone has a different idea about what innovation should be, innovation is very loosely defined thing. I think it is more about thought leadership and consultancy... as a way to money-tise, but also creating innovation culture within the hospital. I'm not saying we shouldn't be making products, but I don't think that's our primary function. I think our primary function is how to think differently within the NHS.'* (Tim, Senior Clinical).

A core purpose of innovation in the Hospital was to bring about benefits for users. Over time, the idea of how to define value created from the Hub emerged as another area of stakeholder disagreement. As stakeholders voiced their opinions on this issue, the role of processes and their outcomes received increased attention as a way to consider innovation outcomes. The role of adequate and robust processes to support progressive project development became more necessary and expected. Where processes were lacking, or underdeveloped staff were working to retrospectively revise and improve areas of weakness. This prompted stakeholders primarily motivated by the idea of the Hub creating benefits for users, to consider the importance of other types of innovation outcome. For

example, the significance of generating commercial profits as an additional beneficial outcome of the innovation process.

Hub stakeholders who were supporters of increasing commercial revenue generation suggest this would help to make the Hub a sustainable facility in the longer term, and reassure external innovation actors of the types of tangible returns that can be anticipated from their investment. During data collection there was a sense of hesitancy amongst interviewees about formalising some elements of Hub processes too hastily, as much of the activity Hub was still so new and changeable. Christine (Board member) commented, '*I am holding back from saying 'it is this' as we don't really know…/… this is a space where you can make money so why wouldn't you? So I want to make sure that we have leveraged as much as we can in terms of financial return, I do think that is important.*'

In line with this view is the business perspective of some internal stakeholders who were concerned that hospital key purposes are appropriately managed, through the creation of Hub processes and structures. Gemma (Professional Internal) stated, '*There is obviously value in the things we are doing in the hospital and in innovation, there is a lot of knowledge in the hospital which has a value, so if we can make that commercialised and a revenue generator, it will help us …grow our innovation offer, because the more money you earn the bigger the team that you can have supporting it, and ultimately the more innovation you do, it will help healthcare in the hospital*'.

These perspectives have emerged amongst stakeholders who have become involved in the Hub as it has developed. There was a different view amongst the founding members, who retained a person centred commitment to resolving existing user issues, such innovative solutions aim to benefit users and indirectly the wider hospital. Roger (Board member) explained, '*A big driver for us, is to do good things, and if we just do good things we would probably be happy, …you want to make it better for the hospital, better for the kids. Or generate some IP and some ownership value from it, that is also good things. In my mind they are the same thing, because if you want to do good you have to have some sort of framework for it where people feel that they want to do it… where everyone knows what they get out of it… therefore they will work on it. You wouldn't survive in the hospital,*

building things that just do good because the hospital will want to sustain itself and see some things coming back, and so you have to have that incentivisation for the people who get involved'.

Over time Roger's perspective has changed to align more with other stakeholders to also indicate that clarity around process is important to provide clarity for stakeholders regarding Hub purpose and objectives. His understanding of the purpose of the Hub has evolved to appreciate that stakeholders need to see how project management processes will lead to anticipated beneficial outcomes and the generation of types of value.

The next section critically presents processes which emerged as the Hub strategy became more focused in how it managed Hub innovation activities.

4.4 Understanding the development of Hub processes and project goals: identifying how processes are used to respond to needs-led innovation challenges.

As outlined in the chapter so far the Hub evolved to provide an environment with a number of designated spaces. Designing these spaces, to support collaboration healthcare created a Hub which was a location for multi-stakeholder paediatric innovation. In conjunction with the development of Hub space, was growth in the number of active needs-led projects within the Hub. In order to respond to issues within these projects the development of Hub innovation processes became a focus for Hub staff members. Many of these processes are required to manage the complexity within multi-stakeholder project teams. This section began by outlining the extent collaboration within the innovation process at the point of data collection. The section developed to explore stakeholder perspectives which inform the approaches used to inform the objectives and development of innovation projects.

The particular elements of these approaches are examined in greater detail in three focused sections 4.4.1,4.4.2 and 4.4.3. In these sections connections are introduced between Hub project objectives, and the characteristics of the approach taken to address the type of needs-led challenges. Examples of current Hub projects are provided to illustrate the purpose driven motivations for current projects within the Hub. The importance of

processes to support these approaches and objectives are developed in greater detail in the subsequent findings and discussion chapters.

At the point data collection commenced, the Hub had a number of active projects, and connected project actors from different organisations. The Hub team had grown to include a team of 12 core Hub staff and supporting 3 clinicians. Relationships had been formed with three local universities and a wider group of engaged commercial organisations, both locally, nationally and internationally. Innovation actors from these organisations worked together as part of multi-disciplinary collaborative project teams. The collective aim was to seek to improve paediatric medicine or patient experience by using their different expertise and resources to use technology like artificial intelligence in an innovative way. Moreover, Hub projects were consistent in their driver of being needs-led. The term needs-led means that projects all aimed to resolve an existing need which has become an issue for hospital users. This objective meant that the innovation outcome had important experiential and process goals, which were important for a wide range of stakeholders including the Hospital Board, key hospital users (patients, families and hospital staff). Furthermore, these projects were of interest to other NHS institutions interested in how digital resources could be scaled to increase NHS capacity, improve paediatric medical care pathways and provide a better patient experience.

A staff member working externally for the NHS explained, '*As an NHS team we are looking to find things that make our practice and our services safer, and higher quality, … a better experience for patients and for service users, and how we add capacity to the system, to preserve the healthcare system*' (George, Professional External).

To achieve this technology was increasingly seen as a means to generate capacity within the NHS system. Multiple interviewees communicated the opinion that investment in digital resources would, in time, bring a number of different benefits for users and broader supporting health systems. The importance of understanding the connection between these two innovation outcomes showed how delivering patient and process benefits did not have to be mutually exclusive. A staff member working externally to the Hub said, '*I think if innovation … should be transforming healthcare, … coming at this with a business mind, if*

you are going to transform things it usually means that you can do them with a higher

quality, and usually a lower cost. So … you are getting better quality care … that would use

the funding better' (Gemma, Professional, Internal).

Therefore, there was agreement between stakeholders that health innovations should seek to increase service quality whilst being mindful of financial constraints. A popular approach was using technology as a tool to deliver this, but directing innovation efforts to focusing on resolving existing user needs. A nurse explains '*I think it is a needs based thing, we need to be innovative and creative about the ways that we deliver services … and I think that innovation is really important because we are working on restricted budgets and if there are ways to work on things that support the delivery of healthcare, that are creative, and are support us be as effective and efficient and deliver good quality services then …that we really need'* (Vanessa, Nursing).

Therefore, recognising the importance of increasing the sustainability of healthcare systems was viewed as an important needs-led driver for innovation projects. The NHS was struggling as a result of experiencing increased demand for services and a lack of resources to meet these demands. The collective perspective of stakeholders interviewed was that investing in technologically delivered care pathways would enable more patients to be supported, without the having to consider further straining the patient staff ratio. A nurse stated*, 'technology is scalable, we already know we can't scale anymore workforce in the NHS but if we can put in a little of what we know is magic in technology and then scale it... (Graham, Nursing).* The design of suitable digital product innovations that satisfied both user needs, and NHS process requirements was the focus of the Hub activities. The following sections will expand on what clinicians have identified as necessary components of digital innovations to support patients, by taking a more detailed look at user driven needs and how the Hub approached addressing them.

Within the Hub there were a number of projects, all at different stages of development. However, three main areas of user need can be identified as needs-led drivers motivating current Hub projects. In the following sections, these needs-led project drivers are introduced and linked to how the Hub environment and processes contributed to projects

seeking to resolve these challenges. Within the context of NHS innovation, the following Hub project drivers align with what were referred to as '*the three planks of innovation'* by a regional NHS external organisation. These three planks of innovation aim to improve access to information for patients through the provisions of digital tools which increase remote access to information. The overall aim was to the increase capacity in the NHS by providing digital access to information which reduces burdens on staff, and empowers and educates patients and families. The objective was to improve the patient experience and increase efficiency. An NHS employee explained, '*You are going to have to spend less time explaining to them what happens when they are across the doors, and also you are going to have less chance of getting bitten or hit by a patient'* (George, Professional Internal).

The following sections present how the Hub is contributing to addressing these user needs through the approaches taken to innovation. Each of the following three sections presents a common needs-led approach within Hub projects, and provides examples of relevant current projects under development in the Hub.

4.4.1 Innovation projects to improve stakeholder access to and interaction with NHS information sources.

The first project common approach pursued within the Hub, is seeking to improve ways to access relevant information about the health service, for users and potential suppliers of innovations. This objective has two main parts. Firstly, in relation to external individuals and organisations who are not hospital patients. A longstanding issue has been the complexity of NHS procurement processes, which are often inaccessible and difficult to understand. This creates a barrier for potential suppliers and collaborators, especially those with limited resource and experience like some SME's and entrepreneurs. Therefore, the European Region Development Fund (ERDF) project, in which the Hub was the main organisational partner, aimed to support qualifying local SME's with a health innovation under development to access the NHS with a view to developing their product using insights from within the organisational boundaries.

Participants of the ERDF project found value in the collaborative Hub approach, and the processes that were implemented to support project participants who were seeking to develop their idea for use in the NHS. A participant explained, *'I have surrounded myself with people who are no nonsense realists because that is what you need. Something like the Hub, their integrity and genuine purpose which is to boost innovation, to boost small businesses that want to have medical impact, that is the journey that we are on and we can join with them, you have to find people who you can trust'* (Charles External ERDF Project Participant).

Hub staff ran a programme of events for project participants, designed to increase understanding of NHS processes, support skill development and create of a local network of external independent health innovators whilst refining their product concept (Faye, Professional Internal). The Hub was important as it provided space and resources where the ERDF project participants could work directly with Hub staff. This enabled participants to have valuable access to clinical staff through meeting arranged by Hub staff, during which they received developmental feedback directly from medical experts.

A Hub staff member Faye recounted, *'you have a room full of neurosurgeons and paediatric neurosurgeons, where else are you going to get that? The information that the neurosurgeons gave the ERDF project participant was, well, we walked out of the room and said wow!'* (Faye, Professional)

Hub staff provided a valuable role in supporting the collaborative process by facilitating engagement and connection between individuals working in different operational contexts. This was necessary because of differences in organisational cultures and operational differences. When externals showed an interest in working with the NHS these differences had become a barrier to successful collaboration.

A Hub employee, Scott explained*, 'The NHS doesn't understand how the NHS works! There is no chance for external companies really to understand it really more than what they do generally. I think that is where the innovation team is helpful in that as we can kind of connect the dots, to get the right people in the room. I think accessing for external*

companies is very difficult. Again that is one of the benefits we bring here and one of the selling points for external companies, that we can give you access to people that you can't normally get' (Scott, Professional).

The second main element to increasing access to health service information relates to meeting the needs of users. This objective was being pursued by using the Hub as a space and collaborative environment, to develop products that created new interactive digital products for users. The shared aim of these innovations was to address the existing need to improve communication between the hospital and patients and their families by creating processes for remote access to key information about health conditions and treatment processes. Gail, a senior clinician commented *'…if you make the communication better what happens is that parents understand the importance (of treatment procedures and adherence to medical advice)'* (Gail, Senior Clinical).

The innovations under development addressed a lack of digital information, and information designed for paediatric patients. The aim of the innovation projects was to enable users with access to generic information about the hospital digitally, in a more personalised, understandable and interactive manner. Furthermore, the content was designed to be understood by paediatric patients, using the delivery mechanism of apps, video content and technology supported by artificial intelligence. These projects are informed by a project team comprising of collaborators with complementary expertise drawn from their experience as clinicians, researchers and commercial professionals. The management challenge of Hub collaboration remained how best to combine this mix of expertise to create innovations that meet user needs whilst providing a supportive and high quality healthcare experience. The patient's wellbeing needs and improved health literacy were addressed through the creation of digital products.

An example was an App for patients. A member of the project team Denise (Professional Internal), explained it is *'… a tool that will help a child understand the hospital before they get here. So it is three things, familiarisation, reward and distraction. So it familiarises the child and family before they get here so there is less fear and anxiety'*. Addressing this need was also important for clinicians and nurses as it was designed to assist them when

delivering medical care calmly and efficiently, by using the App to distract the patient and then give praise through digital rewards used in the built in App games.

Graham (Nursing) working on the app development explains, *'The app is a vehicle of starting to break down barriers in familiarisation, saying it is going to be tough sometimes but you get a reward, or also acknowledging you don't want to look, .. but why don't you look at this shiny thing (the app)? … Then you can get on and do the business. Sometimes it is not nice, and really hard but you have just got to get on and do it, if you communicate it kids are braver than adults and you can do so much more!'*

The Hub team provided a resource to support a number of projects where clinicians were considering the validity of developing their idea beyond being an aspiration. There was an emerging process to standardise the way that ideas were received, considered and supported. The resource available in the Hub has enabled this area to receive additional staff who had experience in this area. Furthermore these staff had begun to explore the commercial potential ideas, by conducting research into its utility in the wider healthcare sector. This support and the development of connected processes was welcomed by clinicians.

Philip (Junior Clinical) explained, *'I think it takes away some of the uncertainty about it for them, that there is a team of people who can help, think through how that works, because I think for the majority of clinicians, they probably haven't considered it much, they have probably just thought, how can I improve it locally? But the idea that we could commercialise this, and it is something that could be rolled out across the other places, would excite some people into developing their idea further'.*

4.4.2 Innovation projects to improve the Patient Experience

The second main focus of Hub projects were aimed at improving patient user experience during their healthcare journey. This includes a number projects to develop innovative products which address patient anxiety about being in hospital and receiving treatment.

These Hub projects have enabled external stakeholders to become involved in addressing this need, broadening contributory expertise and resources.

Tim (Senior clinical) explained, *'The Hospital is well known for being a very caring hospital and there is a lot of synergy within the Trust strategy…, you are trying to make children less scared, who is going to say no?'*

Users highlighted the problems that arise due to a current a lack of digital options with content developed specially for children. Clinicians identified substantial patient and family anxiety about visiting and receiving treatment in a paediatric hospital within their clinics. The NHS is continually seeking ways to increase its' treatment capacity and reduce waiting times. The lack of suitable provision was a substantial issue in terms of patient experience and hospital efficiency. The core of this issue was a need to respond to developments in expected communication tools, patient preferences, and the link to digital options.

A nurse explains *'They (the patients) can actually use a tablet before they can speak…, and so it seems completely incongruous to have these kids coming in with these new demands and having to live in a different world … for me, in order to bring a kid through their health care journey they need a lot of support and rewards and you need to speak to them at the level that they can understand, and one of the methods of communication and reward is based on what they value, they value technology so why aren't we speaking to them in their own language? So that was the big driver, how do you bring technology to the kids because that is what they know and understand and utilise and also, when you give information to children, you give people a leaflet and you walk outside and there they are on the floor'* (Graham, Nursing).

Innovation actors in the Hub have responded to this need by beginning work through a number of projects which aim to provide information to patients through digital pathways using artificial intelligence and apps. The multi-disciplinary teams in the Hub are well placed to develop this content. Collectively innovation actors have knowledge to meet both NHS I.T delivery specifications and clinical expertise to deliver accurate information. The digital design element of the innovation ensures information is delivered in a clear, impactful and

fun way for paediatric users. The Hub staff team has a key role in supporting this work by using the skills of Hub staff and the implementation of processes. An important area of focus for Hub staff is working to implement processes that support the decision making process around progressing ideas, and involving the participation of users.

Robert, a Hub employee explained, *'The audiologists were saying the process just isn't very engaging for children, it is boring for them and we have got computer games now, we can make it really interesting for them…they weren't too biased around a solution, they were just saying 'we think'. They understood the problem and they wanted to solve it and solve it well'* (Robert, Professional Internal).

Within the Hub projects approached improving patient experience by focusing on using digital communication methods. This aimed to make accessing information about the hospital facilities and the process for common procedures easier for patients and families to understand. Guided by user insights and information the Hub was using person centred digital design when utilising new technologies to create novel products. The approach of a number of design concepts used artificial intelligence, virtual reality and augmented reality. Using these emerging technologies alongside the extensive skill set of a multi-disciplinary project team was helping advance methods of improving patient experience, due to the user-led Hub approach of prioritising the needs of their main user groups; paediatric patients, families and clinicians. This in turn was helping to address patient experience issues that occurred due to overburdened operational processes. One such area was how the emotional needs of the patient were met prior to undergoing a medical procedure or appointment.

Therefore, innovations to improve holistic care needs incorporated a recognition of meeting the emotional and psychological needs of patients. From a process perspective this is also important as high levels of patient anxiety contributed to cancelled surgery, missed appointments and increased demands on staff. Therefore innovations were designed to *'…target how children would feel emotionally, to help them to feel more relaxed, whether it is sitting in clinic or waiting for an appointment, or being on the ward.'* (Faye, Professional). Hub projects retained a person centred approach, and became less about profit making.

This focus contributed to the ongoing challenge of defining healthcare innovation and its purpose.

Clive, (Hospital Board) commented, *'Some of this innovation is very human, very subtle not innovation in the sense that we think of, and it goes back to some of the principles that we have used in the design of this building where it is organised around the principles of the person who you are trying to serve, the child or the young person, organise it around them so that you make it easier for them'*.

An example of this was shared by a clinician working in the Hub, (developing AI software) *'to answer questions that people have, so they feel comfortable enough to put them into a system, ask questions freely, and then have validated information come back. This has the potential to reduce anxiety by really explaining things to people ahead of the time they arrive for their procedure or clinic appointment'* (Philip, Junior Clinical)

The Hub was working on a number of digital patient experience products to support the wellbeing and health literacy of patients and their families. Digital technology was also being developed, e.g. use of 3D printed models to support the discussion of treatment options between clinicians and during patient consultations. The accuracy of the personalised 3D printed model was useful in a number of ways to increase accessibility. As a visual and tactile model it enabled a greater understanding of complex medical needs compared to examining a scan. During consultations families could gain an appreciation of the issue and see the reasons for the intended treatment plan. Clinicians could also use the model as part of their pre-operative planning, and if needed experiment using the model prior to the actual procedure taking place (William, Professional External).

4.4.3 Applying emerging technologies within Innovation projects to address user needs

As introduced in the above sections, Hub innovation projects commonly use sophisticated methods of digital technology to create user focused innovations suited to the needs of paediatric patients growing up in a digitalised world. This is a conscious part of the Hub

strategy, as founding clinical staff had recognised the way in which using technology enables healthcare challenges to be approached differently.

Graham, a nurse who was a founding member of the Hub team reflected, *'I think that the role of innovation has to be a bit like lenses, or phone filters… looking at a problem with an innovation lens… it is another perspective with which to look at a problem, to get a better solution… and there is a technology side to it, and it is about the deployment of different technologies or existing technologies in a new way… I think that is where innovation can lie, and these technologies can be very basic things like digital communications or it can be AI or other emerging technologies and solutions, if you keep abreast of developments, its, how does that help here (in paediatric healthcare)'* (Graham, Nursing).

These innovations are specifically designed to suit a paediatric environment, unlike those created in external settings (Tim, Senior Clinical). The aim of the collaborative hub environment was to combine collaborators knowledge, with the design capabilities of technology to develop new innovations, all whilst focusing on specific paediatric user needs. This approach aligns with the motivations of clinicians interviewed, who demonstrated a commitment to the public health ethos of the NHS, rather than seeking to create innovations primarily for commercial gain.

Gail, (Senior Clinical) explained, *'(Technologies help in) 'Overcoming barriers, they have the power to basically change a situation and give that person life…Technology can educate you, can educate the people around you, and also make a significant difference to how your life is really….. 'It is not about money…one of the things which is very very important to understand.. People (clinicians) don't come here for money, they come here for the ethos and the belief of health for all at the time of need, and a lot of people believe in that'*.

The processes developed within the Hub added both a location for person centred innovation to take place, as well as expertise in managing multi-stakeholder projects through appropriate use of space and guiding processes. Initially founding Hub staff had clinical expertise were lacking management, governance and collaborative project experience.

Philip (Junior Clinical) reflected, *'Clinicians are really involved in what is in the patient's best interest as an outcome of this innovative solution …often there are commercial drivers to it but … the people who are more expert in negotiating how that fits with someone else's agenda can help deliver that solution as I think it is quite hard for clinicians to think about all those other aspects of what drives someone to want to engage'*.

User needs in this context are divided between the needs of patients and their families, and the needs of hospital staff. By using technology as a common component within Hub projects there was the intention to satisfy increasing public expectation for access to digital resources, and to provide access to key information on an on-demand basis outside of clinical contact time (Philip, Junior Clinical). In doing so, this had the potential to support clinicians by removing the expectation that clinical meetings were a time to answer generic questions, and re-focus this limited time to deal with clinical matters (Philip, Junior Clinical). Patients and their families were also expected to derive benefits from being able to access information in their own time, and by accessing a range of visual and verbal methods rather than relying on the limited communication opportunities within clinical appointments, which can already by overwhelming and confusing (Graham, Nursing).

In summary this section has outlined the key approaches used in the Hub to respond to user needs identified as challenges within the wider hospital environment. The development of health innovations in the Hub collectively aim to provide patients and their families with access to digital, engagingly designed products that support their interaction with the hospital and provide the generic information they need more quickly. This approach aims to generate a number of benefits including reducing patient anxiety around hospital visits and increasing patient and family health literacy. Operationally the use of digital resources aims to reduce the pressure on the clinicians to be the primary source of generic hospital information and enable clinic time to be used for medical matters. The Hub sought to provide a supportive environment, skilled staff and some guiding processes to support the collaborative innovation process. This was important as it enabled the expertise and resources of collaborators to be joined with that of clinicians. Furthermore, Hub projects supported integration of technology into a paediatric setting, product design was informed by user-led drivers and clinicians' knowledge. This collaborative approach aimed to satisfy

holistic user needs and provide access clinically approved generic health information. Hub innovations are designed to maximise user engagement, and be compatible with existing NHS operational structures.

4.4.4 – Capturing Hub development at the close of data collection.

The empirical data was collected over a period of six months of the Hub's activities. To provide clarity as to the extent of the Hub's development at the close of data collection this section outlines key findings from the data collection time period. The approaches to innovation, and projects outlined in this chapter suggest the emergence of a Hub strategy, and why there is a need for supporting processes to sustain this activity. The development of processes builds on the founding vision to improving paediatric health care for users by creating digital innovations which enhance service provision for paediatric users.

Over the period of data collection, the Hub had already advanced from the initial start-up stage and was adjusting to operate using expertise within a recently expanded team structure. Distinct innovation spaces had been designed, and innovation hub processes were beginning to emerge. Thus, collecting data from the Hub during this transitional time period, provided opportunities to understand the evolving role of the Hub, as a space and as a facility, to support and sustain collaborative projects and address the needs of collaborators. Furthermore, the CASE studentship brief requested research outcomes which provided clarity on how the Hub activities and processes supported innovation activity.

At the close of data collection the Hub team had developed to enable innovation work to be divided up and allocated to staff with suitable prior experience. A number of collaborative projects were underway which were informed through contributions of multi-disciplinary project teams. The Hub had successfully formed working relationships with local universities and a number of commercial firms with knowledge of technology based innovation.

The capacity of the Hub staff had grown to enable an increasingly strategic and process driven approach. This increased opportunities to sustain the progress of innovation projects managed within the Hub through appropriately designed processes. This was still a work in

progress, but staff were working on developing and implementing processes to formalise and validate decision making and allocation of resources. The aim of increasing clarity around the role of the Hub and establishing clear processes was to increase Hub stability. By operating in more accountable and structured way the Hub would increasingly be able to Hub demonstrate and articulate their approach to collaborative innovation. The overall objective was for the Hub facility was to be able to function in a sustainable manner with appropriate levels of investment and well researched project ventures. During data collection this process was underway, as Hub staff began to understand how to manage the Hub, the collaborative process and clinicians' contributions.

During data collection issues emerged regarding the impact of a lack of process during the initial stages of Hub operation, and the issues this had created when seeking to communicate Hub progress to external stakeholders. This issue had resulted in an increased focus on process development, aimed in part to provide tangible ways to demonstrate Hub decision making and project management processes. This would enable the Hospital Board and external stakeholders to increase their understanding of core Hub strengths. It was anticipated that this would contribute to informing decisions about future support to help make the Hub financially and operationally sustainable.

Hub staff involved in managing Hub projects had begun to respond to emerging stakeholder tensions. Stakeholders had differing views and priorities regarding the purpose and goals of the Hub and outcomes of projects in development. However, there was a consensus amongst internal stakeholders that the needs-led Hub purpose and ability to apply clinicians' expert knowledge of the paediatric healthcare environment was important to product design and competitiveness. Regardless of the multiple perspectives on profit generation versus enhancement of patient experience debates amongst stakeholders, there was agreement about the importance of clinicians' knowledge for development of health innovations. The Hub was therefore a facility that contributed to collaborative innovation by making use of user knowledge, *'you have to exploit your strengths and that is what we are trying to do here, … and our asset is our expertise in health'* (Gemma, Professional, Internal). This linked to other issues regarding misunderstandings between other NHS organisational process improvement and develop initiatives, and how innovation was done and positioned.

Joanna, a Hub staff member explained a current issues, *'There is a massive culture change needed, … the whole healthcare sector and the NHS are behind the curve in terms of other industry sectors. Innovation is misunderstood and the word hugely misused. Actually in the NHS I think even more so in terms of, is this process improvement, is this transformation? Oh no its innovation. Is it innovation? You need to define what innovation means to your organisation, but we have struggled…. What is innovation to this hospital? How does it fit compared to IT, Research, Transformation? I think it is getting clearer, and probably that is where the commercial bit comes in because transformation is not about commercial, and research has a different end output. In innovation, one of the strands is going to be commercial revenue'* (Joanna, Professional, Internal).

Additionally, the concept of how to define success was emerging as a central point of debate between differently motivated stakeholders. The place of protecting intellectual property whilst increasing capacity and service efficiency was contrasted with social objectives of person centred digital innovation to meet the holistic needs of patients in creative ways.

Roger, (Hospital board acknowledged, *'It (success) is not just one thing, it is a combination of things... our version of innovation is … getting the stuff out and impacting the world of health, … developing, and not necessarily by ourselves a number of products … if they get commercialised and… out there then they are useful… We have identified which of our projects we think are the big ones … we want those to be successful. We have then said money, …generating value for the hospital is a sign of success for innovation, … then reputation, so …one of the benefits for the hospital being connected to the Hub is getting a reputation for being a world class organisation and somewhere renowned for innovation. Then benefits to staff and patients … benefits to the way the hospital operates, how the innovations impact the kids and the parents as they come through the hospital.'*

4.5 Chapter Summary

This chapter introduced the Hub through presenting a detailed case history of the development stages and emerging challenges which outline how the Hub engaged in

collaborative innovation. Thus, important considerations regarding hub space, process and management of multi-stakeholder healthcare innovation emerged.

The chapter included a chronology of the Hub development, accompanied by a description of the operational and organisational context. This began by outlining the organisational context informing the Hub origins and early developments. The chapter documented the development of the Hub's activities and the role of key innovation actors. The Hub's hospital location provided scope to explore how clinicians knowledge was used to identify and respond to user-led needs and links to attracting external collaborators. The Hub sought to provide an environment where expertise could be combined. Hub projects used emerging technologies in the design of innovations suited to paediatric users. Digital products aimed to increase usablility and enable users to independently access information, reducing reliance on clinicians to provide answers. Chapter five, presents the main empirical findings in more detail.

Chapter 5 – Findings

5.0 Introduction

This chapter presents the main empirical findings for the thesis. The chapter is structured into 5 main sub-sections which are allied to the 5 main themes that emerged from the analysis shown in the previous chapter, the results are presented in Appendix 4. Where findings are relevant to more than one sub-section, or discussed in more detail in a later section, a cross reference is included to indicate this.

5.1 Management of the Hub

This section explores Hub management, as a component of understanding the role and activities of the Hub facility. Hub management is considered on a micro level, focusing on the work of Hub staff. The perspectives and objectives of other stakeholder groups are interwoven to provide context to the issues discussed.

Section 5.1 is structured into five sub-sections which align with emerging themes from the analysis process. The aim of this section is to understand and critically discuss the approaches used to manage the innovation process and multi-stakeholder collaboration. Section 5.1.1 focuses on how Hub staff manage internal relationships between hospital staff involved in the Hub. The novelty of the Hub within a tightly regulated and bureaucratic healthcare sector creates room for misunderstandings and challenges. Therefore, how the Hub is managed contributes to sustaining successful multi-stakeholder collaboration. Section 5.1.2 explores the role of Hub staff in balancing stakeholder and project requirements. The findings demonstrate how Hub staff manage issues within collaborative teams. Activities to raise internal awareness of Hub activities are presented in section 5.1.3. In section 5.1.4 the management approach to the developing an Innovation Culture within the heavily regulated healthcare sector are discussed. The final section 5.1.5 assesses the evolution of management challenges as Hub capabilities have developed. This section shows how Hub staff balanced the day to day operations along with longer term strategy.

5.1.1 Managing internal relationships

At the outset the concept of the Hub, as a facility and space for collaborative innovation was unfamiliar to hospital staff. This organisational context produced a management challenge for Hub staff as clinicians' focus was on healthcare delivery. Thus the concept of user-led health innovation in a dedicated Hub location was not an everyday priority. This section begins by outlining the approach taken to addressing a lack of staff awareness of the Hub purpose and core activities. During the start-up phase, this task was led by founding Hub clinical staff. They developed internal relationships by sharing examples to illustrate how innovation could be a tool to meet user needs. Their aim was to identify and informally recruit staff interested in participating in collaborative projects. Most frequently this occurred as the result of informal conversations between founding Hub team member Tim (Senior Clinical) and other clinical staff.

Tim emerged as a leading figure to encourage staff engagement with the Hub. He possessed enthusiasm and a creative mindset to encourage participation, as well as professional credibility as a paediatric surgeon. The combination of these qualities provided an inspiring pathway for staff seeking to combine expertise in digital technology with paediatric medical knowledge, to benefit healthcare users. Tim's clinical background was relatable, and his objectives for innovation embodied within the Hub environment, helped to demonstrate a shared NHS commitment to patient care. Therefore Tim was well positioned to explain how the Hub facility and environment supports the broader organisational ethos of serving patients. He communicated Hub benefits, and the opportunities to create needs-led innovation for user benefit, rather than focused on generating commercial profit.

As the Hub team expanded non-clinical Hub staff began to build relationships with internal staff. Their role involved expanding communications about Hub purpose and activities to encourage staff to participation. Building relationships with internal colleagues with roles across the hospital was important to resource the needs-led innovation process. As outlined in section 4.3 Hub staff members had different skills to support internal relationship building which primarily used one to one conversation. This was due to the complications of resourcing and executing a larger scale event within a hospital workplace where accessing

staff was difficult due to their job roles. At the time of data collection most initial contact was made by hospital staff interested in the Hub, rather than outreach by Hub staff. Typically, hospital clinicians explained their ideas and frustrations in prearranged meetings with Hub staff. This opportunity enabled Hub staff to offer support by assessing potential points of alignment with Hub objectives. These common objectives formed the basis of a working relationship, driven by clinicians' knowledge acquired from their clinical role .

Managing user needs and assumptions about the Hub emerged as a key part of the relationship building role. I observed the communication skills of Hub staff during supportive meetings with hospital staff. During these meetings they encouraged engagement, especially where they had identified a valuable skill set or promising innovation concept. Hub staff built relationships by explaining the innovation process, and how the projects are managed to help alleviate concerns. This is expanded on more in section 5.1.3.

Many clinicians were reluctant to participate in Hub projects due to apprehension over their existing workload, and a lack of experience of innovative development work. Hub staff sought to address concerns and misunderstandings about Hub activities, beginning with clearly defining Hub innovation. A member of the Hub team reflected, '…*we have a lot of talented people, the baggage of innovation language gets in the way… come to my innovation workshop – nobody turns up, why, 'because we aren't innovators. (I say) anyone a problem solver – yes? Right come to my problem solving workshop – the room is full! /…. What is innovation if not solving problems?*' (Jeremy, Professional Internal).

The duties of Hub staff included a number of people management tasks which were evident through the support given to collaborators during the innovation process. Hub staff engaged with a diverse range of hospital staff and individuals from commercial and research organisations. To build relationships, Hub staff identified characteristics and competencies within people interested in developing an innovation concept, or joining an existing project team. They also assessed their motivation, potential contribution and expectations. This strategic approach was important, as user-led collaborative innovation relies on an

appropriate balance of skills and resources and collaborator priorities. This is explored further in section 5.1.2 which focuses on balancing stakeholder requirements.

The contribution of Hub staff helped to provide stability and structure to support building internal relationships. This was achieved through effective communication, and the design and implementation of processes to structure the inherently complex and non-linear innovation process. This is explored in more detail in section 5.3. Clinicians were supported to learn unfamiliar language and innovation concepts. Graham a founding hub member reflected, '*Whenever I first started the project I didn't know what a business model was, so I was like this is good, just go with this. Then I learned about information governance, planning and more recently business models../…/ I couldn't write a Gant chart.., but I need to know that we need one!* (Graham, Nursing).

Hub staff influenced the pace and quality of the innovation process by educating innovation actors in fundamental business and innovation tools. In turn, this helped provide reassurance to project stakeholders who were working outside of the remit of the normal job role. The commitment and investment made by clinicians was very personally driven, and used knowledge gained from paediatric medical incidents. It was important that clinicians felt confident in engaging with the Hub, as their tacit knowledge was inimitable, and gave Hub innovations a competitive edge. However, Hub staff must respectfully manage and protect the multifaceted value of their knowledge from external organisations. Clinicians' expertise held strong potential for enhancing paediatric innovation, yet it originates from medical situations filled with frustration, disappointment and sadness. For example, a Hub team member explained the disconnect between Hub resources and the expectation, scale and gravity of challenges troubling hospital staff, '*It might be a problem we have but it's not something that we can tackle easily… a cure for paediatric cancer, … is not realistic, specific kind of goal*' (Scott, Professional, Internal).

Hub staff had an important role in directing how these emotive experiences could be incorporated into an innovation concept to benefit users. A staff member explained, '*I am not interested in the solution, I am interested in what is the problem you are solving? If they*

can't answer that …they are going to be very biased about a solution. They haven't thought it through… and that does happen quite a lot' (Robert, Professional Internal).

There were also instances where the focused motivation staff seeking to overcome existing barriers in paediatric care resulted in a steadfast commitment to untenable ideas. In such cases, Hub staff worked to retain the interest and knowledge of staff, whilst filtering, validating and prioritising the large number of ideas brought to their attention. . Joanna, a Hub staff member explained, *'how do you decide from 90 projects the 10 you can actually resource? This is a prioritisation exercise, you have to have some evidence … not clinical evidence at this stage, we are saying let's look and see what is going on in the market, have a look at the needs… understand the process, the pathways and see where it impacts'* (Joanna, Professional Internal).

Hub staff must show consideration in the approach used to manage communication with internal staff concept creators as ideas for innovation concepts came from clinicians who were driven to overcome current barriers in patient treatment or services. The person centred motivation for innovation concepts were an emotionally driven response to user needs. There was the potential to cause ill feeling if the innovation concepts were not managed sensitively, yet Hub staff must be objective. Joanna explained, '*…people are creating things that nobody needs, they are not creating solutions that work or have the utility and the application that is needed, they are too far away from a business perspective…'* (Joanna, Professional Internal).

Hub staff provided support to individuals and collaborative teams to facilitate objective discussion at multiple stages of the innovation process. Part of this approach concerned addressing differing stakeholder project priorities and expectations in terms of focus, pace, available resource and innovation outcome. Hub staff sought to identify and manage emerging issues and the potential destabilising impact they could have if not addressed. These ideas are explored in more details in section 5.1.2 which considers balancing stakeholder and project requirements.

Hub staff supported the collaborative process by using their people management skills. They aimed to sustain effective collaborative working by addressing potential areas of incompatibility with the Hub approach and innovation process. Hub staff provided training and one to one support to help individuals navigate Hub organisational culture and the innovation process. This was particularly important for this Hub as the healthcare environment is heavily regulated. This could create unrealistic expectations from stakeholders who were unfamiliar with context of Hub healthcare innovation, in comparison with what was found in other settings.

Hub staff used people management skills to balance varied stakeholder expectations whilst drawing on their knowledge to support collaborative innovation. By seeking to develop relationships with stakeholders, Hub staff were able to access individuals who could lead the creation of new multi-stakeholder teams. The extent to which this was possible was guided by available resource within the Hub. Hub staff aimed to guide clinical staff to be forthcoming in sharing knowledge, and participate in multi-stakeholder collaboration. As the Hub staff team expanded support for stakeholder relationship management increased. During data collection Hub staff shared how increased team capacity enabled team Hub staff roles to be evaluated. This highlighted the need for detailed written job specifications and agreement on personal and professional characteristics deemed necessary when advertising future Hub staff positions.

Increased capacity in the Hub team enabled areas of strategic management to begin to be considered. An example of this was discussion between Hub staff and the Hospital Board concerning staff reward for their participation in innovation activity, in a way that satisfied their innovation objective. A Board member explained, '…*we are starting to talk about if you got innovation from a particular member of staff then how do you reward that.., is it… not something that the public sector is used to doing*' (Clive, Hospital Board). Further examples include the management of intellectual property that emerged from innovation concepts. This is explored further in section 5.4.4.

During data collection effective communication and relationship management emerged as the central aspects of the approach Hub staff used to manage internal relationships. Efforts

to resolve the gaps between anticipated stakeholder contribution and communications to support successful collaborative working revealed weaknesses in the Hub innovation process. The Hub team responded by dedicating time to understand how to manage disparate stakeholder needs. By improving the innovation process stakeholders have benefitted from access to standardised Hub innovation process, and clarity on factors used to guide the concept selection and the concept development process.

However, despite the good intentions of this work, within the Hospital environment issues of a lack of Hub visibility and understanding the Hub purpose remained amongst staff and hospital users. The importance of using existing internal staff networks had proven partially successful in addressing these issues. But the suitability of solely using a person to person approach had been questioned, as greater impact required an increase in staff numbers to reach staff throughout the internal hospital network. Hub staff recognised the importance of larger scale staff engagement to generate staff receptiveness in preparation for the launch of Hub innovations. A clinician who worked as part of the Hub projects explained '*I think healthcare staff really need to be on board with it being the right solution, so you need a whole group of people there backing what has been produced… a good group of healthcare staff and patients that are supporting a particular innovation… rather than just one party trying to push it*' (Philip, Junior Clinical).

Efforts to build internal stakeholder interest in Hub user-led innovations supported the creation of acceptance for the Hub and its activities. Although the idea of change, and the introduction of new products and processes were not unusual in the healthcare environment, there were existing challenges which could impact success. Thus Hub staff justified why the Hub approach was necessary for innovation, rather than conforming to standard bureaucratic NHS process structures (discussed in detail later in section 5.4).

An important part of this approach was connecting the collaborative Hub environment and enablement of staff knowledge in Hub projects. To achieve this, Hub staff planned how hospital staff already engaged with the Hub could be used to engage with additional departmental hospital networks. The aim was to increase support for the Hub by creating acceptance and support amongst hospital staff. Hub staff commented that using peers was

considered to have the necessary level of legitimacy and rapport. It was anticipated that targeted attempts to improve communication with hospital staff would enable Hub staff to identify and utilise additional internal knowledge and user needs during concept development. Additionally, during the latter developmental stages of concept testing feedback from hospital staff may help rectify oversights in satisfying user needs and ensure compatibility with existing NHS processes.

This work intended to highlight opportunities for staff contribution and increase the number of staff speaking positively about the use of technology within a Hub's innovation process. Efforts to extend support for Hub activities, created opportunities to demonstrate how the Hub helped broader hospital aims to deliver world leading paediatric care to hospital users. Hub staff acknowledged that interacting with hospital staff could be challenging. A clinician explained '… *we are all really spaced out and are all on different shifts so trying to interact is a hard thing to do'* (Philip, Junior Clinical).

During the test launch phase of the first Hub innovation project a number of challenges emerged. The App being tested had been designed to improve patient experience, and support staff in areas where they experienced capacity issues and dated communication options. However, when testing the App, the operational climate and mindset of staff created issues due to a lack of receptiveness. Even though the App had been developed in conjunction with a team involving hospital staff the wider mindset of staff proved to be a barrier affecting deployment. This confirmed that further work was needed to develop and manage internal relationships to increase understanding of work in the Hub and anticipated user benefits. Further details of this App can be found in section 4.4.1.

During the test phase a parent shared their experience with a Hub team member, '… *(the parent said) we downloaded the App but when we came to the hospital no one knew about it… Now isn't that really disappointing? It is doing to be really difficult to generate excitement for the children if you haven't got the organisation ready'* (Denise, Professional Internal).

Hub staff were beginning the task of engaging with internal hospital staff to increase Hub visibility and improve acceptance of digital innovations. As the Hub had committed to work

on MedTech hospital staff must understand how such innovations could improve the healthcare environment and patient experience. Further details on this can be found in section 5.5.1. Early feedback from the trial of the App found that the lack of awareness amongst hospital staff resulted in parent feedback that staff were not prepared to engage in providing 'digital rewards' as part of the App patient reward process. Hub staff equated this with the complexity of the hospital departmental structures and issues gaining access to groups of staff to demonstrate the App, gain buy in and provide training. Informal conversations between Hub and hospital staff revealed a fear of job losses connected to an increase in digital tools and products. This created a reluctance to engage with benefits of App use, and an obstacle for Hub staff during the forthcoming dissemination and adoption process.

Hub staff aimed to demonstrate how their innovations were different to what had gone before, given their user-led, needs based design, and collaborative a development process. However, for these innovations to be successfully implemented staff needed to accept their worth, and how to incorporate them into their care delivery pathways. Hospital staff recalled how attempts to introduce digital innovations, developed externally had been under-supported and caused issues for healthcare staff due to a lack of training. This had resulted in them not being used. This reinforced the importance of effective internal relationship management as the future of the Hub process and implementation of Hub concepts was largely reliant on receptive hospital staff. Strong internal relationships between Hub activities and hospital staff aimed to contribute to positive outcomes for patient users, as staff would be ready to interact with the technology and use it to improve patient experience.

5.1.2 Balancing stakeholder and project requirements: the role of Hub Staff

This section presents how individual contributions of Hub staff supported efforts to balance disparate stakeholder and project requirements. Managing multi-stakeholder teams required an understanding of NHS systems, and the ability to identify staff with expertise to answer arising questions. The complexity of NHS organisational culture, and the connected

processes could only be understood and successfully navigated by staff with existing experience of these systems.

Hub staff previously worked in a number of different roles and sectors. Staff with NHS experience were able to share valuable insights with collaborators which supported the management of innovation collaborations. For example, Margie's background in other service transformation and change management provided a network of contacts across the NHS and experience of NHS project management. This was invaluable in supporting the Hub as navigates using processes not found elsewhere in the NHS. The routines and processes used throughout the NHS have been problematic for the Hub. Margie (Professional, Internal) commented on her experiences of '*how hard it is to make change happen*' during her '*42 years in the NHS*'. Her prior experience in specific areas like NHS process and healthcare regulation had provided the necessary insight and contacts to '*find a way through*' NHS bureaucracy. Whereas the personal connections between Hub staff and specialists working in the hospital provided access to expertise which was of high value to the innovation process.

The Hub brings together stakeholders who contributed to user-led innovation by sharing areas of strength. Hub staff had an important role as the central point of connectivity between stakeholder groups. They promoted cohesion by helping stakeholders understand the focus of Hub projects, and why accommodating the priorities of all users was important. Stakeholders came from vastly different organisational backgrounds including hospital board members, hospital staff, patients and their families, external commercial organisations, and staff from local Universities.

The Hub team tried to bridge gaps in stakeholder understanding about how the Hub operates, and what influenced this. In addition Hub staff responded to stakeholder issues regarding procedure, compliance and conduct. Stakeholder expectations of the innovation process were often challenged by the healthcare context, and its specific requirements. Hospital clinicians provided valuable insights to inform the design of paediatric innovation concepts drawing on their knowledge of current paediatric care challenges. However, clinicians' priorities around positively impacting the patient's healthcare experience often

clashed with ideas of attaining rapid evaluation data and profit generation. The tension between stakeholder groups is covered in section 5.3.3.

As project collaborators were working on Hub projects in addition to their main role, Hub staff provided a constant point of connectivity between collaborators. Hub staff used their position to establish and protect the overall needs of the innovation project. This was important, as despite differing motivations and priorities, each stakeholder group made a unique contribution to the overall collaboration, and therefore their concerns and frustrations must be addressed to avoid jeopardising project progress. Further details on this can be found in section 5.4.

Hub staff used their relationship management skills to build rapport with stakeholder groups. Previously acquired project management experience enabled staff to explain causes of frustration, which arose from a lack of knowledge about the healthcare sector and how this impacted the pace of development and resource availability. Frustration about the time taken to develop Hub projects had emerged from internal board members, even though some have been involved with the Hub since it was created. This reflected a lack of understanding about the complex innovation process, and the intricacies of managing a new facility involving multiple collaborators. A comment from a Hospital Board member, demonstrated emerging frustration, '… *we got the Health Service Journal Award in 2014, the team was different then,… but we have still got some of the same people around. We said we won't go for another award until we have got some products… I said to Tim, that was 2014 and we haven't been back, because we haven't got a product!*' (Roger, Hospital Board).

Hub staff applied their relationship management skills to provide objective support, focused on successful collaborative relationships. Although Hub activity expanded and advanced, some stakeholder expectations remained unmet. From a management perspective, the development of processes to help structure innovation projects gave Hub staff a tool to use when trying to resolve stakeholder issues. As all stakeholders were keen to ensure that their own interests are responded to, the use of a process to justify and explain project progress and direction helped to balance these expectations. Scott (Professional, Internal) a Hub staff member explained, '*I think that you have got to communicate that everyone has their own*

value, and everyone has to have a tick in the box with what they want to do, if they don't, then it is a waste of time'.

This objective approach became important when developing collaborative partnerships as decision making increased in complexity. Differences in stakeholder priorities became more evident as concept development progressed. Hub staff held a neutral role in stabilising discussions and managing expectations. To support this need, staff began conducting detailed research and market scoping, to contribute objective points of reason and context to the decision making process. This is explored in detail in section 5.3.2. The Hospital Board expressed their hope that the Hub will become a self-supporting department. They recognised that well managed collaboration, led by clinicians' knowledge was a method of achieving this. Thus, the approach Hub staff used to manage stakeholder needs were an important variable in the longer term success of the Hub. Hub staff used transferable knowledge, personal skills, strategic insight and research informed objectivity to manage the stakeholder relationships and collaborative dynamics.

The context of the healthcare environment was significant in achieving this aim, as the primary role of clinical users was as hospital staff in healthcare delivery roles. Time spent on innovating, was time that could be spent on healthcare delivery. Thus, involvement in innovation work could become an unrealistic additional pressure unless changes were made to work schedules. Clinicians working in the Hub were often working over their contracted hours, whilst formalising staff time for innovation was considered. This demonstrated their commitment to creating innovative change. Graham (Nursing) a founding hub member and nurse reflected, '*it was meant to be one day in the Hub… but that rarely happens, especially with the App development which has taken a lot of my time… it nearly killed me … trying to do that and everything else at the same time*'.

During the start-up phase, clinical staff were contributing time to complete non-specialist tasks due to a lack of team capacity. The pressure this highlighted a need to review and direct user time, to maximise their contribution. Hub team expansion provided capacity for administrative staff to take on non-specialist project management to relieve this pressure. Redistributing workload tasks successfully focused users towards work requiring specialist

knowledge. Further work was needed at an organisational level to provide flexibility so more hospital staff could lead the development of their innovation concept. A Hospital Board member explained the current dilemma, '…*the guy who thought of it needs space to follow through, it won't happen otherwise…. It is about putting the infrastructure in to make the thing (Hub) a success… which includes back filling some people… but we don't have those resources in the NHS… we don't run with that sort of slack*' (Christine, Hospital Board).

Some progress had been made as the Hub team skill set and capacity expanded. Hub staff with experience in innovation management had taken over stakeholder communication, including strategic meetings with external collaborators where they led negotiations. However, the issue of the best use of clinicians' time was an ongoing issue. During data collection Hub staff were beginning to consider how to compare the intangible value of clinicians' involvement in innovative projects against tangible contributions in their health delivery role. Philip (Junior Clinical) explained, '*innovation in a healthcare happens best when clinicians are trying to improve something.. for patients, and then people who are expert at negotiating how that fits with someone else's agenda can help deliver that.. it is quite hard for clinicians to think about all the other aspects what drives someone to want to engage.*'

Evolution in Hub process emphasised a commitment to the role of users in directing concept development. A key part of the Hub's collaborative process was the value placed on a person centred, socially motivated approach. Increased understanding of Hub objectives, and clarity around stages in the innovation process had improved interaction with stakeholders. Increasingly there was agreement amongst the Hub team that a balance was needed to accommodate innovation concepts which had both commercial and social end points. The expansion of staff in the Hub team added commercial innovation management expertise. Robert outlined his role, '*It is working with people, helping them understand the pathway in terms of how you develop a new product and ideally take that to market, research around the problem and why we need a solution*' (Robert, Professional, Internal). Robert was employed to focus on developing stakeholders' understanding of the Hub innovation process. This decision demonstrated a commitment to managing external partners through using education. Robert's role helped to address current stakeholder

questions around the stages of project development. His role enabled the management of expectations by ensuring key conversations occurred throughout the development process. Proactively managing the innovation actors helped to establish a shared understanding and objectives for concept development.

During data collection, Hub staff were working to develop documentation to outline the innovation process and Hub supporting structures, this is examined in detail in section 5.3. The investment of time and resource allocated to this work demonstrated an acceptance of the role of process in managing multi-stakeholder collaborations in an effort to balance stakeholder needs. Improved articulation of Hub aimed to help collaborators understand the Hub approach, and connectivity with improving paediatric care and generating gains in efficiency or sales revenue.

Differences in stakeholder requirements demonstrated to Hub staff the importance of flexibility to accommodate varied needs where possible. If this could be achieved, Hub staff anticipated that confidence in Hub process would become more evident, through sustained collaborative participation. During data collection Hub staff shared how building an increased understanding of necessary infrastructure and resources was necessary, to support needs that emerged as innovation process progressed. Although initially the creative aspect of the Hub environment attracted attention from internal and external stakeholders, over time it became increasingly necessary to demonstrate that the Hub environment was able to support and incubate innovation. Hub staff commented that using Hub space as more than a space for discussion around creative idea concepts was not appreciated during the start-up phase. The Hub was moving towards understanding and communicating the types of value and impact that could be associated with their digital products. I observed how Hub staff were working strategically in their management of concept development teams. They aimed to create a development process that was self-sustaining and satisfactorily resourced. This approach signalled a marked changed from the initial emergent approach used to manage the needs of collaborative teams during the start-up phase.

Hub staff explained how transferable expertise of colleagues within the team was being used to manage the complexity of multi-stakeholder collaborations. This included time conducting scoping exercises to assess potential demand and uniqueness of the proposed innovation. Hub staff now led the negotiation of formal arrangements with collaborators prior to the start of concept development. This approach helped Hub staff to understand the potential needs and contributions of the collaborator. Taking time to investigate their motives has become a necessary part of the Hub management responsibilities to preserve Hub resource and maintain rapport within the collaborators. Hub team member Scott recounted the importance of establishing early on, '*do you want this, or do you actually want something that is completely different from what we do*? (Scott, Professional, Internal).

An outcome of resourcing the Hub with staff who were experienced in stakeholder and innovation management has been an evident through an '*increased level of assertiveness'* shown in collaborative discussions (Joanna, Professional, Internal). Adopting this position has helped to set initial expectations around Hub process and latterly discussions regarding the protection of intellectual property, and the negotiation of contracts. An objective approach led by Hub staff has created opportunities to identify appropriate partners and establish if compromises could be reached where ideas differ. This growth in confidence has been important, as previously the Hub had a limited ability to resolve stakeholder issues resulting from differences in NHS organisational process compared with that of commercial or research settings. These differences had proven difficult to navigate, and become a source of frustration. The decision to use Hub staff, rather than founding clinicians to guide stakeholders through collaborative discussions has benefitted external stakeholders. Hub staff applied their past exposure to organisational management issues of outside of the intricacies of the NHS. This has been useful in helping external stakeholders understand the different methods of operation and healthcare policy and regulation.

5.1.3 Managing internal awareness: Hub projects and implications for healthcare pathways

As introduced in section 5.1.1 part of Hub management activities involved developing an awareness of the Hub and its innovation projects within the main hospital. The key message

to be communicate was that innovation outputs aimed to improve paediatric healthcare by increasing digital options during the treatment process. It was necessary to generate awareness that an outcome of Hub activity would be the introduction of new processes and elements into the care pathway. To manage expectations of hospital staff it was necessary to begin introducing these ideas during the early stages of the innovation process. During data collection Hub staff were planning how to create opportunities to share innovation projects within the Hospital on a larger scale, and how best to connect with influential key staff across hospital departments.

Amongst hospital staff, an unfamiliarity with the technological aspect of the Hub activities along with the formation of multi-stakeholder partnerships created incorrect ideas regarding who the innovations were for, and who they would benefit. This issue was exacerbated by insufficient Hub communication to provide clarity regarding these concerns. The use of hospital clinicians as key collaborators had benefitted ongoing conversations around the concept development. The main challenge for Hub staff continued to be extending an awareness of Hub activities amongst hospital staff, to gain support for MedTech and generate an understanding of Hub activities. The slow pace of technological advancement within the NHS has created a general lack of understanding regarding user benefits of digital innovations. Although technological devices were an integral part of the lives of young people, a lack of exposure to the design of App's and interactive software has resulted in a negative perception amongst some staff. A hospital staff member commented, '*it (innovation) is a completely different way of working and outlook on life. Tim knows this… there is a perception internally that innovation is a bit boys with toys and nobody here internally hears much about what the impact has been, and that needs to change, a bit of promotion internally*' (Suzanne, Professional Internal).

During data collection a lack of understanding about the Innovation Hub and its activities emerged. Jeremy (Professional, Internal) explained, '*There are different levels… innovation… as a department,… a set of practices that we spend our time on, and then the innovations… those shiny things people point at.. then there is the Trust view… it is not something that is well understood… I make it my business when I talk to colleagues… to understand what they think it is… (and) who they think innovation is for, and it is never the same answer.*'

Efforts to increase staff confidence in innovation and appreciate the benefits of MedTech were in their early stages. However, the verbal methods used by Hub staff had created ambiguity in how the Hub facility and activities were portrayed. A Hub staff member reflected, '*Are we all consistent in what we say? No…. but it needs to be consistent, there has to be one version of the truth… not which is your favourite /…/ what is project three, … the description, why are we doing it… (and) the benefits*' (Jeremy Professional, Internal).

Hub staff team were responsible for leading the education of hospital staff on the benefits of digital products to establish an understanding of potential benefits ahead of product launches. Hub staff all recognised the importance of technology as a method of delivering information to meet the varied needs of patients and families. During data collection they described the intended benefits of their product, and why the use of technology as the delivery mechanism was an efficient and user friendly decision. However, their approval of digital tools cannot be assumed to be shared by staff across the hospital.

Hub staff had begun to discuss how best to build staff interest in the Hub by sharing how Hub activities used a needs-led ethos, and prioritised improved patient experience when developing new digital products. By improving the presentation and delivery of information about the hospital, it's environment and the healthcare treatment process they aimed to meet the expectations users accustomed to accessing digital information on demand. Hub staff were able to advocate for its beneficial outcomes, but without gaining the trust and acceptance of hospital staff it would be challenging for the products to be successful. More detailed information about the Hub projects is presented in sections 4.4.1 and 4.4.2.

5.1.4 Building an Innovation Culture

In addition to managing relationships with internal and external stakeholders, the development of a Hub innovation culture was considered a prerequisite for supporting multi-stakeholder collaboration. Whilst operating within the strict regulatory frameworks of the host hospital, the Hub needed to build a culture that fostered innovation. As a Hub staff member commented, '*people (in the wider hospital) don't understand (innovation) here, culture is very much the thing that kills innovation*' (Scott, Professional, Internal). The

features of an innovation environment were considered to be incompatible with a typical department within the healthcare sector. Therefore, building an innovation culture within the Hub was necessary to avoid being restricted by bureaucracy found within NHS systems.

The management style that best supported innovation activity required a level of tolerance to risk, and a receptiveness to experimentation. The collaborative approach used in the Hub required freedom to meet with stakeholders in a space that was not restricted by hospital protocols on infection control and patient privacy. This was a marked difference to what was deemed appropriate in standard hospital organisational culture. Within the Hub innovation culture there was the belief that there were potential gains from being open to opportunities, and that calculated risk was part of the innovation process. For example, by developing a distinct innovation culture, it had been possible to incorporated these operating principles into a new way of working, and create an innovation mindset within the Hub facility. Investment into developing an appropriate innovation culture support strategic aims of the Hospital Board. A senior hospital staff member shared '*I think part of achieving success… will be an innovation driven culture … the ideas and the intellectual property will come from our workforce* (Gemma, Professional Internal). Section 5.2 considers the theme of innovation culture in more detail.

The Hub purpose lies outside of the healthcare delivery focus of the hospital. The approach of using technology to meet the patient experience needs within a paediatric healthcare environment was unusual. Furthermore, so was the use of the specialist experiential knowledge of staff to lead the design and content of innovations. For example, therefore throughout the concept development process there were multiple elements of risk and experimentation. Innovation actors were attempting to ensure alignment between their product and the differing needs and expectations of users. Within the ever changing healthcare setting this was a difficult but important task. A founding Hub member Peter (Nursing) explained, *'..how children interact with the world is becoming more digital and more virtual /… / how they interact with us is different, so we can embrace and enhance that digital path'*.

The person centred ethos was an integral part of the Hub innovation culture, and was reflected through the design of innovations specifically for paediatric patient which used familiar technologies like App's and digital immersive game settings. More detail about the products under development can be found in section 4.4.1 and 4.4.2.

The position of the Hub, as part of the hospital campus also contributed to the culture within the Hub, as it remained part of the hospital in terms of access points, and surroundings. This held positive associations for external stakeholders who had been eager to form connections with the hospital, and access the valuable staff knowledge. These elements found in the innovation environment helped facilitate the innovation process.

The emerging Hub innovation culture has benefitted clinicians who were able to access the Hub environment where they could innovate, without the constraints and regulations found within their main work environment. This generated opportunities to use novel approaches and pioneering resource to develop innovations that otherwise would have been difficult to achieve. To make best use of the technologies available, collaborative working provided job enrichment opportunities for clinicians who were keen to apply their skills in problem solving in an innovation environment. The Hub innovation culture enabled clinicians to feel comfortable, and behave in a different manner to what was appropriate in their healthcare delivery role. The freedom to meet with external stakeholders within a creative and discursive setting aided stakeholder dialog as contributions could be made without fear of negative medical consequences.

Part of Hub management related to responding to the emergent challenges within multi-stakeholder working. The innovation culture of the Hub required Hub staff to understand and manage tensions which arose when then was a clash of expectations between innovation actors from different organisational backgrounds. Successfully achieving this was an ongoing process, as Hub staff learnt from situations they encountered.

To reflect the diversity of the Hub activities Hub Staff began using a '*portfolio approach*' (Joanna, Professional Internal) to demonstrate the varied nature of innovation concepts under development. This helped to communicate how the priorities of socially,

commercially and data driven stakeholders could all benefit from participating in the multi-stakeholder Hub process, and innovation culture. The inclusion of the insight of clinicians paired with use of emerging technologies added to the distinctiveness of innovation culture. There had been a widespread impact on healthcare staff and patient users due to the lack of digital information pathways for paediatric patients. A lack of accessible information was a contributory factor in patient anxiety. The collaborative methods used in the Hub sought to presented information in an engaging way that supports wellbeing. This aspect of collaboration is examined in more detail in section 5.5.1.

The Hub innovation culture has been informed by the motivations of its founding members. As founding members were from medical backgrounds there was an initial lack of knowledge in the development and implemented of innovation process. This meant that the Hub was led by enthusiasm to pursue novel and creative solutions to user needs. The lack of process during the start-up phase has shaped stakeholder perceptions of the Hub. During data collection some concerns were shared about the stakeholder perceptions of Hub innovation culture as during start-up when the Hub approach was different to mainstream innovation methods to which some external stakeholders were accustomed. Denise, who worked on an innovation project but not as part of the core team stated, '…*people think that they can manage (innovation) by just reading a book and going to a few events, but it falls apart if you have not been properly trained and had experience in other scenarios… /../ my background is… health technology… and I have my Postgraduate Certificate in Innovation and Improvement Science* (Denise, Professional External). She continued to emphasise aspects of theoretical knowledge from her training, including how she viewed innovation management. She stated, '*it should be outcome driven…. better outcomes for people… so the five tenants of healthcare are safe, effective, timely, equitable and patient focused*.' Hearing Denise uphold a theoretical framework as an example of effective Hub management illustrated an underlying tension in stakeholder perceptions of Hub management, which reflected concerns about the innovation culture and use of process. Despite the lack of a formal Hub declaration to the tenants of healthcare principles, they could be identified within the development of Hub culture, albeit in a less procedural manner.

5.1.5 Developing Hub Capabilities

This section shows how the management focus has evolved as the Hub has become more established. The section begins by presenting the initial management challenges that required attention. This is followed by a focus on emerging challenges, and the approach used by Hub staff.

As staff numbers increased, resource was allocated to understand the necessary components of managing multi-stakeholder projects in a more systematic way. The early stages of the Hub operations were heavily influenced by the priorities and availability of a skeleton staff. This resulted in time and resource being allocated to the formation of initial contacts with potential partner organisations, rather than a phase of planning and process development. This is explored in detail in section 5.3.1. Over time as the number of Hub staff working expanded a period of adjustment occurred, as the opinions and priorities of staff have influenced the direction of Hub management. The collaborative teams that were formed during the start-up phase increasingly experienced difficulties due to an initial lack of appropriate project and relationship management. Hub staff became involved in overcoming these issues, by working with founding Hub members to ensure that they agreed in changes made stages of the innovation process. This impacted innovation culture as an eagerness to continually form external relationships was replaced by the implementation of a process that included additional strategic planning stages.

The development of an appropriate Hub innovation process was complicated by Hospital Board agreement that the Hub approach was not expected to mirror processes used in the main hospital. Therefore the Hub team sought to incorporate the differing needs of multiple stakeholder groups. In connection with this, was the need to sustain active projects that were unstable due to a lack of continuity of funding. As a result of the lack of process and planning in their early stages, these projects had a lack of formal agreements and structure. This created difficulties in meeting the requirements of funding bodies, who required applicants to provide evidence and justification for the funding requests, supported by documentation to show what had already been achieved.

Scott, (Professional, Internal) explained that the justification for early collaborative concept development, started prior to the team expansion was begun purely because the ideas were considered '*good*'. Subsequently management and practical issues have arisen which have frustrated Hub staff. Scott, (Professional Internal) shared '*when you go to get funding later and they come back and say, well someone already does this, have you not looked into this? So then we have to say no, we hadn't… those man hours could have put into a well validated project that has legs…*'.

To avoid persistent problems in these areas, Hub staff focused on establishing a process to review and research the applicability and uniqueness of innovation concepts to ensure sufficient demand and an ongoing purpose. They have worked to understand funding grant criteria and align Hub activities, to collect necessary evidence and information. The work of the Hub staff related to innovation process is examined in detail in section 5.4.4.

In conjunction with these challenges a need emerged to develop capabilities to support projects as they developed. Responding to stakeholder pressure to quickly deploy innovations required the attention of Hub staff, to avoid costly mistakes resulting from poor planning and an underestimation of support required during the launch phase. Funding to continually provide support to concept development through years of development and refinement became a major challenge. Hub staff found that there was a disproportionate amount of funding available to support idea creation and invention, but much less to support the deployment of innovations, which also was a resource intensive process. This became a management issue that increased in seriousness as more innovation concepts advanced in their development. Hub staff had begun working on approaches to communicate the timeframe concept development, to educate stakeholders as to the time required to develop and test health innovations.

The need for the Hub to develop capabilities in regulatory and ethical issues related to the eventual use of products has emerged as important. The novel use of MedTech innovation in healthcare has meant that there were not yet established policies and protocols for guidance to align the Hub's operational direction. This is explored more is section 5.3.5. A clinician who worked as part of a project team using artificial intelligence explained,

'*everyone working within this innovation space needs to help design those guidelines as we go… I think if you wait so long that all the policy is well formed then you haven't got a lead on innovating something… you don't even find that there is a product until you start doing the innovation, so you just keep those checks and balances as you are developing a product and make sure you adhere to all legislation*' (Philip, Junior Clinical).

An additional area of emerging focused for Hub management was the development of a Hub communications plan. This was important to ensure key messages about the purpose and Hub activities were reaching their intended audience. A communications plan was considered an important tool in ensuring that stakeholders formed realistic expectations about available Hub resources and support. Suzanne (Professional Internal) a hospital staff member reflected, '*…they get all these ideas but there is no resource or funding to do anything with them, so you have raised people's expectations, staff come forward with ideas thinking something like happen and you end up with a backlog of things that are never done /… / the issue is, it threatens or credibility*'.

A misconception that circulated outside of the Hub was that there was a lack of ideas, and an endless amount of resource waiting within the Hub. Margie, a member of Hub staff recounted '*…a lot of people come in and say I've got a solution, build it for me! We had an anaesthetist who said I need someone who has got funding, and we said well we don't have any!... I think that there is the perception we have money to spare but we ain't, quite the opposite!*' (Margie, Professional Internal). This perception created some negativity and disappointment when ideas suggested by staff were not taken forward. The Hub staff were working on how best to communicate their emerging process of idea validation and prioritisation. Sharing this with stakeholders was intended to help to generate awareness of the stages within the innovation process. The aim was to show the rationale behind why a small number of concepts were resourced and invested in.

During data collection the need to increase Hub visibility was raised by multiple interviewees. Although the Hub was accessible from the main hospital, the busy schedule of staff means often prevented hospital staff from having time or reason to visit the Hub without direct encouragement from Hub staff. The lack of Hub visibility was further

hindered by a lack of Hub brand. This issue was important to address, as it aligned with other efforts to increase understanding of Hub purpose and the usefulness innovation in improving healthcare delivery and patient experience. This is explored in more detail in sections 5.2.1 and 5.5.4.

5.1.6 Section Summary Management of Hub

This section explored the approach taken by Hub staff during early stages of Hub development. Methods used to address challenges whilst establishing relationships with key stakeholder groups were presented. Hub staff identified a need to address a lack of stakeholder understanding of Hub purpose and process in a healthcare context. The contribution and role of innovation actors was defined, in particular that of users. Users' primary employment role in the main hospital restricted available time for innovation. Therefore, understanding how to best use their knowledge and manage skills gaps informed decisions taken during the innovation process.

During interactions between Hub staff and stakeholders to raise Hub visibility, a gap in stakeholder understanding of MedTech innovation emerged. Growth of the Hub staff team provided experienced resource to develop a strategic approach into Hub management and use of process. This section presented how Hub staff created a Hub innovation culture that complemented the formalised processes and acknowledged that whilst risk taking, experimentation and creative thinking were important to sustaining innovation activity, they were not accepted within main hospital processes.

The evolving Hub management style contributed to correcting initial oversights of planning and establishing an effective innovation process. The areas of their management activity were categorised through the thematic analysis in terms of the use of Hub space, collaboration with stakeholders and users and innovation culture. Each of these themes are considered in the following main sections, culminating in a fifth section exploring the evidence for the outcomes of their organisational efforts.

5.2 Collaborative Space

This section explores the significance of collaborative space in the Hub, to understand how it is used as a way to support innovation. In sub-section 5.2.1 the effectiveness of Hub space to facilitate communication between stakeholders is considered. Section 5.2.2 explores the function of Hub space for Users. Section 5.2.3 focuses on the attributes of Hub space that support stakeholder engagement. The chapter concludes with section 5.2.4 which critically reflects on how the use of Hub space evolved over time. The aim of this section is to consider the functions served by Hub spaces and assess the extent to which the use of space is supporting multi-stakeholder innovation.

5.2.1 The Hub as a Communication Space

This section examines how effectively the Hub spaces supported communication. Communication in this thesis is defined as the planned and chance interactions, conversations and meetings, between stakeholder groups. The Hub floor space contained a number of shared spaces. The aim of these spaces was to facilitate communication between stakeholders from different backgrounds within an environment where they feel able to focus on innovation. A dominant perspective amongst interviewees was the importance of the neutrality of Hub space as a key aspect of supporting this interaction. The opportunity provided by shared Hub space was viewed as important for stakeholders, as it provided an alternative to meeting in an existing organisational workspace. The Hub space was described as '*a place that both people (internal and external stakeholders) can go to and feel like they are kind of there (in the hospital) , but not there, and I think it is important to have that*' (Tim, Senior Clinical).

Due to operational restrictions within the main hospital environment, internal stakeholders agreed that the Hub space was necessary to facilitate multi-stakeholder innovation. Shared space in the main hospital was focused on healthcare delivery. Therefore the Hospital Board and staff users both acknowledged the strategic and practical need for a dedicated innovation space. At the outset supporting effective communication between internal and external stakeholder groups was understood to be a key part of the innovation process. As

this was an unfamiliar and complex process for Hub staff, having a separate Hub space was important. This enabled Hub staff to develop an understanding of how to manage the use of Hub space support collaborative working.

The Hub provided access to a type of environment not commonly found in the NHS. '*Where innovation is concerned, what we know is there isn't actually much capacity to do different things, to think about innovation, try new stuff. The capacity to explore, to test, to get things wrong, doesn't exist within the NHS*' (George, External). The Hub space enabled stakeholders to interact, think and behave differently. Hence the evidence showed that Hub space was important to facilitate interaction and creative thinking between stakeholders. Collaborative, exploratory use of Hub space guided by Hub staff formed the basis of a distinct Hub based innovation culture. The use of Hub space to enabled communication and collaboration amongst stakeholder groups, which was at the core of Hub innovation culture. By using and benefitting from the novel environmental conditions, stakeholders were able to collaborate, deliberate and share expertise to inform product development. Using Hub space in this way facilitated person centred development of Hub innovation concepts and supported a multi-stakeholder innovation process.

A number of factors influenced the effectiveness of the communication between stakeholder groups using the Hub space. Initially the Hub space simply provided an identifiable place for innovation activity to occur. As a result of Hackathon events organised in the space, contact was made with stakeholders interested participating in collaborative innovation. Board member Clive reflected, '*…in the Hackathons, hundreds of staff came forward with ideas and problems, wanting to pitch the problems and people pitched solutions as well. So there is an appetite for solving longstanding problems /…/ within 24 hours a prototype was designed with a blue-toothed a signal /…/ 20 years of experience and frustration being put into a group of people who then came up with an idea. So we have actually created a culture that people understand as nurturing and wanting to drive people on.*' Although the Hub space continued to provide an environment that was conducive to stakeholder interaction, during the start-up phase a lack of strategic planning by the Hub team created barriers to the Hub evolving as a communication space.

Accessibility became an issue for the Hub space, and it was acknowledged by the Hub team there was no easy solution. A lack of signage to the Hub, follow by a locked main door requiring a key card, or ring of an unreliable doorbell created a barrier to impromptu visits. Unlike the rest of the hospital new build, the needs of Hub stakeholders had not been able to be planned into the Hub facility. This stood out in contrast to the rest of the building where it was very evident that, *'the design… was organised around the principles of the person (stakeholder) who you are trying to serve, organise it around them so that you make it easier for them /…/ the signage, the environment, the physical environment, a whole set of things'* (Clive, Hospital Board).

Therefore, unless there was prearranged swipe access, interaction between stakeholders was influenced by having access to pre-arranged public events or scheduled private meetings. Given the need to protect the intellectual property emerging from innovation projects under development in the Hub space, this level of protected access could be regarded as necessary. Within the hospital restricted access was active in certain areas of the building. However lessening restrictions to Hub access would create benefits stakeholder interaction. The process of managing stakeholder interaction emerged as requiring further thought. At the time of data collection Hub staff were engaged in reconciling issues connected to protecting the security needs of the hospital whilst stakeholder access to Hub space was improved. The increased focus on how processes were needed to support collaborative innovation are covered in section 5.3.2.

Communications within the Hub were also influenced by the extent of planned activities for stakeholders. Gemma (Professional, Internal) identified weaknesses in how the Hub space was shared, …'*we don't have a communication plan in the Hub, and there are lots of other things around the look and the feel of the Hub, what is brand hub?'.* During data collection I observed team meetings focused on Hub website development, and efforts to submit news stories for inclusion in the hospital newsletter and annual report. There was a recognition amongst staff that it was necessary to use digital and internal communication methods to increase the visibility of Hub space. Growth in the number of Hub team employees has helped address had capacity issues during the start-up phase. As a result, opportunities

presented by using an online, digital Hub space were being considered as a way to promote and manage stakeholder participation.

In addition, I observed meetings where the hub team discussed plans for using Hub space for events that aimed to educate and motivate stakeholders on the purpose of Hub innovation and importance of user participation. The objective of these events was act on Hub staff realisation that '*you have to speak to the wider group (of staff) … there are always good people and you have got to find them*', which assisted the creation of new user connections and access to their knowledge which often benefitted Hub activities (Jeremy Professional, Internal). The Hub space contained physical examples of current project work, including physical prototypes of Hub products, beta test versions of software and an exhibition area with photos and write-ups of concepts in early stage development which stimulated discussion between with staff and other stakeholders. The inclusion of these items in the Hub space provided the basis for users to discuss their own ideas. In turn, stakeholders could begin to understand how innovation was managed and defined within the Hub space. Plans to extending these messages by using digital platforms like a Hub website and communication tools like the internal newsletter and annual report held the potential to develop and increase communication with and between stakeholder groups.

5.2.2 The Hub as an Engagement Space to inspire and support Users

A key function of the Hub space was the provision of a place for hospital users to share their problem-based needs for innovation. The Hub spaces supported users by providing access to a '*resource*'; guidance from Hub staff and access to informal shared spaces (George Professional External). The breakout areas provided sofas and white boards for stakeholder use. Such dedicated space for experimentation and creative thinking were not commonplace elsewhere in the hospital. There were also two meeting rooms that offered space for a range of meetings and events. Although the space was of practical benefit it had not been invested in terms of branded design. Therefore, efforts were being considered to better inspire stakeholders by a visual presentation of Hub activities and purpose. This aimed to convey how Hub space functioned, and to meet stakeholder expectations of an innovation workspace. Similarly, the space occupied by the 3D printing company incubated

by the Hub provided a place of visual interest due to the printing machine and production of 3D body part prints. This space embodied stages of the innovation process, and Hub purpose in a way that was not possible with the other projects. I observed their computer based workspace, which was a strong indication of how the innovative use of technology had been applied to create a user benefit, aided by the support received within the Hub environment. For that reason, their presence in a space near to the Hub entrance, and across from the display space added to the environment of the Hub.

I observed a lack of designated space available to work on making physical prototypes, or engage in other practical tasks. Additionally, use of space for the desks interspersed workspace for full time staff with hot desk areas for part time hospital staff working on projects. Meeting rooms were used to hold conversations and team meetings to prevent disturbing other Hub staff which resulted in an often silent work environment. Although the assumption around the Hub, was an environment of technological experimentation, which could be viewed as intimidating by hospital staff. The need for a large desk-based workspace could also prove off putting for visitors as it created a quiet working environment in the Hub. Although this quietness was supporting the development of innovation projects and the innovation process it may not meet with the expectations of people visiting the Hub. However, the use of meeting rooms for the more collaborative elements of Hub work seemed to be both a functional and suitable use of space.

Off the main floor space were rooms which had received more decoration, in line with their purpose. This signified an intentionality about their purpose and the commitment to aspects of innovation culture. The patient experience bedroom was a space which aimed to help provide iterative feedback during the project testing stages, '*to see if it meets the needs'* (Margie, Internal Professional). The space simulated an environment where paediatric users could engage with hub products in a setting similar to where they would be used, to see how beneficial they were to their patient experience. Similarly the room housing virtual reality equipment provided the opportunity to test the medical usefulness of projects using this technology in an experimental setting by providing the necessary space for simulated testing. However, these spaces were often used for ad-hoc meetings rather than for their intended primary purpose. Perhaps this was due to the current level of development of Hub

projects, many of which have not reached the testing phase where these spaces would be most useful.

Users currently engaged in Hub projects predominantly were employed in surgical or senior nursing roles within the hospital. The Hub space created the opportunity for a change in behaviour, a *'phase shift'* away from the approach to ward based problem solving arising from medical training (Tim, Senior Clinical). This was important to help clinical users begin to understand how participating in collaborative working supports the development of a solution to their needs-led problem. The application of this approach to problem solving was a very different method to what was used in clinical settings.

By using the Hub space, clinicians could become immersed within an environment which was different to the main healthcare environment. The Hub space strived to stimulate innovation through the generation an innovation culture, and a collaborative stakeholder response to ideas suggested by enthusiastic lead users. When contrasting the Hub to the main hospital environment, a founding Hub member described the Hub space as, '… *rough and ready, very changeable, it is in the hospital but it's not really in the hospital, it's a place where I can bring people*' (Tim, Senior Clinical). Much of the Hub floor Hub and furniture could be reorganised into different layouts, providing space to host events, requiring low staging, presentation screens, a lectern, flip charts and rows or cabaret styles of seating. The three break out rooms offered a board room style meeting space and two smaller casual spaces with sofas, flipcharts, wi-fi and presentation screens.

As users were often unfamiliar with the concept of innovation and the collaborative innovation process. The organisational culture of the main hospital created barriers to thinking and behaving innovatively due to institutionalised patterns of behaviour e.g., risk management processes. Thus, experiencing the Hub space helped to introduce different ways of working, like how to think creatively, and work collaborative with engaging staff from commercial and University settings, prior to the user becoming more involved. When hosting groups of people, the Hub had the floor space to showcase a number of prototypes and let visitors try using new innovation concepts, as Margie (Professional Internal) explained, '*during the conference breakout session in here … we had all the simulations out,*

… using laparoscopic instruments to thread a shoelace through a series of loops – harder

than you think because you don't have any depth perception when you are looking at in 2D!'.

As collaboration with external organisations was essential to Hub innovation projects, users benefitted from the option to host external visitors within the Hub spaces. The Hub spaces provided opportunities for external visitors to experience aspects of innovation culture by '*setting up'* dedicated meeting with Hub staff, '*demonstrating'* how new technologies like Virtual Reality were used to benefit healthcare users or by '*touring'* the Hub facility to see how the space was sub-divided. (Suzanne, Professional Internal). A further advantage for hospital staff users was that Hub space was a suitable place to bring visitors. (Tim, Senior Clinical) explained, '*… you can't have some random guy coming in, looking at patients being treated. Whereas I don't worry about that here…, yet they still feel like they are in the hospital. I think it is an important, almost like a neutral zone… a place that both people can go to and feel like they are kind of there, but not there and I think it is important to have that.'* These messages were reflected on by a hospital board member who commented staff users had stated, '*you underestimate the power of… this organisation in terms of being open, engaging, welcoming and supportive'* (Clive, Hospital Board).

Hospital staff users shared personal experience of how the access to the space and the resources housed within the Hub were benefitting their innovation needs. Users working as part of collaborative project teams used desk space in the Hub to engage in digitally based work, and meeting rooms for project meetings. Clinicians typically did not have access to desk space or a PC on the hospital campus as they were theatre or ward based. The onsite support from Hub staff colleagues also working from the same space was recognised as particularly important to sustaining the engagement of users. Graham (Nursing) explained, '*…the project management and support staff are required, because clinicians will always default to looking after patients first… project support /…/ has catapulted the project forward in a massive way /…/ there are so many distractions and time pressures on a clinicians time, actually doing the ordinary stuff is incredibly challenging … printing stuff off, chasing stuff down, being available to answer the phone, that is a killer for me, if anyone phones me Monday or Tuesday then I am in theatre, … it doesn't matter if it is a really*

important project point, I am still not answering it. So that is where the project support infrastructure is really important.'

As clinicians' workspaces were incredibly varied, and they were constantly on the move. The Hub provided a place to pause and focus on innovation task, whilst accessing support from the Hub team. As outlined, users benefitted from the provision of collaborative innovation space to support the development of their ideas. For users the display space functioned as an engagement tool, it aimed to show how user priority for needs-led innovation could be supported through collaborating with commercial companies and research led universities. The Hub have used some space to present examples of current projects that show how technology, external stakeholder resources and knowledge could be used for the benefit rather than detriment of users. During discussion with Hub staff, they shared how this was necessary to overcome reluctance and misinformation circulating working with commercial organisations. By providing examples of existing interesting multi-stakeholder engagement with the Hub, intended benefits of the collaborations could be shared to address user concerns and encourage engagement.

The Hub also functioned as an engagement space that provided a number of different functions. Stakeholders who accessed the Hub space, were able to talk with Hub staff and meet key innovation actors. These interactions demonstrated how the process of how user needs are responded to and connected with stages of the innovation process. A hub staff member, Scott (Professional Internal) explained, '*I think that is where the innovation team is helpful, we can connect the dots, to get the right people in the room*. Being able to see evidence of this within the functional Hub spaces helped to develop an understanding of the role of user contribution to the multi-stakeholder innovation process. Robert, (Professional Internal) shared, '*there is a growing recognition that clinicians can't or don't necessarily want to just be clinicians, they have a good understanding of problems and … access to patients and to the hospital and so on*' and therefore were increasingly keen for space to explore innovative solutions. As current innovation projects progressed, there was Hub staff recognition that further adaption of the use of Hub space would be needed, to ensure user needs were supported during the latter stages of project development. This is discussed in section 5.2.4.

At the time of data collection, users involved in the Hub spaces predominantly came from more senior surgical and advanced nursing positions. Jeremy (Professional Internal) shared plans to engage directly with nursing staff to encourage involvement in the Hub activities, '*we think that nurses are the real innovators as they are the real problem solvers*'. Faye (Professional Internal) explained, '*… they can't leave the ward, when they are working, they get a break for lunch if they are lucky…. We have ordered some banners and an exhibition stand and we are going to try and sit in the ward staff room, and see who we can catch and tell them who we are, especially ICU they are just never ever getting a break. Doctors do, nurses don't which is interesting.*'

For users with demanding clinical job roles, the Hub space provided a place to develop awareness of broader strategic, economic and research based factors which effect resolving their need. Furthermore, this interaction provided a pathway for Hub staff to manage the reciprocity of knowledge between stakeholders. The Hub spaces were vital to facilitate a user-led innovation process, where the innovative approach was orientated towards resolving user needs. For users the Hub space offered an opportunity to explore innovation concepts within a supportive collaborative innovation. A clinician commented that Hub staff had, '*shown me what is possible*' (through using technology and input from collaborators working in the Hub space) (Gail, Senior Clinical). The collaborative innovation process is examined in more detail in section 5.3. The current intention was for the Hub space to function as a place where users have dedicated physical and mental space to detach themselves from their work context and the restrictions associated with this. Graham, (Nursing) commented, '*in order to innovate you need space /…/ what I find in the NHS is that the one little space that you had got isn't there anymore because it has been cut*'.

In summary, stakeholders who spent time in the Hub space were able to access support from Hub staff, and benefit from immersion in an environment focused on technologically driven paediatric innovations. The Hub space sought to encourage users to share their tacit knowledge and contribute to resolving current user needs within the hospital. Without the space provided within the Hub, it would be unlikely that users would have access to a suitable, accessible space for innovation within the hospital campus. Furthermore, having access to spaces which were suitable to host external collaborators and visitors was also

unlikely within the main hospital building. The Hub space provided these functions and therefore supported the development of multi-stakeholder engagement and potentially the creation of working relationships.

5.2.3 The Hub as a Space to engage with stakeholders

A key feature of the Hub is its potential to facilitate collaboration between internal and external stakeholders from different organisations, without generating concerns about *'infection control'* (Ruth, Professional Internal). External stakeholders could access the Hub without entering through the main hospital building. A role of Hub space was the creation of a space that external visitors recognised as a place focused on innovation, whilst ensuring it retained connectivity to being in a healthcare setting. As described in section 5.1.4 although the Hub's central location was within the main hospital campus the feeling of the Hub space was distinctly different. Hub staff prioritised showing stakeholders the project display space. The function of this space sought to benefit stakeholders through shared examples of Hub innovation projects that showed how users and stakeholder knowledge could be combined into exciting innovation concepts.

Thus, as stakeholders experienced different zoned space within the Hub, the foundations of the innovation culture were reinforced. Zoned spaces included, flexible space in break out rooms to discuss concept development, a more formal board room to present and validate ideas in front of potential collaborators, desk space to work on software programming and pieces of Virtual Reality, Augmented Reality and 3D Printing equipment as tools for use in the innovation process. Some stakeholders entered the Hub with pre-existing ideas on the purpose of the Hub space, and connected processes. Therefore space was used to challenge their past experience of innovation, and convey the importance of a participatory, flat innovation culture within Hub spaces. The aim was to encourage all stakeholders to feel comfortable enough to share their perspectives and knowledge, and overcome hesitancy around challenging the opinions of stakeholders who held senior positions in their organisations.

The dominant stakeholder perspective relating to Hub space and stakeholder engagement advocated how space created multiple opportunities. However, there was an external acknowledgement of criticism regarding the presentation of the Hub space. The industrial feel of the Hub space was not intentionally designed. This had created a particular impression, which may not have met with stakeholders' expectations. An external stakeholder commented, '*I don't particularly like the Hub as a working space, it's not great, but at least there is a space, and a resource there*' (George, External Professional). George's comment acknowledged that the aesthetics of the Hub space, known internally as '*the bat cave*' amongst staff due to the windowless, large space with a lack of interior finishes (Tim, Senior Clinical). During data collection internal and external stakeholders both remarked on the presentation of the Hub space, commenting on '*lots of things around the look and the feel of the Hub*' (Gemma, Professional Internal).

Although the physical space was valued by stakeholders, stakeholder comments indicated that the presentation of the space could be improved. Priority had been on developing the foundations of strong collaborative projects rather than on the visual interior design elements of the Hub. As projects were digitally focused, using computer based technology the relevant Hub facilities have been desk-based workspace. Although this was relevant for the projects, it was not very engaging for visitors. Therefore, as Hub staff began to consider increasing their visibility and actively promoting the Hub, the interior feel of the Hub space emerged as needing reconsideration. As the Hub had refined how space was used, it had become necessary for Hub staff to manage the expectations of stakeholders, so there was clarity around the main functionality of Hub space. Stakeholders' expectations about the level of available resources and access to users was often not realistic. A hospital stakeholder working with external organisation commented, '*there are no shortage of ideas or creativity but obviously there is a finite resource that can translate that into a visible project*' (Suzanne, Professional Internal).

Hub staff were keen to promote the external partnerships and members of their staff who were involved in Hub projects. Yet external commercial and research collaborators were not visible within the Hub during time spent collecting data. This reinforced why it was

necessary to be clear about current activities in the Hub space, to accurately manage expectations, and stakeholder perceptions of a collaborative Hub space.

A key reason for stakeholder interest in the Hub was gaining access to user knowledge. But as clinical users had hospital roles, much communication was via email. Thus, the Hub project management and administrative staff were the main presence in the Hub space. It became important for stakeholders to understand the principal role of Hub staff as project managers of the innovation process. As the Hub activities increased, Hub staff became the most visible and active group in the Hub space, within meetings and at their workspaces. Their full time Hub presence aided stakeholder engagement and helped sustain the momentum of projects. I observed that the Hub space was often quite static, not a space where different stakeholder groups were casually meeting and having creative discourse. As the Hub staff occupied space in the Hub full time they were able to compensate for the otherwise intermittent communication between other innovation actors. Once these dynamics were understood by stakeholders, they could understand the purpose and extent of their contribution, in conjunction with the role of others. This is explored in more detail in section 5.3.3 in connection with the collaborative innovation process.

Despite the limitations of the resources available in the Hub space, external organisations and stakeholders could benefit from accessing the Hub. For example, an external project participant reflected on his perception of value found in the Hub space emphasising, '*their integrity and genuine purpose, which is to boost innovation, to boost small businesses... to have medical impact'* (Charles, Project participant). The Hub space provided a new location and type of person centred environment, where it was possible for external individuals and organisations to gain direct access to healthcare staff, which was unusual within a highly regulated healthcare sector. Charles a (Project participant) supported by the Hub's SME development project shared, '*the Hub staff knew the respiratory consultant ... (he is) notoriously hard to get hold of... they do opens doors... turns out he is a big guy in the respiratory asthma world – wow! Could I put a value on that? I mean when the moderator of that grant application reads that the Head of Asthma is quoting this for me ... that is potentially the value of the grant, the £400,000 grant. You will never know because it isn't*

counted but is it the landscape of integrity that we are talking about here, within the medical field that you can't get into'.

An external collaborator reflected on feedback related to the Hub space, '*we hear from the businesses … big and small … they value the sign which says 'innovation – tick' you know, so they value that place (the Hub) where they can just go and have a conversation*' (George, Professional External). The Hub space made it possible for stakeholders to directly engage with clinical users who were unlikely to travel outside the hospital due to their work commitments. Access to the Hub facility provided dedicated space that helped meetings between the external organisations and Hospital users. A key purpose for the Hub space was to manage access to valuable user knowledge for external stakeholders. Therefore the provision of designated space in the Hub, which permitted exploring potential working relationships was of incomparable value for stakeholders.

The location of the Hub space was a key part of this, as it enabled a reconciliation between the differing needs of internal users and external stakeholders. The Hub space facilitated stakeholder to access a supported innovation pathway within a specialised and difficult to access organisational space. In the Hub space, Hub staff had control over the innovation process, and management of stakeholder priorities. Having control of the management of the space provided support to encourage users to meet with external organisations. It helped to allay clinicians' fears over user needs being overruled within organisations used to the commercial innovation process. This capability meant that Hub staff were keen to emphasise the significance of Hub space as a vehicle for creating engagement and collaborative opportunities for external users.

5.2.4 Changing use of Hub Spaces

During the start-up phase, the novelty of dedicated space for innovation prompted the Hub team to discuss how space should be used. Initially the 1000 square metre Hub floor space was totally empty, '*there was no one down in the Hub, it was like, just one desk in the middle of the floor!*' (Margie, Professional Internal). During the start-up phase, the availability of space enabled the Hub team to inform how space was used. Over time, the Hub space was

informally divided into zoned areas to support current key areas of activity. The development of these Hub zones was prompted by a number of factors. On a practical note, founding Hub staff sought to accumulate furniture and resources. This enabled the creation of zoned into spaces that provided different functions. Meeting rooms and shared workspaces gained sofas and small tables to support informal stakeholder meetings. The addition of desks and chairs enabled a seated office style area for Hub staff. Through equipping spaces to host meetings, and enable staff to work from the Hub the foundations of collaborative working began to be possible within the Hub space.

In conjunction with this, the Hub team expanded to better support emerging multi-stakeholder teams. Staff working with innovation actors developed a space to display current innovation projects as part of early project management work. The ability to tangibly present aspects of technologically based projects for visitors became increasingly important, to counteract the otherwise office focused Hub space. The marketing experience of more recently recruited Hub staff informed the development of display spaces with interactive technologies and informative materials relating to Hub projects. As the Hub began to host events to encourage internal and external visitors into the Hub space, managing expectations about what was present within the Hub space became a higher priority.

In summary, the Hub space must fulfil a number of requirements to support the creation of collaborative projects. The space was zoned to meet the requirements concept development, Hub staff workspace, and space for meetings, event and networking. Predominately, space was used as workspace and meeting space. The designated use of rooms like the patient experience bedroom indicated the intention to conduct inhouse testing once appropriate. However, albeit functional the Hub space seemed to lack energy and momentum. This in part was linked to the necessity for quiet workspace for staff, which although supported innovation projects, did not add to stakeholder assumptions of a hub environment. Hub space lacked investment to show the connection between key elements of the Hub purpose, use of technology and multi-stakeholder collaborative process.

5.2.5 Section Summary Collaborative Space

This section highlighted the importance of Hub space for communication, engagement and collaboration. The Hub space provided accessible space for stakeholders to think and behave differently compared to their conduct in the main hospital. The creation of zoned Hub space to support stakeholder engagement were explored. The different types of spaces were detailed. The resource implications of flexible layouts that supported stakeholder collaboration were discussed in relation to the organisational climate of the NHS. Interest from hospital staff regarding using their knowledge of patient care to benefit the patient experience emerged as a key driver behind establishing a dedicated innovation space. The inclusion of external stakeholders introduced additional expectations of the Hub, and latterly this prompted development of the interior design of the Hub environment. The section explored reconfiguration of Hub space over time to support stakeholder engagement. The section concluded reflectively, critically analysing how effectively this was achieved.

5.3 Collaborative Process

The purpose of this section is to present findings which demonstrate stages of the innovation processes that operated in the Hub. This section identifies stages of activity in the innovation process, and the function of Hub staff and collaborators. This section begins with section 5.3.1 which introduces origins of the Hub process. This is illustrated using examples of Hub projects and their particular supporting structures. This is followed by section 5.3.2 which focuses on factors driving changes in the Hub innovation process. Section 5.3.3 presents how disparate stakeholder expectations were managed. The section concludes with a study of the role of technology and compliance issues within Hub process in section 5.3.4 and 5.3.5.

5.3.1 Introducing the Collaborative Process

The foundations of collaborative innovation originated prior to the creation of the Hub, but informed core aspects of the Hub innovation process. As outlined in section 4.1 the hospital had run initiatives to encourage users to share ideas for improving patient experience. The

Hub was identified as resource to develop and operate a multi-stakeholder collaborative process, and increase capacity for needs-led innovation in the hospital.

To achieve this, additional Hub staff were appointed to resource the functions provided by the Hub. In the early stages of operation there was an emphasis was on forming relationships with external organisations. The aim was to incorporate the knowledge and resources of stakeholders to develop an innovation process to develop paediatric innovations. Working relationships developed with a number of research and commercial organisations. This established the foundation for a collaborative process where the differing expertise and resources stakeholders were combined. Over time, the Hub's role emerged as a central point of connectivity between key agents in the innovation process: embedded lead users (hospital clinicians) external commercial and research organisations, and the hospital board.

Although the aims of the innovation process have remained constant, the process stages have been revised. Initially the innovation process begun in an unstructured manner. The sole aim was sourcing resources from an external organisation to support the development of a user-led idea. The user (a clinician) collaborated with the external stakeholder to develop a product concept. During the start-up phase this approach was used to demonstrate the creation of a collaborative, needs-led innovation pathway. The focus was on resolving immediate needs rather than designing and following a planned process. Thus, some lessons were learnt over how to assess the suitability of collaborative partners. A Hub staff member commented, '…*in the past people worked with somebody because they are local or because they have been introduced… that may not be the best solution…*' (Joanna, Professional Internal).

Hub staff have retrospectively worked to improve the management of multi-stakeholder teams that were already working to develop innovation concepts. Innovation concepts were user-led ideas, some of which were selected to undergo development to produce a prototype. Over time, Hub staff have standardised stages of the innovation process to increase clarity for stakeholders. The outcome of this work produced a defined process aligned with the broad aims of Hub innovation goals; using technology to improve digital

resources that positively contribute to the patient experience. Furthermore, to address the imbalance between the quantity of ideas brought to the Hub by users and the availability of resources to invest in their development, additional process pathways were developed. These are all explained in turn in the sub-sections below. By partnering with an external organisation, these processes have enabled the Hub team to assign promising innovation ideas to process pathways depending on their level of development need. This has helped the Hub respond to more users, and provide a way for users to progress with developing their ideas. The next section will present and discuss these developmental processes.

5.3.1.1 Hub developmental process pathways

This section explains the Hub innovation process, and the pathways that operated within it. At the outset it is important to clarify the distinction between innovation projects and the innovation process. Innovation projects refer to particular bounded activity with reportable outcomes. The Hub innovation process refers to the generic stages and patterns of activity that collectively produce the process of innovation that was occurring. Innovation pathways were individual development processes assigned by Hub staff to provide focused developmental support during the Hub innovation process. Over time a set of innovation process pathways emerged as a way for Hub staff to manage new types of user and collaboration in the Hub space. The following sub-sections describe these processes, beginning with the core hub innovation process named the 'Innovation Governance Process' (IGP). The IGP met the core purpose of the Hub, the additional pathways named Pathways A, B and C that emerged reflect a Hub management response to deal with an increased demand from stakeholders, requiring different types support to develop health innovations.

5.3.1.2 Innovation Governance Process (IGP)

The Innovation Governance Process (IGP) shown in figure 5.1 was used by the Hub staff to manage the flow of innovation concepts entering the Hub, and allocate them using the development process pathways. Figure 5.1 shows the process stages informing an objective approach to managing incoming innovation concepts by allocating some to suitable development pathways, and retaining others for development in the Hub space. Further details about the focus of each pathway are provided in the dedicated pathway sub-section.

The IGP is an internally managed collaborative process, used to manage the flow of user-led innovation ideas entering the Hub at stage 1 'Ideation'. Stage 2 was a weekly Hub team meeting where Hub staff reviewed and discussed new concepts. Due to the growing volume of potential user-led innovation concepts the stages of Selection and Validation were important. They provided dedicated time for consideration into how feasibly they could be developed using the pathways available. Additionally as part of stage 2 Hub staff considered arising opportunities for new collaborative partners and their potential contribution to the Hub activities.

After promising ideas had been through the due diligence process at stage 3, ideas were prioritised in terms of their potential contribution, available resources and existing stakeholder connections. After Hub team discussion Stage 4 involves Hub staff recommending a development pathway (i.e., Pathway A or B) to the user, and if agreed the user will commence on this development pathway. The development of pathways provided different types of support for innovations seeking to continue with the design, refinement and testing of their innovation concept. Due to limited internal hub resources, the involvement of collaborators to oversee this development maximised the number of potentially viable concepts the Hub could support through further development.

In some cases, innovation concepts stayed on the IGP as the Hub team considered internal hub development most appropriate, for matters of commercial sensitivity or a where an innovation concept addressed a purely social, patient experience issue. Stage 5 of the IGP provided opportunity for Hub staff to source and meet with potential external organisations interested in participating in providing innovation agents to contribute to Hub multi-stakeholder teams as a collaborators. Hub staff were aware of what was needed to support concept development and so aimed to align stakeholder expectations through discussion at this stage of the process. Hub staff met with collaborators regarding their motives, expectations and potential contribution to concept developed (e.g., finance, resources, access to additional skills or knowledge). Typically, external innovation agents, stakeholder collaborating in the innovation process, came from a research-led university or research and development department of a commercial organisation. The outcomes of these meeting were considered by Hub staff, and where appropriate choices were made regarding

collaborative partners for the formation of each multi-stakeholder concept development team.

The Hub team established a multi-stakeholder teams to ensure necessary resources, equipment and expertise were available to support concept development. For example I observed how commercial organisations had contributed their experience in developing AI and digital products to shape the technical specification of the product's development. Whilst the clinical user shared medically accurate information to input into the product along with informing product design, by sharing insights into paediatric patient needs and expectations.

At stage 6 of the IGP the embedded lead user (i.e., clinician) who thought up the innovation concept or identified the existing need was introduced to external collaborators, and they began working together. The Hub space was used to manage and oversee the innovation processes involved in developing the concept into a prototype. Hub staff liaised with and between innovation agents, many of whom contributed to the project virtually alongside their primary job role. The clinical lead was often unfamiliar with innovation, and was therefore a regular visitor to the Hub. Hub team helped users by problem solving, offering guidance and encouragement.

At the time of data collection both the user-led app and online information portal had entered into stage 7, for pilot testing and refinement. I observed how the clinical user and Hub staff were working out how to undertake this step. This had proved complex as it involved gaining approval from other departments within the hospital, and working out how to capture digital feedback and web based engagement from users. Work was also underway to plan for stage 8, product deployment. The Hub team were developing strategies ahead of the product launch stage, to decide how to measure and maximise social and financial outcomes and their impact.

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┌─────────────────────────────┐      ┌─────────────────────────────┐
│ 1. Ideation                 │      │ 2. Selection                │
│ •Hub recieves user-led idea │─────▶│ •Initial Hub staff ideation │
│  via email, web form,       │      │  meeting. Ideas discussed   │
│  personal contact with      │      │  to assess feasibility      │
│  staff or as after a Hub    │      │  (existing user need,       │
│  event e.g. Hackathon.      │      │  resources needed to        │
│                             │      │  develop concept, finance   │
│                             │      │  options, novelty and       │
│                             │      │  potential collaborative    │
│                             │      │  partners).                 │
└─────────────────────────────┘      └─────────────────────────────┘

┌─────────────────────────────┐      ┌─────────────────────────────┐
│ 3. Validation               │      │ 4. Assign to development    │
│ •Hub staff conduct detailed │      │    process pathway          │
│  due diligence to establish │─────▶│ •User and their idea        │
│  viability, uniqueness of   │      │  assigned to most           │
│  concept and anticipated    │      │  appropriate developmental  │
│  resource needs.            │      │  process pathway Option,    │
│                             │      │  A, B or continue on IGP    │
│                             │      │  (Option C participants     │
│                             │      │  recruited externally).     │
└─────────────────────────────┘      └─────────────────────────────┘

┌─────────────────────────────┐      ┌─────────────────────────────┐
│ 5. Formation of multi-      │      │ 6. Development of concept   │
│    stakeholder team         │      │ •Collaborators contribute   │
│ •Hub staff identify         │─────▶│  knowledge, skills and      │
│  collaborative partner      │      │  resources to develop       │
│  organisations to support   │      │  innovation concept. User   │
│  concept development.       │      │  guides direction of        │
│ •Hub staff source finance   │      │  concept development.       │
│  and resources needed to    │      │ • Hub staff project manage  │
│  support concept            │      │  process and support        │
│  development.               │      │  stakeholders.              │
└─────────────────────────────┘      └─────────────────────────────┘

┌─────────────────────────────┐      ┌─────────────────────────────┐
│ 7. Pilot Testing and        │      │                             │
│    Refinement               │      │                             │
│ •Innovation concept tested  │─────▶│ 8. Launch and Deployment    │
│  using hospital users (e.g. │      │                             │
│  Beta App available to      │      │                             │
│  download and feedbcak      │      │                             │
│  gathered)                  │      │                             │
└─────────────────────────────┘      └─────────────────────────────┘
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Figure 5.1 Innovation Governance Process (IGP)

In cases where the Hub team considered that the user needed additional support to develop their innovation concept two development pathways provided capacity for this support to be given outside of the Hub space. In Pathways A and B one external partner was involved in leading the continued development of the innovation concepts, until they reach the end of the development process. The Hub team kept in contact with the external

partner through this process, with the intention of monitoring potentially promising concepts they may be interested in supporting in the future. During data collection no concepts in the A and B pathways had reached the end of the development process. Pathways A and B will now be explained.

5.3.1.3 Development Process Pathway A

Pathway A shown in figure 5.2 required the user to attend an "entrepreneurial development programme", designed with a commercial end point. A Hub staff member (Scott, Professional Internal) explained, '*it is a partnership between the hospital, a digital development agency and a Venture Capitalist firm. They have a life sciences seed equity investment scheme where people can invest in higher risk products/…/ when we get someone with an idea they will put this 'founder' through a start-up school, and then they pitch for investment to try and develop their solution* (innovation concept).

In Process Pathway A the user must complete a modular development programme. The programme was used to teach the clinical user entrepreneurial skills to develop their idea further, and explore its commercial viability without requiring any investment from the Hub staff in terms of funds of time staff. The programme required the user, a hospital staff member, to find time to complete a number of training sessions in addition to their existing job role. The programme was run by a commercial organisation, working in partnership with the Hub.
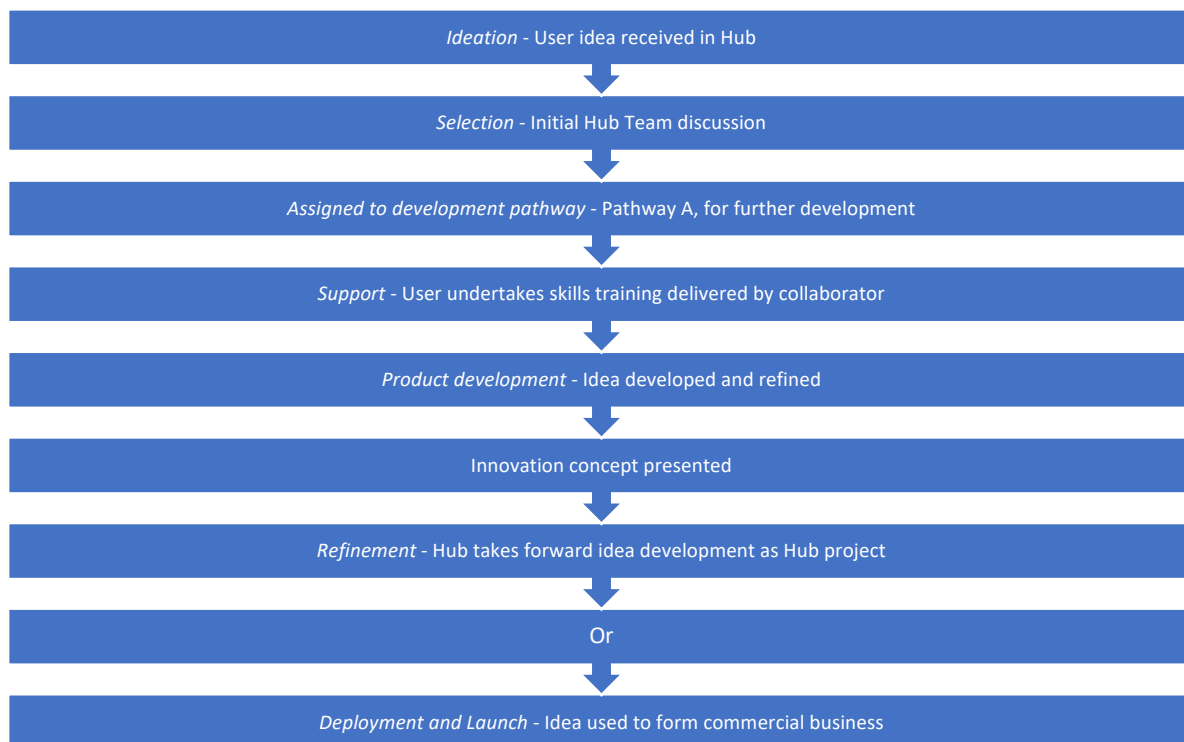
| Ideation - User idea received in Hub |
| Selection - Initial Hub Team discussion |
| Assigned to development pathway - Pathway A, for further development |
| Support - User undertakes skills training delivered by collaborator |
| Product development - Idea developed and refined |
| Innovation concept presented |
| Refinement - Hub takes forward idea development as Hub project |
| Or |
| Deployment and Launch - Idea used to form commercial business |

Figure 5.2 Development Process Pathway A

Hub staff allocated innovation concepts to this pathway on the basis of, '*if we think it sounds like a fit*' (Margie, Professional Internal) and they considered them potentially suitable as a focal Hub innovation project after further development. At the time of data collection, all participants engaged in the process, and were yet to reach the latter stages. A key advantage of this pathway was the capacity it provided, by offering developmental support for early stage user-led ideas. Through participation in this programme Hub staff were able to retain and develop the hospital staff interested in innovative design. The programme provided Hub staff with a process to respond a greater number of ideas than was possible by solely using internal Hub resources. However, Hub staff shared some criticism of the suitability of this process for the needs of clinical users. The concerns shared highlighted the programme's limited ability to meet and support the specialised needs of healthcare innovations. There was an emerging awareness that this pathway was often unsuitable due to the misalignment between the person centred aims of the user and the commercial focus of the entrepreneurial skills programme. A Hub staff member Scott (Professional Internal) reflected, '..*they (the clinicians) have to turn their idea into a business, but it might not be into a business they want, they have to be competent and willing to lead a project, and that hasn't always been the case*'.

These concerns highlighted a separation between the skills and motivations of the clinicians and the requirements of the entrepreneurial programme. This process undervalued the person centred focus which motivated users, instead focusing on commercialisation. Although this would bring benefits to the partner organisation without the continued participation of the user, valuable insights needed for concept development would be lost. A Hub member commented, '*a lot of them (the clinicians) aren't really capable of running a business… they don't have any interest in business /…/ they manage the project to an extent but … you have to have someone who is sweating over this project and running it as a company to make it successful*' (Scott, Professional, Internal). This issue was exacerbated by the prioritise of the partner organisation who used volume of active projects as a measure of success. '*This company can't run alongside another 100 companies, or how many they want to get to, it is not sustainable*' (Scott, Professional, Internal). The core issue stemmed from a lack of attention to appropriateness of collaborator to meet the specific needs of users developing needs-led healthcare innovations. '*…They (the collaborative partner) would be amazing for giving guidance and technical support to people going into business in a medical space, but they (clinical users) are not… medical technology is so complicated, … the collaborator has a system that is not really a fit with medical technology, it's more a fit for general digital consumer products*' (Scott, Professional, Internal).

5.3.1.4 Development Process Pathway B

Pathway, 'B' shown in figure 5.3 provided support to innovation concepts that were more advanced in their development. Pathway B requires the user to collaborate with a small external organisation with expertise in supporting rapid development and testing of '*innovative product device ideas and routes to market'* (Margie, Professional, Internal). Unlike pathway A, which focused on generic early stage development, in pathway B users received support to development a product prototype to meet the specific needs of healthcare stakeholders.

Ideation
Users idea for Medtech device received in Hub

Selection
Users idea discussed by Hub Team

Assigned to Development pathway
Option B for rapid development and testing

Support
Collaborator supports User to align device with needs of healthcare stakeholders

Development
Product concepts undergoes rapid development and testing

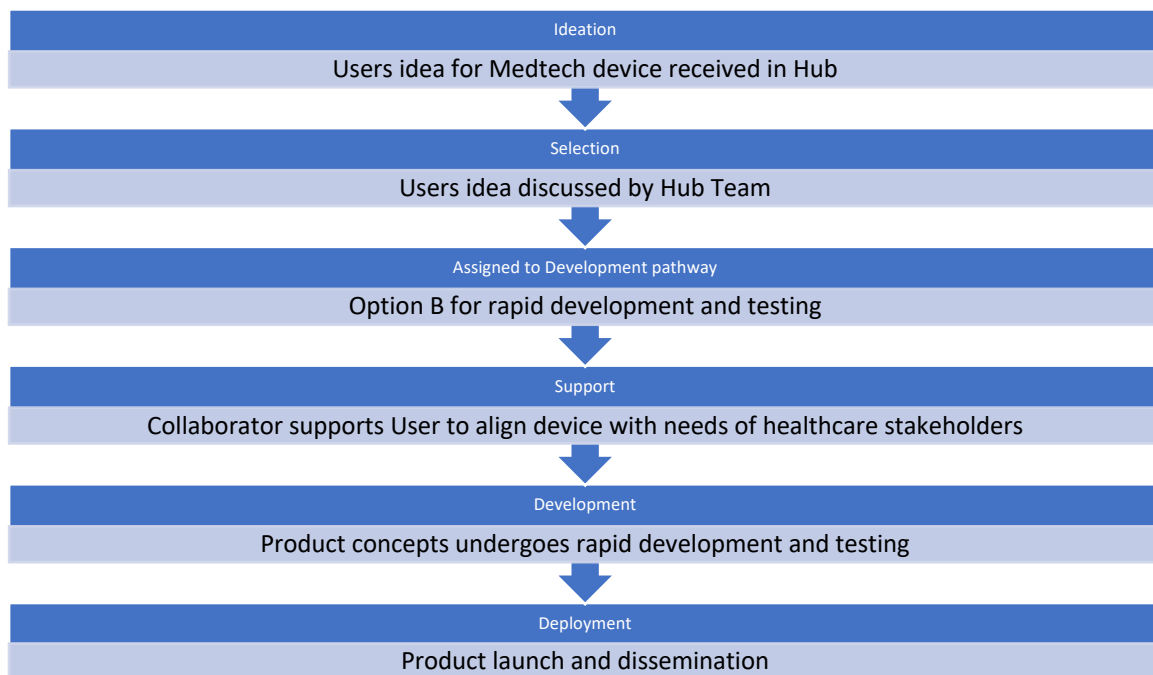| Deployment |
| :---: |
| Product launch and dissemination |

Figure 5.3 Development Process Pathway B

In pathways A and B, the user remains involved throughout the development process. The lack of user time emerged as a barrier to completing process A and B pathways. Clinical staff faced a busy and inflexible work environment, and so the requirement to dedicate additional time to innovation was a challenge that the Hub team were seeking to address. Retaining the participation of the user was necessary to ensure that their insight and tacit knowledge could be used to inform the development of the product. However, there was scope to improve the innovation process, to better utilise user contributions subject to availability of alternative innovation agents to take on certain developmental roles. At the time of data collection, little attention had been paid to evaluating if the contributions made by an innovation actor was the best use of their skill and time.

5.3.1.5 Development Process Pathway C

In addition to developmental pathways of A and B, pathway C began as a way to bring in funds to support the Hub operating costs and internal concept development via the Innovation Governance Process . Shown in figure 5.4, pathway C was established to support innovators who were entrepreneurial individuals or local SME's needing support with product refinement. The project aimed to provide access to clinicians who could give feedback to innovators who aimed for their product to be deployed for NHS use. The Hub

was the main delivery partner of a regionally focused EU funded project for SME's '*to develop products in the health, digital, tech industry'* (Faye, Professional Internal*). This* project differed from the other pathways as it required a specific process to be followed to meet ongoing programme funding criteria. The Hub must meet strict metrics and reporting protocols, detailing hours of support given, and the nature of engagement and feedback given to participants by hospital clinicians.

Consultation
Participant contact Hub via central project advert. Project manager and potential participant meet

Initial Evaluation and Verification
Suitability to join project

General Support	
Bespoke support planned and received	Access to peer skills and networking events

Concept Refinement
Project participant receives critical feedback from healthcare users (Clinicians and Patients).

Evaluation
Development of concept assessed against project activities

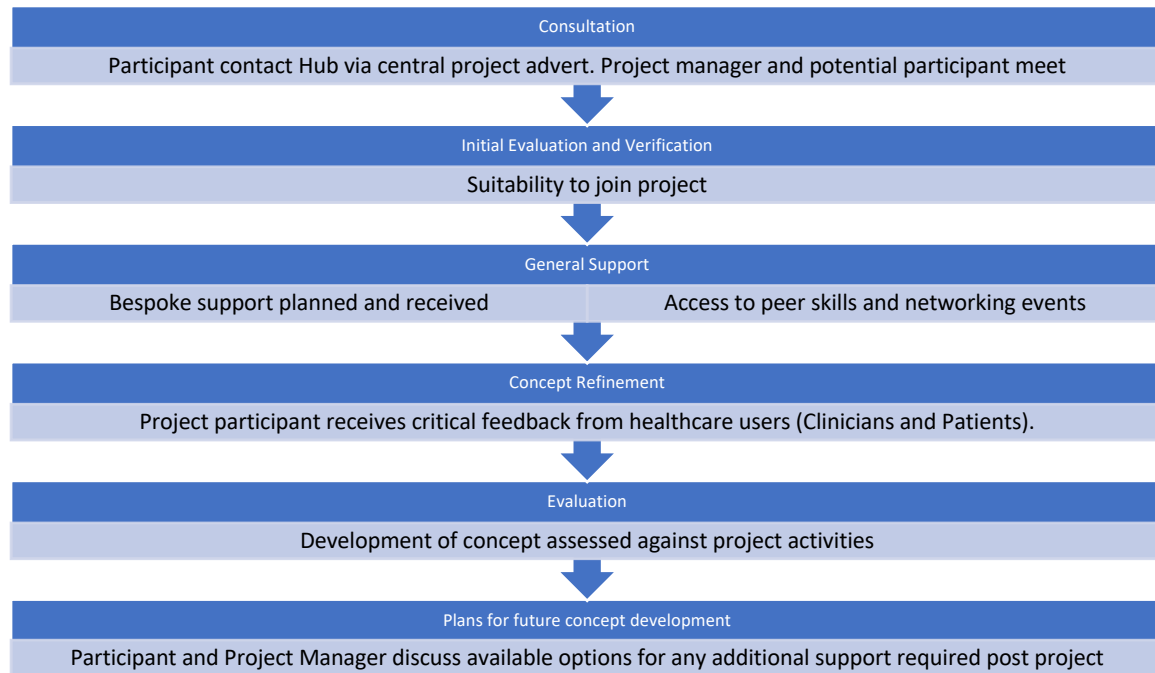| Plans for future concept development |
| --- |
| Participant and Project Manager discuss available options for any additional support required post project |

Figure 5.4 – Project process Pathway C

Participating as a delivery partner in this project generated vital income for the Hub, and enabled new contacts to be formed between the Hub and hospital clinicians. As a project delivery partner, the Hub allocated a set number of hours for project participants to receive support on product refinement. The opportunity to meet with hospital clinicians and gain feedback was a valuable incentive for participants involved in the project. Clinicians' direct experiences of a paediatric NHS environment was often extremely difficult to access to those outside the hospital environment, yet vital for innovators. A clinician frankly described this process as '*shooting down their expectations, explaining why it wouldn't work in an NHS environment. You often only get that from working as a clinician for a long time'* (Philip, Junior Clinical).

Hub staff who worked specifically to support pathway C approached collaboration in a more targeted manner. A key role of Hub project staff was to identify and meet with clinicians who could support project participants. Clinicians with specific expertise were invited to provide constructive feedback during one to one meetings with the project participant. Even though the periods of consultation were short, the knowledge which was shared was viewed by participants as very valuable for the refinement of their product. A Hub staff member who worked on this project reflected on one of the feedback meetings, '*so you have a room of full paediatric neurosurgeons, where else are you going to get that? The information that they gave her (the participant), we both walked out of the room and said wow!*' (Faye, Professional Internal). Furthermore, this approach provided the Hub with usable examples to demonstrate benefits of the value of collaboration during the innovation process. The time spent with clinicians benefitted project participants practically and emotionally. Charles a (Project participant) commented, '*working with the Hub strengthened things beyond what I could do which is great…if you are a one man band trying to do something innovative against the status quo people don't care... So being part of a project, and using their experience … they are looking at you and thinking, yes, this is something that we are interested in and we know people who can help, and that is what they have done'*.

From my fieldnotes I observed how Development Process Pathway C was being used to benefit the wider Hub facility. The project created new interactions with hospital staff, and introduced them to the Hub and the concept of a collaborative innovation process, without requiring any repeated commitment. This allowed Hub staff to identify clinicians who were interested in participating in future collaborations. The project was funded and so generated some stability for Hub finances, through guaranteed payments throughout the project's duration. This income was used to pay Hub staff salaries and essential running costs. The practical nature of the project provided a way to increase Hub visibility and increase engagement opportunities. As part of project delivery, the Hub hosted networking breakfasts and talks for participants. This was important as other process pathway forms of developmental activity mostly took place digitally, or offsite. Development Process Pathway C brought people into the Hub, and enabled staff to demonstrate current Hub activities.

5.3.1.6 Chronology of the Hubs Developmental Process Pathways

The multiple process pathways had become active in the Hub at different times, and for different reasons. During the early stages of operation, a number of innovation concepts rapidly entered the development process. This pace demonstrated the enthusiasm of the founding Hub staff to pursue arising opportunities, and collaborate with notable organisations. Founding staff members were keen to begin collaborating, and had a simplistic view of how this would work. This resulted in a simplistic understanding of the process of multi-stakeholder collaboration. A founding Hub member (Roger, Hospital Board) shared, '*we are not very good at making things, that is not our expertise and also we don't have much money, so we think a good arrangement is us, plus people with money, plus people who can make things*.' The potential to operate a multi-stakeholder innovation process from the Hub provided a new service and novel approach for the paediatric innovators. Collaboration, through the formation of multi-stakeholder teams brought innovation actors from different organisations together. The formation of links between external partners and clinical users enabled concept development to be informed and revised by innovation actors with advanced knowledge and resources.

When the Hub first began operating, a basic version of the IGP emerged to resource initial exploratory concept development in the Hub space. As the number of innovative ideas entering the Hub increased, Hub staff needed a way to respond to as many user ideas as possible. Thus, Hub staff explored options to add to development capacity by partnering with external organisations. As a result two further developmental pathways were agreed. Pathway A outlined in section 5.3.1.3 to specifically support the development of early stage user ideas and Pathway B outlined in section 5.3.1.4 to guide the refinement of innovation concepts. Hub staff recognised that they lacked resource to internally manage any additional concept development and so Pathways A and B delivered tailored externally resourced support. Pathway C commenced due to the opportunity to be a delivery partner in an EU funded entrepreneurial innovation project as outlined in section 5.3.1.5. The main appeal of this opportunity was guaranteed income for the Hub facility, although as the section describes, participation in this project also benefitted Hub visibility and internal relationship building.

Over time Hub staff paid increased attention to the number and management of innovation concepts in the development process. Hub staff recognised that taking time to selectively expand the network of potential collaborators improved the competency of the Hub innovation process. The enthusiasm of users, and development of their ideas were supported by a greater choice of suitable external collaborators. Access to these organisations facilitated Hub staff in forming collaborative teams with stronger capabilities, to better support the development of innovation concepts and needs identified by embedded lead users. The creation of process pathway A, B and C diversified, strengthened and added capacity to the Hub's collaborative innovation process.

Although the IGP became more complex with the introduction of multiple process pathways, these decisions were taken to enable the founding Hub objectives to be sustained; needs-led development led by embedded lead users. As discussed in sections 5.3.2 and 5.4.3, the majority of users become involved in innovation as a way to overcome specific issues impacting the care and experience of patients. Embedded lead users, here hospital clinicians, were an important part of the Hub process. Their participation in collaborative innovation was valued ,as their experiential contributions to concept development were knowledge driven, and usually difficult for external collaborators to access. The process of Hub collaboration enabled external organisations to access and understand user perspectives.

A common focus of Hub innovations was the use of MedTech in both research and design. MedTech is defined as products and services that use technology to deliver improvements to patient experience or improve their quality of life. The design of MedTech innovations required a combination of the specialist tacit knowledge of clinical users and specialist external resources to align current user needs, viable concept development and disparate healthcare stakeholder requirements.

A nurse explained, '*My job revolves around communicating with children, so they understand what is happening and do what I ask /…/ historically healthcare has been delivered via the parent and you feel like the kid in the room is saying, hello I am in here! /…/ so we need to communicate complex things at a number of levels, starting at toddler,*

finishing at adult and covering everything in between' (Graham, Nursing). Clinicians were able to communicate the content of what needs to be communicated, and advise on the needs of the patient or family member. However their experience was that this was not always enough to meet user needs. This prompted the clinicians to look at technological solutions to improve patient experience for patients and their families.

Graham (Nursing) shared, '*Some parents are not very academically intelligent, so they need an explanation at their level. Then you have some precocious kid of 12 who wants something else /…/ we need to communicate how and when they want it otherwise, if it is not meaningful, they just don't take it in, and then you end up with a complete mismatch, they have a lack of knowledge, feel disempowered, isolated, and that is not what you want, you want to look after people, and do what you do very well*.

By using digital technology there was the option to offer a personalised, user focused communication method to convey generic information. The depth and detail of clinician's tacit knowledge were beneficial to external commercial and research based collaborators, who contributed expertise in technical and functional design and direct commercial viability to the collaborative process. Thus, the collaborative elements of the innovation process involved actors who each made a distinct contribution to the project team by sharing access to their particular specialist resources within their organisation. This included access to specialist I.T and medical technology, research labs and knowledge on emerging technologies including artificial intelligence, augmented reality and app design. Through collaborative working, which was central to the Hub innovation process, stakeholders integrated their expertise. The focus on paediatric MedTech innovation was noted as of particular importance as it was often bypassed by corporate innovation due to its complexity and lack of clear commercial potential.

The Hub process was unusual in that it responded to current needs identified in the hospital, whilst, prioritising the person centred needs of clinicians and patients. However as the Hub became more established, Hub staff have recognised that the innovation process must go beyond the initial aim of '*doing good things*' (Roger, Hospital Board) to create viable products. Thus, Hub staff have begun exploring how the Hub could become a self-

sustaining facility. One example was shown through steps taken by Hub staff justify why innovation concepts were deemed worth investing in. During the innovation process Hub staff have begun to address the issue of product sustainability, through collaborative discussions with innovation agents, as concept development matures.

Product sustainability was used to convey the extent of usefulness, and distinctiveness in the market and healthcare sector. Sustainability was measured by the Hub team assessing, if the Hub concept was unique, the existing need applies to a large number of patients and if there was a lack of direct competition. The Hub team used these measures to support objective decision making regarding continued investment into concept development. As clinicians were grounded in a patient care environment, the economic and commercial viability of products was often not a key factor in their thought processes. Therefore, any suggested modification to their idea that was driven by commercial factors, rather than prioritising user benefit was received negatively by users. Within a collaborative innovation process, these differing priorities created tensions between stakeholders. For the Hub to continue to operate, it became necessary to assess the sustainability of concepts. The use of research to demonstrate the process of considered efforts was recognised as a way to objectively predict potential impact and possible types of return on investment; socially or financially driven. This theme is explored again in sections 5.3.3 and 5.4.4.

The evolution in the way in which the innovation process was managed can be understood as a reflection of Hub staff learning. Over time Hub staff have made changes to the management of the innovation process as they have realised the complexity of the collaborative innovation process. The inclusion of collaborative partners to oversee pathways A and B demonstrates an appreciation of the resources needed to support the development of multiple concept developments. The use of different types of collaborator shows have Hub staff have developed innovation management capabilities, and sought to preserve Hub capacity. As part of this process, stakeholders have begun to express concern about the sustainability of the Hub facility.

I observed Hub meetings where concern was raised over sustainability of Hub operations, due to a lack of resources to support the development process. The lack of resources

created a number of issues, the most concerning being concerns over financial continuity for concept development. Finance to support development of innovation concepts remained insecure during data collection, although work was ongoing to stabilise this aspect of the innovation process. The hospital, the hospital charity and commercial innovation actors were all sources of funding at the time of data collection. Stakeholder tension had emerged related to the allocation and best use of available resource and concerns over the slow pace of the development process. This was attributed to a lack of staff time and a lack of process planning during the Hub start-up phase.

In response to concerns for Hub sustainability, the IGP had evolved over time to the process in use at the time of data collection. A number of additional stages had been added to help increase Hub sustainability. The inclusion of a stage dedicated to due diligence had been added to compensate for an initial lack of research during the start-up phase, into the viability of innovation concepts. The founding clinically based Hub team had underappreciated the importance of researching proposed innovation concepts during the Hub start-up phase. The addition of a stage for due diligence activity focused on validating concepts, prior to them becoming actively worked on. This aimed to help to evidence decisions on which ideas to support and develop. Lessons learnt regarding pursuing unviable ideas and hastily forming collaborative partnerships had informed the inclusion of this stage. At the time of data collection, ninety innovative ideas were at some stage of consideration or development. Hub staff acknowledged that there was still an issue in managing the flow of innovative ideas, and meeting the expectations of users. A lack of user time for innovation, and Hub resource to support development had resulted in many ideas being held in an indeterminate position even once allocated to a developmental pathway, without the necessary support to proceed. To break this cycle, the Hub staff were working on modifications to the Ideation stage of the IGP. The creation of a web based form aimed to reducing the ways ideas enter the Hub, and standardise the information received. Staff were also working on a digital system to improve IGP concept tracking and communication between Hub staff and collaborators.

In summary the Hub had provided an accessible, secure environment to generate needs-led digital content, using a multi-stakeholder process aligned to the needs of the user and their

innovation concept. Within the evolution of the Hub process, Hub staff learning had supported new ways of dealing with different types of stakeholder, and meeting the resource needs of concept development. The addition of three innovation pathways enabled the IGP to better meet the needs of stakeholders and maximise support for innovators whilst preserving Hub resources. Users had a leading role in the product design and how the information was presented to patient users through the development of product software. MedTech, including the use of artificial intelligence (AI) and augmented reality (AR) software were crucial to the development of innovation concepts supported by collaboration with research and commercial organisations. Contributions made by innovation agents who were employed within these organisations enables products to be developed to incorporate multiple stakeholder requirements and the latest insights into product design and functionality.

The innovation process served collaborators interests in different ways, but all derived benefit from being involved in the development of user-led paediatric products. The Hub became a safe environment for collaborators to share their knowledge, although over time Hub staff had improved the way in which stakeholder expectations were managed. This had enabled user needs to be protected, and the Hub environment to remain a safe space for embedded lead users to explore innovation. In this context the word safe signifies that the Hub environment was designed to support innovation, and therefore could accommodate risk taking and failure. This provided reassurance to clinicians who were used to working in the risk averse environment of healthcare delivery. Thus, the Hub environment provided a supportive space to suggest and develop innovative ideas. During the innovation development process access to otherwise institutionally protected knowledge presented the opportunity to access extremely valuable user feedback to innovators. The Hub was recognised as being well positioned by externals, providing access to '*the landscape of integrity, within the medical field that you can't get into*' (Charles, Project participant). The collaborative process supported internal hospital users develop their idea into a product concept, it provided access to resources within commercial and research organisations. Collaborating with these organisations opened up access to expensive technology and equipment needed for the development of product concepts. The Hub team managed communication between hospital users and collaborating organisations to oversee the

product development process. The novel use of technologies like AI and AR were of commercial and research interest to these organisations, and therefore their motivations were worked into the agreements, managed by Hub staff.

5.3.2 Exploring factors driving changes in the Hub Collaborative Process

As discussed in section 5.3.1 as the Hub became more established, changes were made to the Hub processes. This section will explore what led to these changes being made and show the impact on the innovation process. The Hub innovation process had been shaped by the perspectives and priorities of key hospital staff and collaborators. At the outset, the processes that were adopted by Hub staff were led by a desire to establish initial connections useful external organisations. Enthusiasm to explore the potential outcomes from collaborative relationships meant that starting new projects took precedent over considering their strategic planning. The eagerness of founding Hub staff to begin working on concept development resulted in the priorities of external stakeholders, who had access to valuable resource and equipment taking precedent. As these changes took place, decisions to tighten management of the innovation process reflected growth in Hub activity, and emerging challenges from multi-stakeholder innovation process. Further modifications were planned to aid objective prioritisation of innovation concepts, and track development milestones during concept development. These challenges will now be presented and linked to modifications in the Hub process.

As stakeholder collaboration became an established part of concept development, tensions have emerged. Apart from in Pathway C which followed a predetermined process, Hub efforts to communicate with stakeholders to explain concept selection and the innovation process have been insufficient. This situation had been compounded by a reliance on verbal rather than written communication and agreements, which meant that processes could not easily be reviewed by stakeholders. During data collection plans to implement further improvements to the stakeholder communications demonstrated that the Hub team was responding to address stakeholder expectations regarding pace of innovation, and the availability of support from Hub staff. Founding Hub members acknowledged the need for a change in process and that it was impractical to continue using an emergent fluid process, although it had been initially sufficient. A (Tim, Senior Clinical) founding Hub member

reflected, '…*that (the approach) is no longer going to fly because that (the process) is not going to support this number of people, so you have to change …when money starts to be involved then you have to have a lot more governance around it, so that is the difficult transition we have to make now.*'

As the Hub team expanded, time was dedicated to project management and process reviews. The lack of emphasis on planning projects in the Hub start-up phase had resulted in a lack of process documentation that detailed and justified stages a collaborative innovation process. I observed that Hub staff with experience in this area have begun reviewing and appraising approaches use to form collaborations. Joanna (Professional Internal) a Hub team member commented '…*we need to be really careful and strategic about our partnerships… in the past people worked with somebody because they are local, they've been introduced or an idea to gift the hospital. They may not be the best (collaborative partner)… we have to be problem led and find the best solution… it takes time to develop a strategic innovation partnership with a large corporate, that is something that I have been trying to do.*'

Additionally, a lack of process during the start-up phase had resulted in some economic and practical oversights. During data collection Hub staff were in the midst of trying to remedy issues by revising the processes to balance needs of innovation actors. The expansion of the Hub team had brought additional expertise and focused job roles. A Hub staff member extensive transferable experience commented, '*there is some of my past knowledge that I itch to include*' (Margie, Professional Internal). Combining the tacit knowledge of Hub staff gained within the NHS and innovation management roles had helped in the design of a Hub process that reflects diverse stakeholder needs. The Hub team role involved revising the Hub process after strategically considering how to combine stakeholder and project needs within the Hub innovation culture. A Hub member explained current work in this area, '*I am trying to get a systematic approach to the projects (concept development), and that doesn't matter if it is focused on commercial or … the hospital patient experience. We want it to be done the same way, it is about a mindset, how you think, … solve problems and view the role of external partners*' (Joanna, Professional Internal). Members of the Hub team were working on both strategic and practical improvements to the way the innovation process operates. A staff member shared a new system currently being tested, '*I have developed a

system which takes our innovation pathway and puts it into a digital database, from that we are able to extract reports and plan meetings, track stuff and get more up to date analytics' (Scott, Professional Internal).

The Hub team had begun reviewing and improving a number of operational approaches that support the Hub innovation processes. Over time the needs-led focus of the Hub approach had become better integrated into informing stages of the Hub process. From my field notes I observed the ongoing work to improve stakeholder communication. This was necessary to manage expectations of stakeholders, some of whom had unrealistic expectations of the innovation process, and potential outcomes. I observed conversations seeking to address how to respond to opposing stakeholder priorities emerging during the development process. Robert (Professional, Internal) shared an example of a challenge the team was addressing, *'how do we assess potential (user-led) solutions and prioritise them in terms of the impact that we (all) want to achieve?'*

The Hub staff were working through a number of complex process development challenges during my data collection. From my fieldnotes I witnessed conversations regarding how the Hub process was challenging the typical development approach used in NHS systems of work. Working from a needs-led rather than solution focused perspective had been difficult, as the Hub process did not have a bank of data to justify innovation activity and support requests for resource. Within the broader NHS there was an organisation wide expectation that quantitative evidence would be provided to support decision making and resource allocation. The Hub process presented an alternative method and rationale for NHS healthcare innovation. Although the Hub staff recognised value in this approach, work had begun to demonstrate validity to stakeholders more familiar with the data driven process used elsewhere.

Over time stakeholders started to appreciate the value of being needs-led within a healthcare context. This had generated an understanding of the importance of embedded lead users' knowledge. The Hub process had been designed to support innovation concepts informed by needs highlighted by hospital clinicians. Hub staff had realised many such

needs-led concepts existed. Therefore post concept validation was important to identify and understand the resources needed to support innovation actors throughout the process.

A key element of this support was stakeholder management, including the selection of and assistance given to collaborators. Hub staff were exploring how to create synergy between accessing resources provided by external stakeholders and upholding the person centred design process, favoured by users. William (Professional External) who worked in partnership with the Hub shared an example of this synergy, *'they (Hub users) introduce us to things (user-needs), and there are ways that the Hub can make money out of the contract with us, which I am fine with, it is a collaboration, I want them to do well out of this /.../ I know that it (collaboration) has been around in other sectors for a while, but for a medical company to be in partnership with a hospital I think is quite a new thing'*. The Hub environment and organisational structure had the freedom to create processes to achieve this aim. The possibility that existed within the Hub space was a key reason why users worked with the Hub rather than becoming involved with an external commercially minded approach.

During data collection discussion continued regarding managing and making best use of collaborative relationships, and how to define the contribution of each stakeholder group. During the start-up phase of Hub operations, the potential to be creative and experimental were promoted as key benefits to participation in the Hub process. This encouraged user participation, as the Hub was presented as a place that was receptive to their experiences, and valued how this informed ideas for innovative products. Therefore, the needs-led approach became recognised as a strength of the Hub as an innovative environment.

However, over time resource availability in the Hub had become depleted, and the number of ideas was disproportionately high for the available resource. Areas of concern emerged when reviewing the number of user ideas awaiting feedback, along with outcomes of stakeholder interaction, that demonstrated unrealistic stakeholder expectations. This led to stakeholders seeking clarity on the aims of the Hub process and questioning how equipped the Hub was to meet their needs. Observations in my fieldnotes witnessed Hub staff discussing how the initial enthusiasm for encouraging users to contribute ideas had resulted

in a reputational challenge and unrealistic stakeholder expectations for Hub staff to address. A lack of process to inform users about how ideas were triaged had unintentionally created feelings of anti-climax. To sustain a user-led innovation process, the Hub needed better manage communication with stakeholders. I observed how Hub staff were increasingly aware of the need to manage stakeholder expectations at various stages of the development process.

Over the first two years of the Hub's operation the number of external organisations participating as collaborations had also increased. Additional staff resource in the Hub team created capacity to facilitate consideration of how to build mutually beneficial relationships for stakeholders. This work sought to address misconceptions and frustrations of collaborators that developed due to a lack of clarity about how the use of MedTech in a healthcare context slowed the pace the innovation process.

Hub staff concluded that stakeholders would be reassured by the standard and transparent Hub process shown in the IGP, figure 5.1. They believed that this process would help stakeholders understand the relationship between Hub innovation culture and the role of their contribution as part of a multi-stakeholder development team.
Hub staff were finalising a written Hub approach to managing relationships with stakeholders. As founding members of the Hub team were largely clinicians, their priority was driven by personal investment in mobilising the needs-led aims of the innovation process. The involvement of professionally focused Hub staff replaced the original emotionally-led approach with one driven by achieving strategic objectivity in decision making and project management. A Hub staff member summarised the objectives now used, '…*is it really worth doing, worth spending time on, … then (assessing) the commercial scope of opportunity - research and analysis of opportunities and competitors* (Scott, Professional, Internal)*.

A notable phase in the development of the Hub process was the increased number of events hosted by the Hub. These were planned by Hub staff to target groups of internal and external stakeholders that could support Hub activity. Hub staff had recognised the need to attract additional collaborators to fill gaps in knowledge relating to distinct medical or

commercial development requirements. Events in the Hub space were used as a way to explore future potential partnerships. The growth in this activity, alongside work to strengthen support throughout the innovation process signified an important milestone in the maturity of the Hub. In this manner Hub staff addressed the process issues which emerged from operational oversights during the Hub start-up phase.

5.3.3 Managing expectations about the Innovation Hub Process

Hub staff superseded founding clinical staff to lead and manage the collaborative innovation process. They have prioritised the effective stakeholder management to respond to needs from innovation actors during the innovation process. This was evident through the increased guidance, stakeholder support and project management provided by Hub staff.

I observed how Hub staff had identified a link between sustaining project progress and better stakeholder management. They had responded to this and were beginning to implement strategic planning meetings, regular stakeholder communication and mediation where problems of stakeholder tension occurred. An example of strategic planning was evident in Hub staff recognition of the commercial and research interest of concept developments to collaborators. They used this to negotiate collaborative agreements concerning methods of resourcing and the sharing of outputs generated. Hub staff were leading work to establish fair collaborative agreements which protected valuable intellectual property generated from using user expertise to drive the innovation process. This helped to change the dynamic within collaborative partnerships. A Hub staff member commented, *'it is really interesting when you start to see partners who instantly disappear when you say actually no, this is worth money!'* (Joanna, Professional Internal).

As introduced in section 5.1.2 an area of ongoing complexity concerned differing stakeholder interpretations of innovation, and expected outcomes from the innovation process. The Hub brings together stakeholders who had expectations around the pace of innovation, how the process was managed and different opinions about what constitutes an innovation culture. As explored throughout section 5.3, the Hub facility developed its processes to fit with the needs-led objectives of its user driven collaborative process. Even within broader approaches to healthcare innovation, the Hub approach was different to the

data driven NHS process used elsewhere. Therefore, even the expectations of internal stakeholders were challenged by the Hub process.

To address this, Hub staff had begun to respond to unrealistic stakeholder expectations in an attempt to reduce stakeholder tension. Within the IGP shown in figure 5.1, stakeholder expectations from the innovation process were broached by Hub staff when initial interest in becoming involved as a collaborator was shown. Hub staff appraised the anticipated objectives of stakeholders from participating in the process and assess their prospective contribution. Thus, forming connections with individuals and organisations became a more selective process. This helped to ensure that there was acceptance and cohesion with the Hub culture. During the Hub start-up phase, a lack of consistency in project stakeholder management, was raised as an issue by a number of interviewees. Hub staff were addressing lessons learnt where stakeholders have struggled due to a lack of consistent management during concept development. Stakeholders indirectly involved in Hub viewed a consistently used process as a tool to demonstrate Hub strategy, and the anticipated end point of the concept's development. In my fieldnotes I noted how diverse stakeholder priorities reflected the eagerness of stakeholders to reach concept deployment as soon as possible, to create social, financial or efficiency based improvements. A minority view amongst stakeholders questioned the person centred, emotional stimulus present in needs-led innovation and suggested using *more business like decisions'* would improve the Hub process (Clive, Hospital Board).

An ongoing challenge for Hub staff was balancing the socially motivated priorities of users seeking an improvement to patient experience, and stakeholders who wanted the Hub to replicate an evidence based, commercially minded innovation process.
Efforts to address these conflicting priorities were evident through improved discussion and planning in the initial stages of the process, through to improved communicated with stakeholders during concept development. The importance of accurately communicating the Hub purpose and role for collaborators was raised as a concern during data collection.

This influenced perceptions amongst hospital users regarding opportunities for them to participate in the innovation process. A Hub staff member identified that misconceptions

around the definition of innovation terminology was dissuading users from participating in Hub projects. He concluded, *'I think we have got a lot of talented people and the baggage of innovation language usage gets in the way of it… the minute that we say, 'you are an innovator' they think oh no, I'm not like someone from MIT '*(Jeremy, Professional Internal).

Hub staff recognised a need to focus on engagement activity with potential collaborators as part of the innovation process. It had become apparent that within the wider hospital there was a lack of basic understanding about what innovation. A Hub staff member reflected, *'if you are not directly involved with the Hub, you may have the wrong idea, you may interpret it wrongly'* (Faye, Professional Internal).

From exploring the factors which informed the development of Hub process pathways A-C, the complexity of the Hub start-up phase was explained. But without access to this knowledge, it was difficult for stakeholders to understand the reasons why functionally based process decisions were made. As outlined in section 4.1 initially the Hub was granted freedom to explore creation of a collaborative user-led innovation space. During this phase of the Hub process there was an emphasis on creating space for users to think in a person centred way to create innovative digital solutions to user needs. The initial energy for user-led design supportive from external collaborative partnerships as the Hub lacked resources to support concept development. In retrospect the experience of Hub staff was not sufficient to engage in balanced negotiations. A founding Hub staff member reflected, *'we couldn't do deals or different things we just got what we could out of it, and that was actually very important at the initial stages of building this place up /…/ Corporately and financially, these are areas I am not an expert in which is why you have to bring in a wide variety of people'* (Tim, Senior Clinical). During the start-up phase priorities were to begin working on some concept development rather than consider longer term strategic goals.

The collaborative approach used in the Hub was not commonplace in the NHS. Therefore, all stakeholder groups have undergone a period of learning, to understand how their needs connect with and were different from other innovation actors. One interviewee reflected on the lack of experience of collaborative working within the NHS, which can be seen in the emergent nature of the early Hub process. A board member commented, *'we know there*

are things to be tapped into and we are not always very smart at doing that because we haven't always got the line of sight' (Christine, Hospital Board).

From my fieldnotes I observed work underway to try and align the resource needs at stages of the innovation process with conflicts that emerged from different stakeholder priorities. Hub staff had a challenging task of '*retrospectively*' (Scott, Professional, Internal) introducing amended processes like *'collaboration agreements to joint working arrangements that had been in progress for several years'* (Gemma, Professional Internal). Over time initial judgements made regarding which skillsets would be needed during the Hub start-up phase had exposed some oversights. Furthermore, the emphasis on recruiting staff with '*strong networking skills*' to grow the Hub network had unintentionally created issues for the Hub process (Clive, Hospital Board). Demand was created for participation in a collaborative process where the importance of sufficient Hub staff to project manage a complex innovation process was underestimated.

Additionally, an absence of Hub staff with experience in stakeholder management had resulted in a lack of awareness around managing conflicting stakeholder expectations during concept development. Emerging tensions between stakeholders observed during data collection reflected contrasting levels of stakeholder tolerance for experimentation and creativity versus tangible project progress. The initial absence of a consistent and transparent innovation process had created scope for stakeholders develop unrealistic expectations about the pace and outcomes from a complex and pioneering innovation process. Hub staff had the challenging task of reconciling stakeholder expectations with an emerging new reality governed by an overdue recently implemented revisions to the Hub process. Thus, the innovation culture of the Hub had developed as outlined in section 5.1.4. This helped justify the changes made to the Hub process, which sought to combine the founding principles of needs-led, person centred innovation with longer term strategic objectives; Hub sustainability and improved patient experience through MedTech.

5.3.4 Process and Technology

The use of technology became a core component of the Hub innovation process. Stakeholders shared multiple reasons as to why using sophisticated technologies were

considered an appropriate innovative method for developing paediatric MedTech. The main narrative amongst NHS stakeholders was that technology was used to *'modernise and improve care pathways'* (Gemma, Professional Internal), *'simplify access'* to information for users and increase process efficiency by digitalising resource intensive processes (Steven, Professional, Internal). However more work was needed to build awareness of the role of technology in Hub innovation activities. An interviewee shared an example of underlying tensions in wider hospital regarding hospital perceptions of technology use in the Hub. A Hospital employee working outside of the Hub shared, *'the word on street is, 'how you are doing this fancy stuff, but I can't get my computer to work properly…' but it is about having an understanding that they are two very different issues'* (Joan, Professional External).

The Hub process focused on creating digital care pathways which benefitted the patient experience. This included innovations focused on advancing digital tools to improve the surgical process of treating patients and products to benefit users. By working collaboratively, the Hub gained access to expensive equipment owned by commercial and research organisations. When combined with the experiential knowledge of hospital users, this technology could be used in new ways to design products that meet the needs of users. A key element of the development process was prioritising the needs of the product users' groups. To achieve this users (hospital clinicians) contributed design suggestions and experiential feedback to maintain alignment between the product and user needs. External collaborators involved in applying and researching the use of this technology in other operational settings contributed to areas of product functionality and construction. The product concepts under development used technology to engage with patients and families prior to and during their healthcare treatment. Using advances in artificial intelligence enabled patients to *'interact with the world'* in a digitally familiar manner. Artificial Intelligence (AI) had been programmed to interpret and provide answers to questions posed by patients and their families. Augmented reality presented opportunities to make the hospital setting less intimidating, through designing interactive app based software to familiarise children with hospital environments (Peter, Nursing).

The Hub created new possibilities to integrate digital technologies into the patient experience. Within the Hub the excitement of increased access to digital technologies was

evident from clinicians seeking new methods of medical treatment and to reduce anxiety in patients. However, within the wider hospital concerns were expressed regarding training needs to ensure staff were confident to use the products within care pathways. A hospital staff member with experience leading staff training on new products reflected, '*I don't necessarily think we have the (training) support right for new technology, systems, processes and ways of working, it is really difficult, …trying to balance people's different levels of absorbing something new*' (Sally Professional Internal).

Previously, initiatives to digitise processes within the hospital had been problematic due to a lack of resource to conduct training, and complications in finding time within busy clinical work schedules. This had resulted in technology being rolled out, and staff feeling frustrated due to being underprepared to adapt to use new processes. The Hub attracted hospital staff who were interested technology and the potential for how digital products use could be used to benefit patient experience. However, initial interactions between Hub staff and staff within the hospital revealed broader hesitancy and a lower appetite for digital products. As the digital products being developed required staff to adapt their behaviour and processes, time was needed to grow staff acceptance and confidence as product users.

5.3.5 Process and Compliance

Hub staff had begun to provide stakeholders with insight into hospital processes and regulatory compliance issues impacting the innovation process. However, this was challenging as the Hub was innovating using emerging technologies which were yet to become widely used within the NHS. As a result, there was a lack of published policy and regulatory frameworks to specifically guide the development of such MedTech. Elsewhere in the health sector there was a well developed and implemented set of regulatory processes. Even without published MedTech policy, healthcare innovations should be developed with broader safety and quality benchmarks in mind for the future protection of users. Hub staff were applying experience gained in relevant NHS compliance roles to ensure there was due consideration during concept development. In place of published guidance, it was necessary for Hub staff to consider how digital technologies were being used within the projects and potential areas of concern. This ensured that ethical considerations were not overlooked, especially as some collaborators were unfamiliar with existing healthcare policy and

regulations. There had been interest in using the knowledge of innovation actors to inform the creation of NHS policy on digital innovation. A clinical member of the Hub team commented on the 'policy catch up' that was underway, and interest in incorporating the learning experiences from the Hub innovation process and key actors (Philip, Junior Clinical).

5.3.6 Section Summary Collaborative Process

The section detailed emerging Hub strategy collaboratively to develop products which improved patient experience by using MedTech. The section explains grounds for using multiple innovation pathways; increased demand for innovation resource, the need for a staged innovation process, and an increased understanding of specialised support. The distinctive purpose of each pathway was explained.

Section 5.3.2 explored factors driving change to the innovation process. Initial goals of building collaborations evolved into a need to manage a complex Hub environment with an expanding Hub team, multiple projects and increasing governance requirements. Changes in the connection between innovation process and Hub management were explored.

Section 5.3.3 focused on understanding how process emerged to improve stakeholder management and manage emerging tensions. Changes in Hub staff behaviour were outlined to demonstrate intentions behind a newly implemented appraisal and validation stages in the innovation process. The introduction appreciating multiple types of innovation outcomes aimed to balance often conflicting stakeholder priorities of user impact, improved organisational performance and commercial returns. The section concluded by considering compliance to ethical standards amid current gaps in NHS digital innovation policy.

5.4 The impact of NHS culture and climatic factors on Hub Innovation

To better understand the Hub, it was important to recognise how its purpose, process and activities were shaped by NHS organisational culture and socio-economic political context within which the NHS operates. In the thesis the word culture is used to represent characteristics of the NHS as an organisation, in terms of values, approaches to delivering care and justification for the systems used to manage NHS organisational processes. The

word climate refers to the impact of factors that were observable through stakeholder behaviour within healthcare environment, like work based pressures caused by bureaucratic processes, and the consequence of limited service capacity for users. The purpose of this section is to understand how pressures within NHS organisational culture, and healthcare climate influenced Hub innovation. The organisational complexity of the NHS shaped the direction and effectiveness of the Hub's activity to date.

5.4.1 Changing expectations of service quality in the NHS

The Hub's user-led innovative approach was influenced by emerging differences in patient expectations regarding availability of information and supportive resources related to their healthcare journey. These needs were evident to clinicians who witnessed the disparity between user expectations and experiences of available services in the hospital. The increased use of technology and digitalised information in daily life has formed a user expectation that service providers offer '*digital and virtual*' service pathways (Peter, Nursing). Increasingly patients and families searched online to understand the treatment process and find answers to their concerns. Interviewees suggested that patients and families were increasingly interested in understanding their healthcare treatments and questioning what would happen. Thus, during data collection Users, (currently hospital clinicians) consistently emphasised the importance of developing digital products to improve communication around the delivery of paediatric care. They explained that as receiving health treatment involved new experiences and environments, patients and families now expected access to digital information, through products designed to support their healthcare journey. Hospital staff shared that the components needed to deliver quality care had been revised, to reflect the growing importance of meeting the '*holistic*' mental health and wellbeing needs of the patients and their families (Christine, Hospital Board). Thus Clinicians' experience of the limitations of existing communication pathways to meet patient expectations contributed to how the Hub approaches product innovation.

As reported in section 4.4 the NHS was prioritising an increase in digitalisation throughout the operational areas of the healthcare system. As this was such a complex process, implementing these changes was expected to take time. Faye (Professional Internal) shared

her past experience of NHS bureaucratic culture and the impact on developing and approving new products, '*the average time for a product to get into the NHS is 17 years!! That is just unacceptable*!' The Hub provided an alternative environment, and an innovation process to contribute to NHS digitalisation. However, the novelty of the Hub environment, and the experimental technologically driven innovation process had been misunderstood by some stakeholders. A Hub staff member addressed this by clarifying the Hub approach to MedTech innovation as, '*less about boys with their toys and more about what does the patient need, looking at it through a different lens*' (Graham, Nursing).

Changes within the NHS organisational climate alongside the increased use of technology in society had created patient expectations to not only access, but interact with technology. Hub staff shared how user experience of technology was limited, '*the quality of tech in the NHS… is diabolical*' and there is a '*technology lag*' where in some areas of the organisation they '*are just digitising what we did on paper*' (Robert, Professional Internal). Hub stakeholders were responding to a lack of specially designed digital infrastructure for paediatric patients. Hub projects outlined in sections 4.4.1 and 4.4.2 focused on using emerging technologies to respond to user and service delivery needs. It was anticipated that the quality of healthcare provision would be supported by Hub innovations which will create new digital user-led care pathways. If applied appropriately, technology would allow personalised treatment and help overcome organisational capacity constraints.

The issue of sustaining service quality amidst continued capacity pressures across the NHS was also an area the hospital was responding to centrally. The hospital transformation team were working on '*a bit of thinking outside the box*' to improve the slow and convoluted process of despatching hospital appointment letters which could take '*weeks*' (Sally, Professional Internal). In the Hub, innovation concepts aimed to create new digital pathways for patients and medical staff to communicate, and access generic information related to their care. This activity aimed to meet changing expectations of service quality by increasing process efficiency, meeting patient expectations for informative digital health resources and improving patient experience by providing interactive digital tools designed for paediatric patients. Digital innovation concepts were designed to provide a resource to help patients increase their understanding of healthcare treatments by using on demand

digital devices. This held benefits for the patient, and reduced demands placed on staff within the wider NHS system.

An NHS staff member explained, '…*we are striving for additional capacity, in banking or travel, consumers have been channel shifted to non-mediated solutions. So now we expect and accept not to have to interface with a person. Digital stuff has helped, but it is just an enabler, we know when the transition occurs it impacts people… so in health, if we can get patients better information about their conditions and treatments, they start to take control… then you start to increase service capacity… user technology that can do all of that; information, education, confidence building and allow patients to remotely monitor their conditions and send readings back to clinicians. Patients treated like this are less likely to be inappropriately admitted to hospital, and use services in a more informed manner.* ' (George, Professional External).*

In addition to responding to organisational capacity issues, Hub innovations prioritised meeting patients' emotional needs when seeking to understand a hospital environment, potentially for the first time. The current method uses clinic consultations to deliver information verbally. Clinicians have noted this method was often ineffective, leaving the patient with unresolved anxieties. By developing digital alternatives, there was potential to increase efficiency of this process and to meet users' digital expectations through providing digitally accessible information pathways.

5.4.2 Understanding how NHS organisational pressures shape appetite for innovation.

During data collection, staff members were keen to share their experiences of how operational pressures within the NHS impacted patient care delivery, and patient experience. Hub innovation activity had been influenced by these circumstances. A hospital staff member explained, '*I think that innovation is really important because we are working on restricted budgets, and if there are ways to support the delivery of healthcare, that are creative, and help us be effective, efficient and deliver good quality services then that it is something we really need'* (Vanessa, Nursing).

The NHS has a long history of initiatives to change and improve services, an NHS staff member working in service transformation shared, *'we have done a lot, and lots has been promised, particularly IT systems, this system will revolutionise the world, and it hasn't delivered. I think that there is a complete lack of confidence in IT and therefore any system that is IT based system will be met with a whole degree of, 'Oh it won't make any difference, it will probably make it harder, so why should I participate?'* (Sally, Professional Internal).

Efforts to increase efficiency within the healthcare system, by increasing the use of digital service pathways was driven by operational and patient experience needs. Graham, a Nurse commented, '*technology is everywhere else, except healthcare …the NHS doesn't have the technology and the communications infrastructure to do what people do every day on their own… my phone, even though it is 3 or 4 years old, is more powerful than the computers that I use in the healthcare environment it is a bit embarrassing really*.' His perspective reflected a lack of modernisation in technology specifically focused on supporting the emotional needs of patients, and digitalising paper versions of information users had become accustomed to expecting online access. Economic austerity had heavily impacted health service budgets, and caused staff anxiety about objectives underlying digital service improvements. When Hub staff have shared digital products designed to increase hospital efficiency, they have been met with a range of negative emotions from '*snobber*y… *we weren't involved so you aren't going to implement that here..,* to '*hesitancy*' and to being '*very defensive*' (Robert, Professional Internal). Concerns were linked to potential job loss, and resistance due to past negative experiences of NHS service transformation.

It was important for the Hub to be receptive to pre-existing user experiences of innovation as it may influence readiness to contribute to and adopt Hub innovations. Although there was hesitancy about the impact of digital innovations, in my field notes I noted how stakeholders expressed expected improvements to care quality and the holistic patient experience. The complexity of the healthcare environment meant that staff often balanced concerns of impact on patient experience alongside practical repercussions on health delivery. Therefore the opportunity to inform service improvements through collaborative innovation appealed to some healthcare staff.

5.4.3 Staff and their Personal Motivation for Healthcare work

Staff users were integral to the work of the Hub, and therefore so was understanding their relationship with the NHS as a public provider of health care. Within my fieldnotes, I recorded the personal testimonies shared by hospital staff which related to why they worked for the NHS, and in some cases why they were involved in innovation. The passion amongst staff users to improve paediatric care and methods of support for patients and families was clearly articulated. Hospital staff expressed the significance of the alignment between the culture of the NHS and their own personal ethics, '*People don't come here (to work in the NHS) for money, they come here for the ethos and the belief of health for all at the time of need*' (Gail, Senior Clinical). In several cases the healthcare treatment received as a child or by a family member had created a desire to work for, and contribute to the evolving national health service. This added to the motivation of some users to participate in healthcare innovation.

A hospital staff member shared, '*For me, is not just professional, this role is personal, … my 3rd child had a brain injury when he was 6 and a half/…/ he was here for a long time and I remember thinking, the most awful thing happened in our family/…/ I want to work here /…/ it was a feeling of wanting to give back, loyalty to the organisation because effectively they saved my little boy, if it wasn't for this hospital he wouldn't be here*' (Vanessa, Nursing).

Another staff member shared his personal gratitude after receiving paediatric care, '*the surgeon who saved my life still works here, if it wasn't for him I wouldn't be here … because of the number of complications I had on the operating table, I should technically be dead*' (Steven, Professional Internal).

Even where there was no personal history of experiencing paediatric healthcare, clinicians' interactions with paediatric patients drove their interest in patient care, to create innovative solutions to meet patient experience needs. Graham (Nursing) recounted a patient interaction when testing an augmented reality prototype, '*he was bed bound… frightened, stuck in hospital and he would for weeks… literally within 2 minutes he turned into a little boy again, playing, engaging, he was smiling, it was almost as if the dark cloud had lifted off*

him /…/ just to see this child come to life, even for a little bit…'. The depth of personal staff motivation to overcome paediatric care needs through innovative design firmly retained a person centred approach to Hub innovation. Furthermore, the insights of users who work within the NHS care environment provide opportunities to advocate for otherwise unknown user needs. This experientially driven, compassionate user's perspective informed by gained experience of NHS care environment forms a valuable component of the Hub innovation process.

5.4.4 Resource Issues

Differences in the organisational cultures of the Hub and Hospital influenced the way that resources were viewed and managed. The differing perspectives and priorities of Hub stakeholders were at the core of this ongoing challenge. The clinical staff who were interviewed during this research recognised that their priorities for innovation may not align with priorities of other stakeholders. Furthermore a clash between Hub and NHS cultures could be seen through different attitudes to planning and the use of scarce resource in the healthcare sector. The Hub facility was often misunderstood as it was not involved in healthcare delivery. A Hub staff member explained, '*So there is very much an attitude of, 'that is not our core business' or why should I be creating a platform for VR in Radiology when I am having trouble getting the straightforward stuff done… I am very much about getting the cherries on top of cakes, I am not really a cake guy. I think you can build a cake if you get the right cherry, so I view it the other way around, doing something really cool will attract other resources, but that is not a common way of thinking, especially in the NHS, and with the way accounting structures work, very transactional – we will buy an endoscopy unit if next year you can prove that you can do 60 endoscopies that will pay for it. Whereas if I say there is about a 5% chance that this may work and if it does it will be big, but that doesn't compute to any form of NHS business plan'* (Tim, Senior Clinical).

This tension impacted the Hub in two main ways: how to secure the resources needed to sustain innovation projects, and how to retain value found within Hub resources. The main area of disagreement concerned sustaining the Hub by using the commercial potential of user knowledge to generate revenue from innovation products. The concept of

commercially successful innovations was a notion that clinicians felt did not correspond with the ethos of the NHS public health service. A Hub staff member shared his experience of working with NHS staff, *'it's this kind of, 'we are in the NHS', and I got into it for this reason, /…/ Public Service, and people feel very strongly about that, … when you talk about … developing a product and commercialising it to generate revenue, that is almost considered to be a dirty kind of thing to do'* (Robert, Professional, Internal)

For Hub staff, and members of the hospital board this user perspective created challenges when seeking a route to the Hub becoming self-sustaining. Users either were not aware of the value of their clinical knowledge, or prioritised reaching beneficial solutions over protecting and profiting from use of their intellectual property. This issue became more significant, as resource demands increased in line with the number of innovation projects. Even where clinicians were aware of the role of protecting intellectual property connected to innovative design, they favoured free distribution of ideas rather over generating sales revenue.

A clinician commented *'…health shouldn't be just one person's business; health is everybody's business. If you have a child in Wales who can benefit from this, then why not? … there is money involved in development, I understand that, but I have absolutely no problem with ideas being shared with collaborators /…/ Health can't be intellectual property can it, that is what I understand?'* (Gail, Senior Clinical).

Additionally as projects progressed, had been a continued pressure to provide finance to support and resource the developmental process. The Hub team had attempted to raise finance through submitting grant applications to internal and external funding bodies and forming partnerships with commercial organisations. Opportunities within the wider hospital had provided some initial options. The alignment between Hub and Hospital charity objectives to enhance patient experience beyond what was routinely available had provided some Hub projects with pump priming funding. A hospital staff member explained, *'our sole remit is to support patients, families and staff… we only fund things that are enhancements or above and beyond NHS core activities … enhancements, so patient experience, medical*

equipment that is state of the art that … the NHS couldn't afford, research, and obviously innovation' (Suzanne, Professional Internal).

However, unmet stakeholder expectations and conditionalities connected to receiving funding had caused this process to stall, *'we came into innovation and then pulled back and have dipped back in at times… we have said we have this (funding)… we are ready, and they aren't ready to do it, I would rather pull back than fail…'* (Suzanne, Professional Internal). Hub staff have experienced obstacles in gaining finance, especially linked to loosely managed projects launched in the early stages of the Hub. This had limited the options for qualifying for additional funds and resources mid-way through the development process. A Hub staff member explained, *'it doesn't matter what funding we have gone after, we have got to have done the due diligence on the project, you have got to make the justifications in the business case… they want to know what the outcomes are going to be, … and the deployment potential /…/ So what I am trying to do now is look them (the projects) and say ok where is the opportunity? Who is this going to impact? Will it provide commercial revenue? If not does it provide patient outcomes?'* (Joanna, Professional Internal).

The hospital board, who approved initial resource for the Hub continued to be a key stakeholder group involved with Hub progress. Due to the climate within the NHS healthcare environment, there was widespread recognition amongst stakeholders that the Hub needed to become financially independent. A Hub staff member explained, *'we cannot be an investment that is not being funded, they want to see a return... at some point we are going to have to transition to being self-sustaining, … we want to be able to take a punt on an idea that might just revolutionise health care'* (Graham, Nursing).

Ongoing meetings with the Board presented opportunities to discuss two main resource issues; the need for additional Hub resources, and the extent to which the Hub could become self-supporting in the future. The Hospital Board had considered how to manage the longer term development of the Hub as a connected entity within the hospital campus and when and how could it support itself financially. The Board member perspective on how best to sustain Hub innovation acknowledged the need for additional resources due to increased Hub innovation activity. However, due to restricted budgets within the hospital,

the potential to generate commercial revenue from Hub innovations was viewed as a way for the Hub become self-sustaining. The main internal '*asset*' was held within '*intellectual property... from our workforce*' generated during the Hub process development (Gemma, Professional Internal). Therefore, commercially minded Hub and Hospital innovation actors were keen to begin actively protecting and generating income from Hub intellectual property emerging from the user-led design of new products. A hospital staff member explained, '*…there is a lot of knowledge in here which has a value, so if we can make that commercialised and a revenue generator, it will help us grow our innovation offer, because the more money you earn the bigger the team that you can have supporting it, and ultimately there is a reinvestment opportunity…*' (Gemma, Professional Internal).

At the time of data collection, no conclusions had been reached about how best to meet the ongoing resource needs of the Hub. My fieldnotes recorded a connection between increased stakeholder interest in Hub performance and efforts to understand the value of Hub assets and resources. In the context of the health sector, the atypical characteristics of the Hub facility presented opportunities to explore new options to generate and access resources. Hospital Board members demonstrated a growing awareness of the importance of users as a resource for innovation activity. The role of user tacit and experiential knowledge were not only resources for informing Hub projects, but also could have a key role in sustaining Hub activities.

5.4.5 NHS Culture and Systems

Hub activities introduced a new type of work and method of working into the hospital. The existing NHS bureaucratic systems were designed to be risk averse to enable complex organisational needs to be managed. A Hub staff member explained, '*I think that we are … so far away from the business norm, unless risk is embraced and resources and budgets are given to innovation, … it can't be just be done in your spare time. If organisations don't put resources and budgets into actually changing to an innovative culture and investing in experimenting then that is why it fails*' (Joanna, Professional, Internal).

Each NHS hospital was controlled using a structure of rigid processes designed to meet the healthcare delivery needs of the organisation. Therefore, challenges that arose from

interactions between the Hub and the main hospital were grounded in understanding the necessary differences in organisational cultures and methods of operation. In my fieldnotes I recorded the widespread frustration amongst Hub stakeholders who had experienced complications when seeking to use existing NHS processes to help advance the innovation process.

Graham, a Hub staff member explained, '*it's a system set up for health care consumables and to apply that to innovation, well it's not set up for it, and on the backdrop of continual cost pressures and slimming down of teams they lack the capacity to innovate themselves to build a team that could have the flex to do that work*' (Graham, Nursing).

The central issue related to the differing operational needs of the Hub and the main hospital, and the inability for existing hospital processes to accommodate Hub needs. The Hub's innovation process was unable to fit into the existing systematic NHS annual financial and resourcing cycles. This was beginning to create '*horrendous*' issues for the Hub staff, who needed to identify ways to navigate procurement and financial processes that were not designed with the flexibility that the Hub process requires (Tim, Senior, Clinical). Attempts to establish the viability of product concepts during the due diligence process, were made difficult by the fragmented nature of the NHS and its communication pathways.

From my fieldnotes I recorded stakeholder difficulty in understanding how to work with the NHS as an organisation. Even hospital staff acknowledged that '*each hospital is like its own little kingdom in its own right*' (Tim, Senior Clinical). The lack of connectivity, and vast networks parallel processes were further complicated due to a lack of shared, digital systems. A staff member shared his frustrations after financial pressures '*dismantled*' a government funded programme that was developing a '*national system for IT, …to allow every hospital to have access to a repository of patient information*' (Steven, Professional Internal). The scale and fragmented nature of the NHS as an organisation, along with the complexity of the organisational structures was perceived as an ongoing obstacle for Hub staff. Increasingly, as Hub projects advanced there was increased contact between collaborators and hospital administrators. These interactions had exposed the extent of the incompatibility between existing NHS system design and flexibility to accommodate Hub process needs within the main hospital procurement and accounting systems. A Hub

stakeholder explained, *'The administrative and bureaucratic resistance to it (innovation) is dramatic I mean, unbelievable… Inefficiency is most of it, there is no urgency, and there is no pathway'* (William, Professional External).

The distinctive Hub organisational culture was uniquely positioned within the hospital campus, enabling the formation of new connections across the main hospital structure from Board level to administrative departments. I observed ongoing efforts in the Hub to introduce and revise process pathways to accommodate needs of collaborative partners. The activities within the Hub were often not recognised within the setup of existing procurement and finance processes. Due to the extent of NHS bureaucracy, the scope to adapt current systems was a source of frustration for Hub stakeholders.

An external collaborator explained, '*The NHS is great at procuring the things it is used to buying…, but to buy something that is not on the list is quite hard. Very hard in fact, and we are a service not a thing … we are kind of a process that is being added in… so there isn't really a single thing to be approved… the problem is when you are adding something new into the process, there is nothing to pay for that. In fact quite the opposite, so hospitals get paid for every operation that they perform, and they get a bit of money back, so they are getting funding for it. /…/ I am making it more expensive for them, but they are not making any money back. Why would they do it?'* (William, Professional External).

5.4.6 Points of alignment between Hub activity and the healthcare climate

Throughout this section innovation challenges which occurred because of differences between the Hub innovation culture and common NHS approaches have been presented. However, during my data collection points of alignment were also identified by interviewees. For example, a clinician recognised how Hub interactive innovation concepts were supporting a hospital commitment to delivering quality care, by providing paediatric patients with '*the chance to play whilst in hospital'* (Graham, Nursing). Strategically these play focused Hub innovations could be used by the hospital to demonstrate a commitment to enhancing care quality and responding to patient's holistic care needs.

There was broad stakeholder consensus that Hub innovation activities could positively contribute to addressing complex issues facing the health sector outlined in NHS Strategic plans. In these NHS strategies the importance of modernising the NHS through improved access to digital resources was considered a solution to current quality, efficiency and capacity challenges. Hub commitment to creating digital resources to improve the patient experience connects Hub activity to national NHS strategic objectives. The Hubs innovation process can be used to demonstrate a pioneering response to user focused and operational objectives within the NHS digitalisation strategy. As the Hub was operating semi-autonomously , the innovative development process was not impeded by organisational challenges found within healthcare settings. This enabled the Hub to contribute to NHS strategic patient experience policy objectives using a new approach. Within my fieldnotes I noted examples NHS organisational challenges to adopting new digital innovations posed by having '*computers that are over ten years old*' and lack of resources meaning that '*getting computers replaced is a real issue*' and existing NHS systems were often incompatible with the '*processing*' requirements of new technology (Stephen, Professional Internal). The Hub facility and collaborative creative space have presented a new way to expedite addressing user frustrations, arising from a lack of NHS modernisation.

5.4.7 Section Summary Organisational Climate and Culture

This section studied the impact of NHS organisation culture and the broader healthcare climate on the Hub. A gap in service quality was identified, driven by changing user expectations of digital support services. Current pressure on healthcare service capacity, restricted budgets led to interest in developing scalable digital solutions to contribute to meeting patients' needs. The design of digital products aimed to provide users with informative interactive tools that can be accessed independently. However some hesitancy emerged amongst hospital staff related to job security and product usability, based on previous experience of NHS digital infrastructure.

In section 5.4.3 NHS Organisational challenges and their impact on innovation were studied including factors driving staff commitment to needs-led innovation, the importance of meeting patients' emotional needs amid limited resources. The section continued by

studying differences between mainstream NHS and Hub culture and processes, and tensions within this relationship. Challenges of differing stakeholder expectations were considered in conjunction with, how and when resources were accessed and procured.

Efforts to resolve these issues through revisions to Hub management and the innovation process to better relate to NHS culture and process were explored. Part of this work focused on improving stakeholder understanding of innovation outcomes during product development. Hub staff efforts to creating a self-sustaining Hub facility were presented. The section considered efforts to balance clinicians' knowledge as a resource and commercial commodity, with their person centred perspective, which overlooked the strategic importance of using knowledge as an asset to sustain innovation activities.

The section concluded in 5.4.6 by highlighting points of synchronisation between Hub activity and the needs in the healthcare climate; a dedicated facility for collaborative innovation, support for the NHS digitalisation strategy, and NHS commitment to improving patient experience.

5.5 Innovation Outcomes

This section is present in six sub sections. Each will introduce early indications of outcomes of Hub activity, along with stakeholder perspectives regarding anticipated benefits for patients, hospital reputation and hospital operational processes and systems. Section 5.6 gives a section summary.

5.5.1 Patient Benefits

Throughout the process of collecting data strong evidence emerged to demonstrate how Hub projects had considered patients' needs through the design of innovative solutions. Hub MedTech aimed to prepare and support paediatric patients to cope with their healthcare experiences which could be '*hugely intimidating*' (Christine, Hospital Board). In my fieldnotes I recorded how hub staff member Steven, shared an analogy how of the Hub innovation concepts were creating a way for the hospital to be experienced in a similar way to a theme park from a child's perspective, '*scary things happen, but you cope as you are prepared, and therefore it does not stop you wanting to go back*'. Steven (Professional

Internal) shared how he viewed the anticipated patient benefits generated from using Hub MedTech, '*it's a way to relate to them [the patient] that calms them down, and makes them look at the hospital in a different light*'. Innovations in the Hub prioritised user needs by using a person centred focus during the development. A founding Hub staff member explained that a reason for this focus was to serve paediatric patients needs that, he argued were not prioritised within mainstream commercially focused innovation. Although Hub concept development was still in progress, a number of intended patient benefits were identified by stakeholders.

A major objective of the Hub's technological focus was to meet the particular expectations of paediatric patients, through accessible and engagingly designed digital products. It was anticipated that patients will be positively impacted in a number of ways. Firstly, that patients will benefit from continuous access to information sources powered by artificial intelligence. Secondly, the patient experience will be improved as products have been designed specifically to support paediatric healthcare journeys. Hub products used interactive digital technology to communicate with and provide support to patients using 'familiar' interactive digital platforms. Specific attention was given designing products that addressed patient's holistic healthcare particularly reducing anxiety and building confidence using familiar processes. Graham (Nursing) explained, '*kids … are digital natives /…/ to bring a kid through their healthcare journey they need a lot of support and rewards. You need to speak to them at the level they understand … one method of communication and reward is based on what they value, they value technology /…/ that is what they know, understand and utilise /…/ when you give information to children, you (typically) give a leaflet and you walk outside and it's on the floor*'.

A Hub staff member explained, '*the focus of the product is the (patient)user, and their understanding of and comfort within the hospital which then effects their emotional wellbeing*' (Scott, Professional Internal). Thus, innovation actors hoped that patients will benefit from improved health literacy associated with the procedures and new healthcare environments they will encounter. From my fieldnotes, clinicians expressed a connection between increased levels of health literacy and improved mental and physical health outcomes. Hospital staff shared their aspiration that patients would be better informed, and

therefore better able to cope with their time in hospital and manage impacts to their physical and mental health. A Hub staff member explained, '*I hope by developing these educational pieces in the app and communicating to patients, at their own level that will have incredible effects and hopefully remove fear. You could also get the operational fall out, quicker theatre times if the patient is compliant … (or) a reduction in traumatic referrals to our clinical psychologist over patient distress*' (Graham, Professional Internal).

Hub innovations sought to aid patients through increased access to information via digitally supported pathways, that sought to engage the user through augmented reality and artificial intelligence software. These tools provided an added layer of communication with paediatric patients, which the child initiated by using the product. This lessened reliance on traditional clinic based interactions as the main way to prepare future clinical processes. In my fieldnotes clinicians working on Hub projects emphasised the importance of empowering patients during a time when they were provided with complex information and being asked to comply with new procedures in an unfamiliar hospital setting. Clinicians acknowledged the patient experience challenges that patients and families experienced as part of the healthcare journey. The engaging way that Hub products have been designed aimed to invest in addressing previously under resourced '*emotional aspects of healthcare, what children experience*' otherwise known as their '*holistic, mental health'* care needs (Christine, Hospital Board). The Hub innovation culture had created an environment where stakeholders' knowledge guides prioritisation of needs-led innovation projects. This was important as it enabled the outstanding holistic care needs of patients to be addressed. Although clinical users understood the importance supporting the specific holistic needs of paediatric patients, without dedicated resource like the Hub there was very limited opportunity and capacity to respond to these needs within the existing NHS service pathways .

An example was shared by a nurse working on a new pathway to supported patients transitioning from receiving care in a paediatric hospital, to an adult hospital. The need to acknowledge the stress and uncertainty felt by this vulnerable group of patients, and their families was understood by staff working in this area. Their experiential knowledge was valuable in directing the creation of a new care pathway and accompanying resources. An

interviewee shared how a patient handbook containing relevant information had been created to help address the anxiety and uncertainty experienced by users during an otherwise purely operational process, where care provision moved from a paediatric to adult hospital (Vanessa, Nursing).

5.5.2 Reputational Benefits

Hospital Board members commented that the addition of a Hub was beneficial to hospital brand and reputation. The Hub provided the hospital board with an example of their already documented commitment to the innovation, as part of hospital strategy. Hub based opportunities for staff to innovate through the range of collaborative pathways aligned with the hospital objective of developing their onsite innovative capabilities. Hospital support for the Hub provided further commitment and investment to hospital initiatives seeking to empower staff to be innovative, and strengthen the organisational culture that '*serves the child*' (Clive, Hospital Board).

The creation of a Hub within the hospital campus was considered as pioneering by senior staff. Roger (Hospital Board) argues, '*I think our big idea … was a big opportunity, getting staff and patients and the guys (Hub Staff) working on things with universities and companies, putting those things together, that is a big win*.' As introduced in section 5.1 interactions between the NHS and other organisations had faced a series of barriers and challenges, partly due to a lack of dedicated space and resource. The Hub facility symbolized an appetite for innovative thinking, and complements other examples of pioneering technology integrated elsewhere in the hospital. This receptiveness to change using innovation, along with support for listening to hospital users was promoted as a key part of hospital culture. Therefore in recruitment materials, the Hub was presented as an opportunity for staff to diversify their role and become paediatric innovators. This prospect had helped to '*successfully recruit a top notch cardiac surgeon*' (Christine, Hospital Board).

Paediatric medicine involves treating fragile patients, sometimes with multiple health conditions. Therefore staff with experience in these specialised roles were sought after in a highly competitive, global marketplace. The hospital used the Hub as a strategic tool to

support the recruitment and retention of highly skilled clinical staff. For example, Christine (Hospital Board) shared, '*Have you seen the portfolio we have put together? … we have got a pack as we are trying to recruit a medical director and part of the pack is this* (a section on Hub innovation opportunities for staff) Using the Hub in this way had been recognised as a contributory factor to maintain and stabilise hospital staff capacity. Christine (Hospital Board) stated, '*how many people did we attract to this organisation because we have an innovation hub? … we recruited a top notch cardiac surgeon who has an interest in innovation, equals a result. So for me, there is a recruitment and retention piece there, never mind the product or therapies or ways of working that they are actually developing as products of innovation. That is one aspect of the output, but there are a lot of others … real intangibles but vitally important. Reputation, recruitment, these are really big issues for organisations like ours.*'

Additionally, through recruiting clinicians with rare, advanced skills the hospital was able to accommodate the care needs of the most complex patients and gain these cases. A Hub staff member explained, '*If you can offer something over and above solid clinical practice, then it encourages people, as the best staff in the world come to the best hospitals and some of that comes from things that aren't the everyday clinical practice*' (Jeremy, Professional Internal).

This approach contributed to the hospital's reputation as a pioneer of paediatric medicine, which attracted funding and additional Hub staff resource through involvement in an EU funded project described in section 5.3.1.4. Clinicians acknowledged the appeal of opportunities to contribute to advance healthcare delivery within the pressured, and often repetitive clinical routines of their roles. A founding Hub member explained, '*You get a lot of inventive and entrepreneurial people in medicine who get a bit crushed by it, because medicine is performing the same thing over and over again really, that is what it is, lots of tasks to be done. Whereas some people want to do a deed, a let's get that dragon and you need to give them the opportunity to do it*' (Tim, Senior Clinical).

5.5.3 Operational Benefits

The anticipated outcomes of innovation activities aimed to address NHS operational challenges discussed earlier. The need to create additional capacity in existing NHS systems was supported by an increased use of artificial intelligence (AI) to create new technologically supported communication and information pathways. George (Professional External) who works for the NHS explained, '*When they (patients) start to take control then you start to increase your service capacity. So we have found with user technology that can do all of that stuff, information, education, confidence building and allowing patients to monitor their own conditions /…/ What we have found is that can give us between 20-30% additional capacity in services, now that is huge.*

One aim of Hub innovation was for patients to use Hub AI enabled products to find answers to standard queries, reducing pressure on a human driven process. Graham (Nursing) explained, '*That is where the technology comes in because, technology is scalable, we already know we can't scale anymore workforce in the NHS /…/ if you can prep people before you bring them in you don't spend the first 5 minutes of a consultation allaying their fears*. The intention was to create performance improvements, and focus how clinic time was used. It was anticipated that capacity will be created when patients could use AI technology to answer general queries. This could enable staff to focus on clinic matters during appointments, thus creating desired efficiency improvements.

An advantage of using a digital system was the capability of the technology to simultaneously respond to multiple users without the need for additional resource input, unlike traditional face to face process. Operationally, this was significant as the introduction of digital products would enable all users to have access the same level of support despite differences in the severity of their healthcare needs. The aim was to create operational and user benefits for the organisation, and help to extend the provision of person centred support and a consistent level of service provision. Concerns over a reliance on specialised human driven holistic support could then be partially alleviated through use of patient experience digital products being developed in the Hub.

As noted earlier there was a connection between meeting the holistic care needs of patients and maintaining the schedule of healthcare delivery. Specialised staff, like play therapists could then dedicate their skills to supporting patients who require in person support. A Hub staff member explained, play therapy *'is a finite resource …so just because that child has a fractured femur and that child a nasty graze, that for them is the worst injury in their life, should they not have the same level of distraction? but (through innovation) we can put in a little of what we know is magic into technology and scale it'* (Graham, Nursing).

The Hub facility provides an opportunity for the hospital to capitalise on the tacit and experiential knowledge of staff, and therefore create operational benefits for the hospital in terms of efficiency, quality of care and new income streams. It was intended that operational benefits will also emerge from user-led process improvements which consider existing hospital processes from a different perspective. Although other hospital departments were engaged in service improvement, the combination of the needs-led Hub focus, and collaborative input of different stakeholders have provided new opportunities for the creation of operational benefits.

During data collection the importance of creating positive childhood health experiences were connected to the current strategic preventative healthcare agenda in the NHS. The ongoing capacity pressures experienced in organisations across NHS services highlighted the need for patients to engage with their own health, and call on services prior to a *'crisis point'* being reached (George, Professional External). The development of user-led digital resources to support patients, and increase their health literacy was seen as a key component of supporting the evolving patient/clinician care relationship.

Longer term operational benefits for the NHS were also attributed to meeting the needs of paediatric patients during their initial contact with the health service. Clinicians shared the perspective that avoiding negative experience of healthcare would promote responsible use of healthcare services into adulthood and prevent avoidance of accessing care. Operationally this was important for the NHS, as increasingly there was a view that many long term health conditions *'are preventable'* (George, Professional External). There were concerns across the health service around available capacity to treat patients. Therefore the

Hub approach of engaging and informing young patients supported broader efforts to move away from the position where '*the NHS is becoming a reactive ill health service … and think about doing things differently … the evidence says that prevention, education and information works*' (George Professional Internal). Users who chose healthy lifestyle choices and early intervention from healthcare services operationally benefitted NHS as services as they were less costly and resource intensive than care needed at a crisis point like instances of a heart attack or development of chronic illness like diabetes.

5.5.4 Current Challenges

The Hub has experienced barriers to the process of developing innovations. A key factor in these challenges related to the anomaly of the Hub facility within the hospital setting. This impacted Hub stakeholders in different ways. The time and resource pressures experienced by NHS staff have created a staff mindset focused on addressing present health delivery needs. A founding Hub staff member explained, '*if what you are doing is (in the Hub) going to impact on somebody else they don't want to do it, because why should they.. they are busy. So there is very much a, 'that is not our core business*' (Tim, Senior, Clinical). During data collection, the Hub was still in the phase of concept development, which meant Hub staff were, '*at the early stages of showing people what can be achieved*' (Robert, Professional Internal).

Hub staff seeking participation from hospital colleagues have struggled to find available staff time as the hospital was already operating with '*insufficient resources*' (Jeremy Professional, Internal). A Hub staff member summarised a common initial staff response to engaging with Hub innovation, '*Despite the need for us to think about the future I am struggling with this afternoon, so yes of course we will help, but can we do it tomorrow?*' (Jeremy Professional, Internal). Hospital healthcare delivery services were in high demand, so expanding staff involvement in the innovation process was an ongoing challenge for Hub staff. These difficulties paraphrased by Jeremy (Professional Internal*) '…could you stop doing that (healthcare delivery)… for future (innovation) glory and impact, because instead you helping one person now, we could maybe help a thousand people next year, nobody works that way do they?*'

The participation of Hospital staff was vital to the needs-led Hub approach, yet the Hub innovation culture was unfamiliar to hospital staff. Clive (Hospital Board) explained, '*NHS culture, organisationally is very top down, controlling, so room for innovation and individual's scope to be radical is limited … healthcare is very serious, and safety is a big issue … we tend to focus on writing reports on … options rather than the, let's try it and see if it works idea… That methodology is not something the NHS finds easy*.' The Hub culture required staff to change their mindset, and work in a manner to which they were unaccustomed. Graham (Nursing) commented that ordinarily clinicians '*never enter into a scenario without knowing how to get out of it*.' Thus, from the NHS staff perspective, the Hub represented an opportunity to contribute ideas to overcome problems that impacted their role as paediatric care providers. The Hub was seen as '*a safe environment*' (Clive, Hospital Board) that was accepting of risk and experimentation associated with innovation. Initially the Hub was promoted as an environment to be creative, however two main challenges arose as a result of this.

Firstly, the Hub had limited resources, and so was not able to respond to all ideas contributed by staff. This created a challenge for Hub staff who were also keen to run events to encourage future participation from staff. Previously well attended Hackathon events generated a large number of potential project concepts, yet this positive result unintentionally caused individual staff members to feel let down if their idea was not taken forward. Similarly, in my field notes I recorded concerns about the damage caused to external stakeholder relationships when their expectations were not met in these circumstances. This issue drew attention to a need for improved stakeholder communication, and transparency around the innovation development process. Investment in the Hub team to better support stakeholder relationship management will contribute to resolving this issue. A board member commented that '*we have made huge progress, created a reputation as embracing innovation, but we are in a moment where we need to bring some better business (processes) into it*' (Clive, Hospital Board).

Secondly, the collaborative nature of the Hub process had to be receptive to stakeholder expectations about the pace and focus of Hub processes. Again, the way in which the Hub developed an association between creativity and innovation was of key importance as a Hub

staff member explained, '*Creativity isn't innovation, they are not the same /…/ there are lots of good reasons for creativity, but it doesn't necessarily solve problems /…/ it is understanding the context of creativity and why you want to use it… most people in industry will expect very convergent thinking, make a decision…, make a choice. With creativity you are expecting people to be divergent, how many options can you come up with, so it is a fundamentally different thing*' (Robert, Professional Internal).

Consequently, the enthusiasm of founding Hub staff to encourage stakeholder interaction with the Hub facility had been re-evaluated. The absence of strategic planning created some longer term issues related to stakeholder expectation of pace and idea development and available Hub resource. Part of this issue arose from the Hub innovation work being '*not core business*' and therefore Hub staff faced some organisationally based '*resistance*' (Tim, Senior Clinical) for hospital colleagues. Innovation activity generated additional resource requests and placed additional demands on staff time, which were not a priority for the healthcare delivery focused hospital.

In response to these emerging challenges Hub staff were continuing to work on revisions to innovation management processes to provide a framework to guide the innovation process. This aimed to help stakeholders understand the challenges faced by Hub staff, and current points of disconnection with main hospital processes and resource provision. Senior Hospital staff had requested development of strategic processes to justify decisions made in the Hub. One hospital staff member commented, '*It's the 'so what' isn't it! I am winding the team up a bit with my questions because I keep saying so what? /…/ I mean it's about getting beyond the 'it's really cool'* phase (Gemma, Professional Internal). As Hub staff became more familiar with the differing priorities of stakeholders, challenges arose regarding how to accommodate their expectations. The user-led culture of the Hub was heavily influenced by clinical users seeking an improvement to patient experience. A hub staff member commented, '*In this environment seeing the solution deployed and their department is what they want, and I feel bad as we can't do that for everybody who comes up with an idea and solution, you can't work on everything*' (Joanna, Professional Internal).

However the financial investment required to develop innovative solutions to their needs required the participation of commercially motivated stakeholders. Their participation provided access to resources and advanced technology that was at the core of the Hub innovations. Tension between stakeholders who were part of the collaborative innovation process was further complicated due to differing opinions on the use and value of knowledge. The tacit knowledge of users was identifiable as a fundamental asset of the Hub innovation process. Within mainstream innovation, the insights of users were not able to be accessed by other organisations and therefore, were highly valued by external stakeholders engaging in the Hub process. However different stakeholder views on the sharing of knowledge to benefit patient healthcare created tension. Some clinical users were of the mindset that information should be '*freely shared*'. They found the idea of commodifying knowledge driven innovations as intellectual property as against their ethical beliefs (Gail, Senior Clinical). In contrast, without a strategy to enable the Hub to become self-sustaining, both expansion and continued operation of the Hub were more uncertain.

The Hub facility created a new link between the world of healthcare delivery and the world of multi-stakeholder innovation. From the hospital perspective, relationships with other NHS organisations provided another area for misunderstandings. From an organisational perspective, the locally managed nature of NHS organisations meant that there an external trading market was operational, and other NHS organisations were in fact potential customers. However, from a medical perspective, there was a purpose driven desire to share progress in and increase access to innovations. Thus clinicians seek to share innovations freely with the intention of maximising benefits for healthcare users. This example of stakeholder tension links back to the public sector ethos that many NHS employees shared, and their objection to commercially controlled restrictions on healthcare services. A staff member captured the perspective of some hospital staff, '*if you are a clinician within the NHS then money and business is a bit of a filthy loo*' (Scott, Professional Internal).

The Hub staff held an important role in mediating between stakeholders, whilst '*demystifying*' the role of IP and commercialisation in conjunction the operational problems facing the Hub (Philip, Junior Clinical). The perspective of Hub staff was captured by a team

member who stated, '*we are not in a society where everything is free, so even though the NHS gets funded they are really strapped for cash, so why wouldn't you do activities that bring in more cash?*' (Joanna, Professional Internal). However, this conflicted with some clinician's motivations, who argued, '*this won't make a massive profit, but it will make a massive impact*' (Peter, Nursing). For the Hub, the need to be a financially 'self-sustaining' department often conflicted with the user-led drivers of the innovation process.

Yet there was a lack of familiarity with how to balance the disparate priorities of stakeholders to successfully deliver a balanced portfolio of Hub projects. Hub staff working in this area understood that a stakeholder '*mindset change*' was needed to demonstrate that social and commercial returns were not '*mutually exclusive*'. In fact, patient experience focused innovations '*can still be a commercial product because if it is beneficial to the patients in this hospital then it is beneficial to the patients in other hospitals*' (Joanna, Professional Internal). The need to clarify this approach to internal users to avoid them becoming disengaged with the Hub and misjudging its purpose was being addressed. A member of Hub staff leading this work identified the Hub role as one of promoting the purpose of innovation, and '*improving outcomes*' so Hub innovation outcomes will be seen in a '*variety of … health outcomes or (within) hospital processes*' (Joanna, Professional Internal).

Hub staff were seeking to deliver an answer to the complex question which exists within the hospital, which is, '*… are they hospitals or are they businesses and I think it depends on who you ask*' (Gemma, Professional Internal). The Hub was a new form of organisational structure within the NHS with a distinctive purpose, process and set of capabilities. It was, therefore, important to consider whether the Hub should be regarded as an example of an evolution of public sector healthcare organisations? Elsewhere in the hospital there were examples of innovative work that was evaluated in terms of benefits to patient experience rather than financial metrics. The arts based intervention activities which aimed to improve patient experience were externally funded but judged by '*softer outcome*' evaluation criteria. These criteria valued patients having a '*better experience in hospital,… being less isolated, less anxious,… increasing in confidenc*e', being '*distracted*' from their pain or illness or becoming 'reenergised' after having participating in arts based activities to counter '*being tired all the time*' after treatments (Ruth, Professional Internal). As some projects reached

the testing phase there was scope for the Hub to use this as a benchmark to validate their person centred approach to innovation. Given the context of paediatric patient experience, this could support future efforts to sell Hub innovations to other NHS institutions, and thus aid sustainability by providing a financial return on investment.

5.5.5 Intangible Innovation Outcomes

Throughout this chapter the significance of the intangible outcomes of Hub activity during the development process have been explored. During data collection, understanding their importance were often the focus of Hub staff meetings. Hospital Board members also acknowledged the need to better understand *'vitally important'* intangible innovation outcomes as a way to appreciate Hub progress (Christine, Hospital Board). As many projects were mid development, it was not yet possible to provide tangible results or undertake an evaluation to establish innovation outcomes. Yet Hub staff were increasingly being pressured by stakeholders to tangibly suggest some outcomes of product concepts whilst undergoing development.

Stakeholders varied priorities all identified a connection between the growing interest in understanding outcomes of innovation and relieving some of the *'wicked problems'* in healthcare (Graham, Nursing) that pressurised NHS staff and processes. Hub staff member Joanna (Professional Internal) explained, *'unless we bring in new innovation we can't help to make their jobs and work life balance improve /…/ even though the NHS gets funded they are really strapped for cash, so /…/ the core goal is improving a variety of health outcomes and operational outcomes.* This view was supported by Gemma (Professional Internal), *'we are all here to support patient care … innovation … should be transforming healthcare, for me that means higher quality, and … more for the same money, so better value, better quality care for patients.'* (Gemma, Professional Internal).

An example of the Hub's role in this challenge was shared by Hub staff member Robert who recounted, *'…guys (clinicians) came to us and said this is a really old process, it doesn't work very well, we get lots of need for retesting, so people come to outpatients more than is needed, that costs us more money and causes disruption for patients who are not in school…*

So… looking at the problem in a different way, /../ we found a problem in screening before you get to outpatients. The clinicians said the screening process isn't very engaging for children, it is boring… we have computer games now, we can make it interesting /…/ What is the issue? Lack of concentration and poor engagement so we developed a series of /…/really basic games, but …that is innovation. That wasn't hard to do, it is probably going to be cheaper to deliver as you don't need as many staff, there will be less defective tests and the child will get an earlier screening result and so potentially a better (healthcare) outcome. We did a proof concept test. We have since developed the product fully and it needs to go to clinical validation to see if it provides a diagnostic output' (Robert, Professional Internal).

Hub staff were working on demonstrating outcomes of Hub projects, which was a challenge during the development stages, due to a lack of experience in testing and evaluation amongst Hub staff. Therefore, there was a view that the Hub staff would have a role in '*stage managing'* people involved in the testing and rollout of Hub projects. This aimed to combat a lack of connectivity between NHS organisations and minimise avoidable points of failure (Denise, Professional Internal).

In my fieldnotes I recorded examples of work attempting to classify intangible benefits, and explain their value to stakeholders. A number of areas were emerging as potential ways to demonstrate the beneficial impact of hub project. Types of '*social value'* (Gemma, Professional Internal) included improvements to patient experience, health literacy, and healthcare quality which could be all classed as socially beneficial. There was also a link to financial benefits: improved efficiency, the creation of capacity along, '*glory'* delivering a boost to the hospital '*brand image'* and new income pathways from the sale of innovative products (Gemma, Professional Internal).

Hub staff claimed that a contribution Hub facility had made was the creation of a novel innovation culture , along with a new grouping of innovation focused job roles. A Hub staff member explained, '*We have popularised the idea that we can have interesting people doing an odd type of job that might benefit the Trust … we have got to continue being the merchants of cool, the people who do good stuff, but, it has then got to quickly be followed by so what?'* (Jeremy, Professional Internal).

Hub staff were working on defining the '*so what*' in an attempt to begin to define the contribution of the Hub facility and Hub outcomes (Gemma, Professional Internal). In addition, work was underway to understand the intangible benefits that resulted from the collaborative working relationships of Hub innovation actors. Within the Hub there was a consensus that stakeholder and organisational benefits emerged from Hub events and activities. Furthermore, the multi-stakeholder innovation process itself was of value to developing specialised person centred user-led innovations. Hub staff had made a significant contribution in supporting Hub development, and its innovation process. Founding Hub staff made comments related to their aspirations for outcomes in this area, like regarding '*smoothing the (collaborative) process, to make the interface disappear so all these people are easier to manage*' although they acknowledged their early stage challenges achieving this '*we have had mixed success, as we can end up not being the main part of the system. So we have to work it out*' (Roger, Hospital Board). However, during data collection no formal efforts had yet occurred to understand this. Despite the complexity of defining intangible the contribution and innovation outcomes from the Hub, there was a consensus that the Hub made a novel, positive contribution to creation paediatric innovations. A staff member commented, '*I think that what we are doing is definitely unique and I certainly think a lot of hospitals want to follow…in terms of having the infrastructure here and the way we thinking about it, not just philanthropically or in terms of transformation. We are thinking around commercial aspect… I am sensing that there aren't many that are doing what we are trying to do*' (Joanna, Professional Internal).

The work of the Hub staff had enabled collaboration between stakeholders who otherwise would have found it difficult to engage with each other due to bureaucracy, work pressures and differences in organisational culture. As a result needs led innovation ideas had been able to progress due to the combined knowledge and resources of these stakeholders. An example of this was the leading role the Hub played in '*properly incubating'* of a 3D printing company who operated from within the Hub which enabled them to develop a healthcare focused line of medically relevant 3D prints (Tim, Senior Clinical).

As discussed, engaging in multi-stakeholder collaboration had introduced challenges into the innovation process. However, Hub staff recognised that there were a number of connected intangible benefits for the NHS and staff users. A Hub staff member reflected,

'we have clinical input that other people can't get, access to patients that companies and the private sector can't get. We have access to health economic data if people get their sh*t together, and that is unparalleled. From a workforce point of view, there is a huge (NHS) resource if people have the resources to tie it together, and there is the incentive to do it' (Scott, Professional Internal). However, in my field notes it became apparent that the Hub had been struggling to access sufficient resource in the NHS to benefit from the potential they had identified. This challenged how well the Hub could demonstrate outcomes of Hub activity. Without efforts to formally record testimonials from participating staff, and access to data, it was more demanding to convince the Hospital Board that their aspiration for the Hub to be a staff retention and job enrichment resource was beginning to materialise. The experiential knowledge of Hub staff gained from working closely with different stakeholder groups was in itself a valuable resource for the hospital when seeking to understand Hub benefits. However, I observed the pressure Hub staff were under to address a number of conflicting priorities linked to the development of Hub projects, and related issues of stakeholder management. Therefore, there was limited capacity to dedicate time to the creation of resources which demonstrated the intangible insights they gathered, in a format that could be presented to key stakeholders.

5.5.6 Section Summary Innovation Outcomes

Section 5.5 presented the intended innovation outcomes of Hub activity, alongside some initial indications of benefits resulting from the Hub facility. The section divided these outcomes into those impacting patients, organisational reputation and operations. Users identified a potential universal patient benefit to patient experience as novel digital products in development would enable information to be accessible on demand by digital native paediatric users. Additionally Hub products addressed holistic healthcare needs by improving health literacy and emotional wellbeing for patients and families.

Initial evidence of benefits to the hospital from Hub activity were presented, including strengthened reputation and use as a recruitment, retention and job enrichment tool. Further beneficial outcomes were evident in operational efficiencies within the hospital's existing service pathways and scalable capacity to deliver the same level of service to users as needed.

The section concluded by considering current challenges impacting the Innovation Hub; resource issues arose as innovation activity was not being regarded as core business in a hospital setting, allocating staff time for innovation within their workload remained a challenge. The connection between stakeholder expectations of innovation activity, innovation outcomes and resources needed to sustain innovation activity emerged as key challenges. Hub staff emphasised that improved communication, stakeholder management and use of business process would strengthen innovation activity. Yet stakeholder tensions continued around the place of profit generation from innovation activity, paired with a lack of understanding of innovation process. This created obstacles for sustained momentum of concept development.

5.6 Chapter Summary

This chapter presented empirical findings which established stakeholder perspectives on innovation management and the importance of space, process and collaboration. It was structured into five main sections to align with the structure of the thematic analysis. Section 5.1 explored the progression of Hub staff management and how challenges including integrating user knowledge into the innovation process and stakeholder management were addressed through the creation of an innovation culture to support innovation activity. Empirical data illustrated how Hub staff managed the innovation process to support stakeholders, and overcome barriers within a highly regulated healthcare delivery setting.

In section 5.2 the function of dedicated innovation space was studied to understand the impact on the collaborative innovation process and creation of an innovation culture. Key findings showed how access to Hub space changed user behaviour, which facilitated discussion and experimentation. The changing use of Hub space and how this aligned with stakeholder needs were presented.

In Section 5.3 three innovation pathways were explained outlining their specific use and reasons for the introduction of complementary innovation pathways. The main process, the Innovation Governance Process was presented, detailing the inclusion of modifications which assisted resource allocation and prioritisation. Key findings related to stakeholder

pressure for the Hub to become self-supporting, and how process was used to increase Hub sustainability.

Section 5.4 considered how the healthcare climate and NHS organisational culture influenced Hub activity. Key findings relate to how the objectives of Hub innovation concepts were informed by the NHS context, supporting user's holistic healthcare needs amid NHS operational struggles.

Clinicians' allegiance to the social founding NHS ethos were explored to provide an understanding into their motivation for innovation activities. Conflicting views on commercialising Hub products led to consideration of the tension between the NHS as a provider of care meets a more versus a business focused perspective of hospital management.

Section 5.5 presented intended innovation outcomes, along with early indicative areas of impact. Findings showed how the conflicting drivers of user needs and commercial prospects can coexist and mutually benefit the Hub innovation process. Key findings revealed intended innovation outcomes of improvements to hospital reputation, service capacity, HR processes and patient experience through increased health literacy and digitalisation.

The chapter contributes to the thesis by presenting key findings that document transition of the Hub from an exploratory place of creative experimentation to a more structured environment. The next chapter will discuss how key findings provide an answer to the research questions guiding this thesis.

Chapter 6 – Discussion

6.0 Introduction

This chapter will critically reflect on empirical findings presented in chapters four and five in order to articulate a contribution to the research literature on Innovation Hubs. The outcomes of the discussion in this chapter will provide an answer to the research questions informing this study. The chapter is presented in three sections to align with the research questions which focus on understanding hospital Innovation Hubs in terms of their development, role of clinical users and the innovation management processes to support multi-stakeholder collaboration.

6.1 Managing the start-up phase of a Healthcare Innovation Hub

This section will answer to RQ 1, '*How are Innovation Hubs developed in a healthcare context?*'

Locating a Hub near to an 'institutional anchor' (c.f. Owen Smith and Powell, 2004:17) has the potential to increase stakeholder accessibility and user engagement in innovation (Vespestad and Clancy, 2019:132) and facilitate a 'collision of ideas' between otherwise separate stakeholder groups (c.f. Dzau et al 2015:1426). The choice of Hub location often targets a key demographic of stakeholders (Veeckman et al (2013) with contextually significant 'sticky knowledge' (c.f. Von Hippel, 1994) relevant to that organisational context. Thus developing a Hub that was both proximate to healthcare knowledge and accessible for stakeholders that had shared goals (Nicolopoulou et al, 2017) was important in the early stages of Hub development. The literature presented a picture of a Hub as 'a nexus' (c.f. Sharma and Meyer ,2019:87) between key stakeholders and organisations seeking access to innovative enabling space (c.f. Moultrie et al, 2007:62). This was especially relevant in the public sector where dedicated innovation space is a rarity (Dzau et al, 2013). However, the research undertaken in this thesis revealed that the complexity of healthcare delivery and Innovation Hub environments produced challenges for clinical users seeking to balance their

participation in these often distinct operational contexts. That is, the ease of accessibility associated with the proximity of the hospital and how this actually contributed to challenges of developing a healthcare Hub.

The literature stated that developing an innovation Hub which is proximate to and accessible by key stakeholder groups created 'a central point of connectivity' (Longo and Giaccone (2017:881) which 'eases' access for internal stakeholders (c.f. Lawton Smith et al 2016:1426). In a healthcare context, users wanting to contribute to innovation activity could benefit from an accessible Hub location, as the proximity between the hospital and innovation Hub removed the barrier of travel time. This research identified that the hospital location for a Hub faced complications in benefitting from presumed opportunities to leverage of user knowledge and joining up of different public policy logics aided by an accessible Hub location, contrary to prior research (Miller and French, 2016) User participation required more than a physical presence in the Hub space, and therefore the close proximity also created a pressure for clinical users.

For clinicians to contribute effectively to both the Hub and Hospital work environments different behaviour and approaches were expected (Batayeh et al, 2018). The separate yet connected work settings required users to shift between appropriate behaviours, and detach themselves from other aspects of their working day. The practical and emotional intensity of healthcare delivery made this difficult. Yet the literature does not acknowledge this, and rather focused expected outcomes from the pursuit of difference made possible by a dedicated innovation space (Veeckman et al, 2013). The development of a healthcare Hub was found to be influenced by clinicians' availability to engage in innovation, which was often informed by their clinical schedule and thus an addition to 'normal' workload. Furthermore the findings showed how using the Hub to conduct a new types of work was unfamiliar to Hospital managers. As a result, this required hospital managers to consider how to organise time to permit clinicians to undertake effective work in both contexts. This confirms research elsewhere that acknowledged the broader organisational and communication challenges clinicians working in hospital maker spaces (Aakus et al, 2018:4599) and problems organising sufficient time for their participation (Tang et al, 2018:96).

Many staff had a ward bound role, and the close proximity between the Hub and their main workplace did not remove the obstacles they faced. Most nurses, healthcare assistants and office based staff unlike Doctors and Consultants, had little mobility in their role. Some users worked in different locations and in a manner which allowed them to visit the Hub, although this flexibility was not available for all hospital staff. Therefore, the potential benefits gained from Hub proximity required additional organisational arrangements in cases of clinicians who faced restrictions in their place of work. Deployment of clinical resource required hospital managers to acknowledge the different expected outputs of staff who invested time in healthcare delivery and innovation roles. This research reinforced findings in the literature to underline the point that developing a Hub presented opportunities for healthcare policy makers and hospital managers to 'hybridize' differing approaches and use Hub space to respond collaboratively (Miller and French, 2016). Developing a Hub space to address operational pressures and changing user needs enabled healthcare challenges to be seen as 'opportunities to be explored rather than costs to be endured' (c.f. Miller and French 2016:1534). User commitment to socially motivated innovation (Nicolopoulou et al, 2017) combined with stakeholder pressure (De Vries et al 2016:163) supported the creation of a 'home' (c.f. Saidi et al 2017:38) for healthcare innovation to enable a new way of working. By balancing immediate and longer term returns on the use of staff time it was possible to utilize clinician's skills to address acute needs alongside healthcare challenges addressed in the Hub studied.

The creation of an onsite Hub extended the type and purpose of operations on the hospital site, blurring bureaucratic public sector hierarchies (Veeckman et al, 2013). It also provided an environment for creative thinking across organisational boundaries, through providing 'common space', important in supporting the early stages of creative experimentation, confirming research elsewhere (Saidi et al, 2017:42). The distinct purpose and process used in the Hub required some level of support from the main hospital balanced with recognition that the Hub was different, and had to be operationally and culturally somewhat separate. The connectedness between the Hub and the Hospital is intended to be of mutual benefit innovation and hospital outcomes. Yet the operations of the Hub are required to accommodate demands of healthcare delivery. The development of the Hub required management processes that accounted for these different requirements. The fieldwork

identified that Hub accessibility brought organisational benefits to the hospital, including its use as a recruitment and retention tool for staff which extends findings in a previous study which identified improvements in job satisfaction (Locke et al, 2019) .

The Hub operation functioned in a different manner to the main hospital and was becoming recognised by hospital managers as making a separate contribution to the wider hospital agenda. The way in which Hub staff championed the idea of a self-sustaining facility demonstrated potential for the Hub to become an established location within the hospital site; and the need for functional and distinct operational and governance processes. Hence, this thesis provides initial insights into developing a functional balance between the Hub being part of, yet distinct from the main hospital organisation. This is an important contribution to extant case studies on healthcare Hubs by detailing additional examples of Hub characteristics that are different to the main hospital, and importantly why they are significant for Hub development (Miller and French, 2016, Saidi et al, 2017).

A central characteristic studied in this thesis is the nature of Hub space and its importance for innovation. Moultrie et al (2007) identified the importance of 'dedicated' 'physical' space for innovation, and the expected social, institutional and creative outcomes. During the empirical research, clinicians described the benefit of the Hub as providing 'neutral' space, a word also used by Saidi et al (2017:38). This acknowledged how an additional space to innovate outside of the usual organisational context was important for innovation actors (Peschl and Fundneider, 2012). However, during the empirical research it became apparent that there was much in the Hub space that was not neutral. The Hub provided a gateway for external stakeholders to access the hospital in pursuit of their own commercial or research goals. External stakeholders had access to pursue their objectives outside the conventional healthcare setting, including direct contact with users. However, the different agendas of stakeholders entering the Hub destabilized the notion that the Hub space was neutral and free from external organisational agendas. Although similar policy based stakeholder tensions were noted by Miller and French (2016), acknowledgement of a lack of hospital based innovation studies may account for the lack of connection made to resources needed to manage stakeholder interactions covered in section 4.3.

The Hub environment was complex, as was the role of the Hub within a broader innovation network (Sharma and Meyer, 2019). Tensions in stakeholder relationships showed the extent of management challenges when balancing operational and experiential outcomes of the innovation process (Nicolopoulou et al, 2017:369). Although the Hub provided a distinct physical space, facilities and opportunities it is misleading to promote the Hub as a 'neutral' space (Saidi, 2017:38). Rather it is a multi-faceted environment that hosts often competing stakeholder agendas, where not all perspectives are of equal importance. In a similar manner to a study on hospital living labs and innovation (Veeckman et al., 2016) Hub staff attempted to manage the Hub space and increase its sustainability to deliver a portfolio of projects to improve service quality, operational efficiency and staff job satisfaction. This approach acknowledged the 'not harmonious' (Miller and French, 2016:1534) challenge of aligning conflicting stakeholder priorities. Yet stakeholder interests ultimately need to be reconciled against the novel Hub objective of using MedTech to create products that met user-needs, and improved patient experience.

The Hub was positioned as a nexus between different organisational contexts; public, commercial, policy and research (Sharma and Meyer, 2019, Longo and Giaccone, 2017). However, the initial classification of the Hub as a neutral space by founding staff failed to acknowledge the extent of disparate stakeholder aspirations and their different reasons for commitment to healthcare (Miller and French, 2016). However, the Hub location remained a valuable tool for sustaining relationships with stakeholders. Retaining the participation of external organisations was a key element of achieving the Hub objectives, as a result of opportunities that arose through the process of collaboration. Both the hospital community and external organisations can derive benefits from participating in innovation projects that used the Hub environment confirming from results elsewhere (Peschl and Fundneider, (2012).

The Hub facility became a gateway into accessing other types of resources and knowledge that were otherwise missing from the host organisational context (i.e. the main hospital) and provided 'enabling' opportunities and resources that support the 'sophisticated knowledge and cognitive process of innovation' (c.f. Peschl and Fundneider, 2012:21) . The unfamiliarity of how to navigate the potential of this new space and 'living ambience' where

innovation transitioned from being a 'professional activity from a singular event' was documented in the literature (c.f. Saidi 2017:38). Yet this research has further evidenced how Hub staff managed stakeholder tensions as their agendas become clear, and extended beyond 'neutral' participation in the collaborative Hub environment.

The empirical research focussed on the start-up phase and how, after an initial period of interest in gaining access to the Hub, stakeholders' expectations developed. The initial enthusiasm for providing a dedicated innovation space for multi-stakeholder innovation (Leminen, 2019), created a requirement to respond to their priorities. To pursue innovation projects that had both commercial and patient experience objectives Hub staff recognised a need for Hub staff to manage competing stakeholder expectations. These findings extend the literature by providing evidence of a new type of 'interaction' between Hub staff and stakeholders to support achieving the enabling potential from dedicated Hub spaces (Peschl and Fundneider, 2012). This research contributed to the undeveloped literature on a type of space identified in their research, the role of 'digital space' in Hubs and how it can be used to supplement in person collaborative innovation (Peschl and Fundneider, 2012:13). In the context of healthcare, and broad interest in increasing digitalisation this is a valuable contribution to the wider conversation in healthcare literature and policy documents.

Rather than following a single objective for Hub innovation, Hub staff acknowledged the differing stakeholder needs. Difficulty in fulfilling conflicting stakeholder expectations of the innovation process gave rise to the Hub team becoming interested in pursuing the concept of Hub self-sustainability (Veeckman et al, 2013). Seeking to define Hub strategy in this way enabled the introduction of a portfolio approach of innovation projects to reflect differing stakeholder priorities, rather than a neutral collaborative space. This provided a way to operate socially, operationally and commercially orientated innovation concept development in parallel. This approach also helped to balance the separate, yet connected relationship with the main hospital. Hub staff intentions for the Hub to become self-sustaining demonstrated a belief that innovation activities could generate outputs that would provide reinvestment back into the Hub facility. This would also lessen Hub reliance on the Hospital and external organisations for the provision of funding and resources. Operating an independent yet connected manner enabled the Hub facility to have some

operational freedom to support innovation whilst maintaining a working relationship with the Hospital. Over time, the independent development of new stakeholder relationships and access to key resources demonstrated to the hospital Board that the Hub was committed to pursuing an approach that embraced a balance between using key hospital assets in the form of user knowledge and opportunities connected to collaborating with external stakeholders. This confirms research that acknowledged an increase in using co-creation as part of Public Sector innovation to enhance the innovation process (Bason, 2010:206) and broaden inclusion of individual stakeholder perspectives (Bason, 2010: 174, 179). Findings in this study provide an example to show how stakeholders from different organisational backgrounds can begin to work together, extending research that focused solely on integrating contributions of surgeons, community nurses and specialist nurses within needs-led hospital innovation study. By combining different types of clinical knowledge Savory (2009:166) identified positive outcomes for increasing the 'knowledge translation capability' of different healthcare stakeholders. This research showed efforts to extend a replication of this approach, within a Hub that is enabling knowledge to be used collaboratively across organisational boundaries. This research provides a detailed example from a novel healthcare context, adding to work by Bason (2010) on public sector innovation and increased interest in collaborating with stakeholders from outside of the public sector.

A significant tension during the early stages of the Hub concerned the differences in pace between healthcare delivery in the main hospital and concept development in the Hub (Hoyssa and Hyysalo, 2009). The difference between hospital and Hub purpose and organisational culture only extents part of the way to explaining why each facility moved at a different pace and implementation of process (Carstensen and Bason, 2012). Within the healthcare sector, a lack of familiarity with the process of innovation was acknowledged by hospital staff. This was compounded by a lack of experience with working across institutional boundaries. Thus, understanding the organisational position of the healthcare sector can be used to begin to justify why the Hubs needs to be managed differently (Sharma and Meyer, 2019). It is necessary to appreciate that the there was a difference in the appropriate speed for hospital and Hub the pace of activity. As prior experience of developing innovations was only held by members of the Hub staff team, a period of

learning was needed so hospital stakeholders could adjust their expectations of the Hub pace. Educating stakeholders as to the role of risk and failure within the innovation process (Miller and French, 2016) took time, but was an important step in stakeholders beginning to appreciate why the Hub pace was often not in line with their expectations.

In the hospital, an efficient, fast pace to deploy patients along generic healthcare pathways was used to realise health and wellbeing outcomes. It took time to counter the routine application of linear healthcare systems that were followed to reach health outcomes as efficiently as possible. Whereas the Hub operated using 'intertwined processes of ideation, creation and design… balancing risk and reward' (Moultrie et al, 2007:53) with a vague notion of the desired end point. A fundamental requirement of concept development was the need to consider and revise the design and functionality of innovations to ensure alignment with healthcare users and systems. Hub proximity to clinicians to access their feedback and tailor concept development aimed to align need and operational functionality as part of a 'virtuous circle' of innovation (Miller and French, 2016:1540). Thus, a distinct characteristic of the innovation process includes time to accommodate revisions, enter dead ends, take risks and discuss challenges during the design of new products and processes. The Hub environment was found to benefit from applying stakeholder knowledge and facilitating different behaviours to those used in the main hospital. This included experimentation, creative thinking and modification of design concepts, all confirming the literature (Toivonen et al, 2015). Although the hospital environment required innovative behaviour to improve performance and healthcare delivery, the experimental use of risk was normally only evident in the context of highly-regulated clinical trials. Therefore to enable Hub stakeholders to explore available approaches, and new freedoms a slower pace than normally evident in a healthcare delivery setting was beneficial. The thesis explored how Hub development required a tolerance for experimentation within a multi-stakeholder innovation process and healthcare setting.

Research added to a study of the challenges of 'contemporary' entrepreneurial research hospitals, positioned at the intersection between healthcare delivery, research and innovation. This study makes an important contribution by exploring the origins of Hub stakeholder's frustrations through studying how previously separate organisational,

healthcare and innovation priorities became more closely intertwined in the new Hub environment and the consequences of this (Miller and French, 2016). The thesis contributes to this literature by unpicking tensions resulting from the pace of the multi-stakeholder innovation process, and links to unmet expectations. Hub development contributed to hospital objectives of increasing organisational capacity and efficiency, user motivation for social impact, and commercial stakeholder interest in generating revenue to be considered. Each stakeholder group showed a limited understanding of the rationale behind the pace of the innovation process. This research extends understanding of how stakeholder tensions are managed with a collaborative innovation context by analysing and identifying contributory factors; differences in stakeholder priorities and expectations alongwith a lack of understanding of the healthcare sector and collaborative process. The use of process to better accommodate stakeholder needs, and sustain pace during stages of development is explored fully in section 6.3. This provides a transferable example of how a hub used process as an approach to balance stakeholder demands against available hub capacity and resource.

Hub staff occupied a unique position as 'intermediaries' in terms of their capacity to listen to and appreciate multiple stakeholder positions, adding to research elsewhere (c.f. Howells, 2006:720). The results demonstrated how their role in managing the pace of the Hub process evolved over time, reflecting a growing fluency in understanding stakeholder needs in conjunction with fixed availability of Hub resource, and clinician time. Efforts to increase continuity of finance and improve alignment between stakeholder innovation goals can be seen as an attempt to support the speed of the Hub innovation process.

Developing the Hub required stakeholders to undergo a process of learning and reflection, as the association between the Hub and the Hospital is not replicated in any other existing relationships (Miller and French, 2016, Saidi et al., 2017). Over time, as the management style of the Hub evolved to be distinct to from the main hospital and stakeholders became familiar with the parameters of Hub activities, and the role of stakeholders within them.

The thesis also contributes to research on the place of experimentation as part of Hub operations, and the different attitudes that can emerge (Moultrie et al., 2007) in a creative

collaborative space (Toivonen et al., 2015:29). In the hospital, experimentation was carefully managed through a highly regulated and risk averse operational culture, where clinicians used their knowledge and approved medical approaches to address care needs (Bason et al, 2010). In the Hub setting experimentation was part of the innovation process, and supervised by Hub staff who assess the potential benefit of resourcing development of novel innovation concepts. Thus experimentation and creativity had a place in Hub development, but were managed to determine the extent of alignment of Hub objectives, to process efficiency and patient experience. The development of MedTech is an emerging area of innovation (Liedtka, 2020), thus this research explained how a lack of established policy and process impacted Hub development as they had to create rather than was a lack of evidence base on which to base decision making.

As the governance of healthcare systems is tightly controlled, and clinicians were trained to approach decision making to minimise failures, the ubiquity of experimentation in the Hub environment initially proved disconcerting for clinicians. This research provided insight into how healthcare stakeholders working in hospital management and clinical roles had different responses to the acceptable tolerance for risk in the Hub. As the Hub operated with close ties to the hospital, healthcare stakeholders were expected to be able to adjust their perceptions of experimentation to accommodate differing needs of the hospital and Hub settings. At times finding a balance between the continuity of healthcare norms and needs of the Hub was difficult. For clinicians, working in the Hub as users, innovative work required a more exploratory and creative mindset (Aakus et al., 2018). The Hub approach accepted failure which is vastly different from the accepted processes and behaviour patterns used in clinical settings (Bessant et al., 2019:243). These differences perplexed Healthcare managers who struggled with the operational approaches used to support innovation activity. The thesis explored Hub management in context of the public healthcare system and the impact of different organisational cultures on Hub development. Hospital managers were challenged by the unsuitability of using hospital bureaucratic processes to manage the Hub. Hospital processes were used to protect uncalculated use of resource, and had no capacity for unsubstantiated spending. Thus during the early stages of concept development, it was difficult for Hub staff and clinicians to justify the differences in

Hub process and for the longer term potential benefits of experimentation to be appreciated by hospital managers.

The literature argued that benefits are realised when Hubs become creative spaces (Carstensen and Bason, 2017, Peschl and Fundneider, 2012). Yet this thesis argues that promotion of a Hub as a creative space makes for problems in continued Hub operation. Adding to research elsewhere Hub staff emphasised that promoting the Hub as a place for experimentation and creativity can be damaging to Hub reputation and stakeholder expectations. The importance of creativity for innovation was acknowledged in the literature (Amabile, 1998, Giannopoulou et al., 2013). This study confirms findings by Hattori and Wycoff (2002:27) that this is most tolerated in early phases of concept development. This study evidenced how stakeholder expectations developed into pressure to produce innovation outcomes meant that the time for creativity and experimentation had to fit within a wider managed process of innovation. Experimentation was a stage in the Hub process but it became important not to mislead stakeholders into thinking the Hub was primarily a place for creativity. The innovation process required collaborators to use creative experimentation to solve problems by integrating stakeholder knowledge and skills. During start-up in a hospital Hub, Saidi (2007) identified like-mindedness and commonality however this thesis showed how tensions began to emerge over time, prompting questions about Hub pace, priorities and purpose. Hub staff attempted to address stakeholder tensions through improved communication and the introduction of replicable structures to guide the innovation process. Therefore this research agreed that experimentation and creativity can thrive in a Hub, but explained why their role is a part of a wider, managed and focused innovation process, which seeks to develop a useable product.

6.1.1 Concluding Remarks

This section has critically reflected on the complexity and challenges of developing a Hub (Gryskiewicz et al., 2016:81), especially in a healthcare context (Barlow, 2017), Kim, 2019). The importance of balancing areas of connection and distinction from the hospital as the parent organisation was discussed. Such balance was evident in the management of space, speed of operation and use of experimentation which began to be 'blended' in a similar way

to research by Sharma and Meyer (2019b:4). Functional differences between the Hub and hospital influenced stakeholder behaviour and created tensions emerging through both debate and conflict confirming findings by Isaksen and Ekvall (2010). However over time Hospital managers grew to appreciate the new type of space available in the Hub, and the potential it presented for interaction between different stakeholders. The capacity and opportunities made possible in the Hub space, helped the hospital community to begin to address healthcare challenges, which built acceptance of the role of a healthcare Hubs.

The Hub facility provided a gateway for stakeholders to engage with the hospital but they needed time and support from Hub staff to understand how to benefit from the space. This transition was not covered elsewhere in the literature. Data unpicked how tensions between stakeholders during Hub development could often be linked to misplaced expectations when Hub operations differed from established procedures used in the hospital. The hospital environment does not have to accommodate complexities resulting from multi-stakeholder collaboration or due to the novel way in which technologies were used in the Hub as a way to address user-needs.

As a result of the semi-autonomous relationship with the hospital, the Hub faced a number of strategic management implications regarding how best to allocate staff resource to support both user focused environments. The very location of the Hub, and the potential benefits that can be derived from its hospital location, can also create a deeper layer of challenges, in terms of deployment of staff resource, enabling participation and balancing current and future needs. The literature acknowledged that having a Hub space is viewed as a benefit for healthcare organisations (Salzman, 2017, Liedtka and McLaren, 2018). This research contributes to the literature by showing that the provision of a dedicated space is not sufficient to generate the expected positive outcomes, and healthcare Hubs also require resource and Hub staff facilitation. This study makes an important contribution to the literature by challenging the perception of Hubs as providing dynamic spaces. The research suggests that a healthcare hub context can experience issues with visibility, stakeholder access and user time. The varied challenges of managing a collaborative Hubs in the healthcare sector were discussed, in particular the complex dynamics of a relationship between the Hub and the hospital, and how this prompted a number of changes to Hub

management. To accommodate hospital and external collaborators conflicting expectations of outcomes of innovation activity, collaborators were joined into concept development teams where synergies existed. In response to continued tensions over balancing patient experience and commercial priorities Hub staff pursued supporting a portfolio of projects, each with differing expected primary outcomes. Furthermore, opportunities presented from initial modifications to Hub management, received further attention as Hub staff sought to resolve ongoing difficulties in attempting to justify differences in innovation culture and Hub process to hospital managers. Thus, the idea of increasing the separation from the hospital, and becoming self-sustaining was considered. This is explored fully in section 6.3. In additional to increasing autonomy of Hub management, these plans enabled the changes in management approach to address the reality of collaboration; managing complexity rather than a neutral collaborative space characterised in the literature (Saidi et al, 2017:38). This approach also sought to sustain the separate yet connected relationship with the main hospital and address emerging barriers to the expected enablement of innovation created in a Hub space.

The discussion continues to focus on the role of users in the Hubs in section 6.2 followed by a discussion on the use of process to support collaborative innovation in section 6.3.

6.2 The Role of Clinician Users within Healthcare Innovation Hubs

This section answers RQ2 '*How do users inform innovation within a Hub environment?* through a critical discussion focused on clinicians. Data collected revealed that clinicians were the key user contributing to collaborative innovation during the start-up phase of Hub development. This aligns with research elsewhere on the historic position of clinicians as the main type of user contributing to healthcare innovations (Riskin, 2006, Schiavone, 2020:38-39). Whilst the aspiration was for patients to become involved, reflecting growth in patient-user involvement reported elsewhere (Schiavone, 2020), there was a need to build some core innovation capabilities and processes first. The merits and limitations of such clinician-led contributions will be discussed by exploring four main areas emerging from the data; idea generation, use of knowledge, concept development leadership and representing hospital requirements.

6.2.1 Idea generation

Working in healthcare settings enabled clinicians to inform innovation by sharing their perspective on gaps in the capability of healthcare equipment, and issues with NHS systems and process. Findings confirmed results in the literature that clinicians are well placed to identify user-needs due to the time spent with patients undertaking their primary clinical role. Interactions with patients and their families presented opportunities to gain insight into situations patients found challenging (Kluijtmans et al., 2018:652) . User experience of working within existing hospital systems equipped clinicians with understanding of gaps in service provision, especially regarding gaps in service provision related to patient experience (Garibyan et al., 2020, Metcalfe et al., 2005). Their hospital position is important as it provided opportunities to gain and then transfer contextually specific 'sticky knowledge' from the hospital to the Hub as part of an intentional process, for use in addressing existing needs (von Hippel, 1976, Harhoff and Lakhani, 2016:2).

The problem solving capability of clinicians applied in their clinical roles provided motivation to suggest innovative solutions. Results confirm the importance of the clinician's position to contribute to innovation as embedded lead users, who possess both passion and profession (Herstatt et al 2016:400). First-hand experience of difficulties faced by patients drove clinicians to use a shared person centred objectives to improve patient experience. Thus, clinicians informed innovation by sharing needs-led challenges they identified whilst working in their primary role (Svensson et al., 2018:283), along with initial ideas to overcome them. Gaining direct access to patients was problematic. Clinicians were the user group currently active in the Hub, and there was no direct patient voice during the early stages of concept development. Thus the extent to which clinicians could adequately represent patient's needs should be acknowledged as a significant necessary limitation of operating in a highly regulated and sensitive context, concurring with research findings elsewhere (Pereno, 2020:9, McNichol, 2012:217.220).

Clinical users as a stakeholder group prioritised responding to socially-motivated innovation drivers including reducing patient anxiety, improving patient health literacy through digital resources to improve service quality and patient experience (Edwards-Schachter et al.,

2017: 67,73). Clinicians were involved in the Hub as individuals, so there was not necessarily a consensus amongst clinical colleagues on every aspect of their contribution. Yet their opinions were taken as representative of user needs. Clinicians' opinions and motivations were imparted to stakeholders to emphasise why an appreciation of patient wellbeing was important to achieve good health aligning with findings from Liedtka (2017:217) regarding the importance of design versus strategy which explores who is served and the necessary capacity to do so. Thus, clinicians informed the approach used in the Hub environment by prioritising an emphasis on improving patient experience. This shaped Hub objectives as clinician's identification of areas for innovation were intertwined with advocating for a person-centred design focus for innovation concepts, rather than one focused on commercial revenue creation. In the hospital setting, the emphasis was on efficiently delivering medical care. Yet clinicians believed the healthcare process could be improved in terms of patient experience and efficiency if patient-led digital resources were increased. This is consistent with findings that patients cope better with their healthcare journey through improved health literacy and associated increased feelings of empowerment (Palumbo and Annarumma, 2016, Tettegah et al., 2016).

A potential differentiating strength of clinicians' ideas was their entanglement in the current unmet needs of the hospital environment. Clinicians presented preliminary aspirational innovative ideas to Hub staff with the objective of improving patient experience and wellbeing, through MedTech products that provided enhanced support. The motivating factor behind these ideas presented the Hub with innovation concepts that had both a different origin and type of motivation to externally developed commercially-led healthcare products. Despite different motivations for creation, the needs-led Hub products still required input from industrial partners to support their production aligning with findings elsewhere (Pereno, 2020:9, Consoli and Mina, 2009:297, Savory, 2009:43,162).

The person-centred focus of clinicians' ideas required input from other stakeholders to assess viability and critically refine aspects of their intended contribution. As part of the process of managing idea generation, data explored changes as Hub capabilities matured, user innovation concepts began to receive additional, more focused support. Clinicians had 'big ideas' which were at an early conceptual stage – they required time, resource and

finance to support their development, none of that the Hub had secured on a stable basis. Therefore Hub strategy of investing in responding to the users' needs-led ideas made the Hub vulnerable to criticism from stakeholders, as it was difficult to assess the potential of the idea at its early stage, and thus confidently allocate resources due to a lack of existing data and the unpredictable nature of the innovation process.

6.2.2 Application of knowledge

In addition to generating ideas, clinician's informed Hub development by using their position as Embedded Lead Users to contribute medical and experiential knowledge to critically appraise concept design throughout the development process (von Hippel, 1986, Lettl, 2020, Herstatt et al., 2016:413-414). Drawing on practical knowledge of hospital systems, medical knowledge and interaction with patients. Clinician's unique position to inform and evaluate the development of needs-led innovative concepts was highly influential in Hub activities (Svensson et al., 2018). Collaborators respected that their opinions were informed by in their medical training and experiential knowledge of the healthcare settings. It would be difficult to replicate the depth of these insights without direct involvement of clinicians, thus differentiating the Hub process from other methods of innovative development (Oliveira and Canhão, 2016:325).

The Hub space provided a new environment for clinicians to explore opportunities in an experimental way, not otherwise possible in a hospital setting (Svensson et al., 2018). The collaborative approach used in the Hub helped to identify potential within clinician's aspirational ideas. Incorporating knowledge from multiple stakeholders made it possible to pose questions and share opinions from commercial and managerial perspectives that were also relevant when developing successful healthcare innovations. This adds to research that explored the necessary complexity of using multi-stakeholder collaboration to develop healthcare innovation in a sufficiently thorough manner to successfully balance conflicting stakeholder priorities and broad social and operational needs within the healthcare environment (Savory and Fortune, 2015). Furthermore provision of a dedicated Hub to integrate and manage the interrelated of stages of the knowledge-led innovation processes

was important for clinicians who began using their skills in a role classified as 'clinical engineers' (c.f. Clark et al., 2019:543).

This research adds to this work by providing a detailed example of the nature of clinician's contributions to the product creation process, where conflicting commercial and clinical opinions were brought together. Access to different types of knowledge helped to align product design with needs of healthcare users (patients and clinicians) and the wider marketplace. Thus the Hub process used stakeholder knowledge as a resource to help to resolve potential issues as possible prior to product launch. Although at the time of data collection, products had not been launched application of clinician and commercial stakeholders' knowledge to influence concept design was emerging as a key aspect of Hub strategy. A challenge remained how to rectify differences of opinion and the tension this created for working relationships. Stakeholders expected that access to and inclusion of clinicians' specialist knowledge would provide beneficial insights for collaborators, and enhance suitability of products that were developed. However, dedicated resources were needed in the Hub to fully explore the clinician's initial idea prior to resources being allocated for concept development. Attempts to improve support for collaboration by developing pathways in the Hub process are outlined in section 5.3.

Clinicians possessed a fluent, often tacit understanding of the complex healthcare environment. The Hub aimed to provide an environment that was able to help capture that knowledge so it could be used to enhance the design of healthcare products (Schweisfurth and Raasch, 2015:177). Throughout the innovation process clinicians' insights contributed contextual depth and focus to ensure functionality for users. The emergence of stakeholder tension could be seen as an indication that the collaborative process was successfully capturing clinician's tacit knowledge, as sufficient challenges were being made to commercial stakeholders commercially-focused contributions. When presented with options clinicians were quick to critique, using strong intuitive opinions of why ideas would not work in a healthcare environment. This response was indicative of an application of tacit rather than codified knowledge as it wasn't proposed as a rationale at an earlier stage, and only emerged as developments occurred (Senker, 1995).

Additionally this research evidenced how the collaborative Hub process provided opportunities to assess the merits of clinicians' innovative aspirations against the knowledge and experience of other stakeholder groups. Within the innovation process collaborators knowledge was used as a resource to pursue receiving clarification and justification from clinicians regarding their perspective and opinions. Using knowledge as part of the collaborative process helped Hub staff to benefit from clinician's tacit knowledge, and apply it to the product development process. The involvement of other stakeholders supported this approach by adding additional dimensions and capabilities to evaluate the product concept's potential impact for different types of healthcare stakeholder.

To support integration of clinician's knowledge dedicated administrative support was introduced into some project teams. Clinicians considered this beneficial in alleviating pressure of administrative tasks. However, it was not evident if consideration had been paid to mitigating the loss of subtleties in representing clinician's potential insights if this became part of the Hub staff role. Thus, managing inclusion of tacit and experiential clinician's knowledge was something that required further development to implement suitable support to sustain a knowledge-led innovation process. Hub staff had suggested designing digital systems to record collaborator input and opinions of decisions to be made. However as clinicians had restricted time to contribute to their role of an embedded lead user reliance on making clinicians regularly updates could render a system ineffective, and again rely on Hub staff to update on their behalf. These challenges of working with lead users have been noted in other innovation contexts (Brem et al., 2018:17).

This study adds to the literature by providing a detailed case which analyses the complexity of innovating in the Healthcare sector, and suggests why this maybe more complex than other sectors due to diverse user needs, financial restrictions and organisational bureaucracy (Worthington, 2014, Schiavone, 2020:23). Although the role of hospitals as locations for innovation has been thoroughly reviewed, this research responds to a gap identified by Thune and Mina (2009:1555) relating to the role and relationship of key participants, and the nature of their stakeholder relationship when working collaboratively in an innovation context.

Data provided an opportunity to analyse clinical users and how they were able to support product design, development and refinement using their experiential and tacit knowledge of user needs and the NHS operational environment (Kluijtmans et al, 2018 Tang et al, 2018). This approach appealed to hospital managers and external stakeholders who both sought minimal risk and maximum impact from the development process. During data collection stakeholders shared their innovation priorities but as the innovation process incorporated a clinically-led perspective collaborators had access to knowledge to align product design with current systems, user needs and alignment with marketplace requirements. Despite advantages of including clinical users this study added to research elsewhere by showing how socially motivated priorities also added complexity (Schiavone, 2020:26). Data showed how tensions occurred when clinicians objected to decisions which prioritised commercial or operational requirements over their opinion on what users needed (Farchi and Salge, 2017:143,150, Worthington, 2014:63). These findings are consistent with research by Bason (2010:45) regarding 'clashes' between trying to achieve more than two of the four value outcomes in public sector innovation; improvements to productivity, service experience, user benefit and organisational results.

Furthermore, as clinicians were representing patient needs, a question remains regarding the extent to which clinicians can represent the needs of other users, like patients and their families who were currently neglected in the Hub process. This findings concurred with research elsewhere that they are an under represented group of healthcare users, despite the added opportunities from accessing their experiential knowledge perspectives during product design (Djellal and Gallouj, 2007:188, Oliveira and Canhão, 2016:314, Kim et al., 2019:62). The lack of direct patient involvement in the Hub process failed to recognise a change in dynamic between patients and clinicians, and how the increased patient interest and involvement in informing healthcare innovation is noted as a valuable resource elsewhere (Laudal and Iakovleva, 2019, Vallo Hult et al., 2019, Sharma and Meyer, 2019).

Although clinicians were present in interactions with patients, it was only possible to contribute a personal perspective on unmet patient needs. Therefore, although of value and interest to both external stakeholders and the development process, clinicians' knowledge and opinions are only a representation of hospital patient and other clinician's needs (Clark

et al., 2019:541). Realising intended plans to include patients as contributors during the design process would add to the depth of user insight that the Hub is seeking to benefit from. The opinions and perspectives of Clinician's were held in very high esteem within the hospital culture and with external stakeholders, keen to access scarcely accessible clinical judgements. Clinicians' knowledge was also highly valued in the Hub, and viewed as a vital component of developing a sustainably viable product. However it also became apparent that counterbalancing their priorities with those of operationally and commercially astute collaborators was of comparable importance for product viability. This confirmed research elsewhere as to the often 'radical' nature of clinician's ideas and the need to 'constrain' them through use of appropriate policy and organisational requirements (Lettl, 2020:115).

Over time data indicated changing lead influences in the Hub environment. As Hub staff capacity increased reliance on the use of clinician's knowledge to inform the innovation process was reduced. The emerging implementation of a strategic innovation process retained the value of clinician's knowledge within a more structured collaborative process. This change reflected an increased awareness amongst Hub staff that clinician's knowledge was not sufficient to sustain the Hub, and it was necessary to promote the importance of Hub longevity. Hub longevity, also referred to as sustainability, concerned a need to produce products with a relevance in the marketplace rather than a clinician backed, but unjustified radical product concept (Svensson et al., 2018: 285, Thapa et al., 2019:118-119). This use of knowledge was important to support Hub development in creating a financial and social return on investment, that also capitalised on clinician's knowledge, named as the hospital's main unique asset during data collection. Thus, over time the contributory focus of clinician's began to change in conjunction with a growth in influence of the role of the Hub team. The Hub team perspective questioned the suitability of clinician's abilities to lead the multi-stakeholder teams and the most appropriate use of their time (Savory, 2009:162). The introduction of new Hub processes required all stakeholders, including clinicians to justify their actions. This increased in accountability introduced a new dynamic into the innovation process, to support the objective of increasing Hub sustainability. Although remaining led by clinician's knowledge, data showed increased attempts to balance clinical and commercial stakeholder knowledge, and their differing priorities. Hub staff implemented a process to assess the sustainability of innovation concepts during the

intangible phases of concept development, rather than a reliance on particular stakeholder perspectives, this is explored in section 5.3.1.

6.2.3 Concept Development Leader

During the concept development process stakeholders worked collaboratively as explored in section 6.3. During start-up clinicians were tasked with leading of multi-stakeholder development teams, harnessing their enthusiasm for involvement in innovation to pursue their innovative idea. Over time the suitability of retaining clinicians to lead concept development was questioned as part of the evolving Hub process. Practical challenges of clinicians' availability to access the Hub and remain involved in projects alongside their hospital role impacted the pace of project progress, contributing to stakeholder tension. Operational issues also became apparent despite physical proximity between clinicians' and the Hub. Hub staff attempts to diarise in person multi-stakeholder meetings was challenging and subject to changes at short notice due to hospital emergencies. Furthermore, over time, clinician's lack of proficiency for leading concept development became clear, as the role demanded skills outside of their areas of expertise. These findings are comparable to conclusions that identified the importance of clinicians' engagement in design of innovations, whilst acknowledging areas where they were less effective. This research evidenced why it became important to limit the use of clinicians pursuit of 'curious experimentation' without consideration of any form of strategic thinking (Aakus et al., 2018:4600). This research analyses the consequences of using creativity and experimentation to inform Hub activities and why the managerial experiences of Hub staff were needed to negoticate a change to this approach for the benefit of stakeholder management and effective resource allocation.

Leading the collaborative process required clinicians to be familiar with project management tools. A lack of confidence using such approaches became a source of frustration for Hub staff who wanted to use established methods like Gant charts and business plans to evaluate and communicate hub activities. Thus, in light of increased capacity in the Hub team, the suitability of using clinicians to lead concept development

became an issue for discussion as Hub staff had more relevant experience in project and stakeholder management.

Data showed how motivation of founding clinicians contributed to establishing a Hub. Overtime as the collaborative process became operational the complex reality of the process presented unfamiliar non-clinical challenges. This confirms results in the literature regarding the combination of expertise required to operate a well-functioning collaborative team (Guinan et al., 2019:719). The commitment and leadership shown by founding clinicians was central to the Hub's success in start-up phase, where their esteemed position and personal commitment was used to gain stakeholder support for a multi-stakeholder innovation process in the Hub facility. Confirming results elsewhere clinicians were effective peer influencers, and well respected innovation actors (Greszczuk et al., 2018:72). This study critiques their contribution by evidencing areas of limitation due to their other responsibilities and skills gaps. Despite consistent dedication to innovation activity the demands of participating in a collaborative innovation process proved challenging. Finding clinicians who were able and willing to commit to working additional hours on innovation projects caused a number of challenges in sustaining the pace of the innovation process and meeting stakeholder expectations.

In parallel, clinicians' workplace experiences continued to provide stimulus for new suggestions for novel ways to improve healthcare outcomes. Yet the demands of their primary roles meant there was a lack of capacity to commit time to help develop these ideas further to establish their potential use and exclusivity. A bottleneck in how to manage the flow of new ideas grew, as Hub resources were insufficient to effectively handle the volume of clinician's ideas. This became problematic as clinicians expected the Hub facility to swiftly respond to their idea with a shared enthusiasm. External collaborators also grew frustrated as they were keen to access novel, potentially lucrative clinician-led ideas. Using clinicians to inform the Hub environment created practical challenges for the role and position of the Hub capacity as a nexus for collaborative innovation. Operating with limited resources, the Hub required improved process to manage an ever increasing volume of needs-led ideas from clinicians.

Despite issues accommodating clinicians' expectations of the Hub, their involvement in the innovation process was used to attract external organisations to the Hub as an environment that responded needs-led innovation comparable to research findings on hospital maker spaces (Svensson and Hartmann, 2018). Thus retaining and managing how clinicians informed the Hub emerged as significant for Hub knowledge creation and securing collaborative participants. This study adds to existing literature by exploring how the enthusiasm and leadership of founding clinicians facilitated the start-up of the Hub, and attracted other clinicians with a similar mentality to a space where experimentation and creative thinking was possible. However, managing the demand for using this approach effectively on a larger scale, and in the longer term, proved to the problematic.

Furthermore, as the Hub had not managed communications regarding the Hub purpose misunderstandings about the function and capabilities of this new space emerged amongst the clinical staff body. The Hub represented a new type of space not found elsewhere in the hospital, new activities were occurring, and external organisations were working with clinicians in an unfamiliar manner. The potential and novelty of the Hub approach was viewed as a way to address existing frustrations within a highly bureaucratic system, especially regarding ways to modernise outdated technology and patient health information in some areas of the hospital aligning with research elsewhere (Lacy, 2016).

It can be argued that the role of clinicians in the Hub should have been more strategically considered from the outset. As clinicians had a limited understanding of the operational hub challenges. Their presumptions that there was a correlation between using MedTech in the innovation process, and involvement with external organisations generated extensive funding opportunities were not corrected. Rather, start-up Hub events encouraged to participate in Hub innovation, without consideration for resources that would be needed to support their involvement. Therefore, following events like hackathons, an unfounded assumption emerged within the hospital community that ideas would be supported by necessary resource. A lack of communication to mediate this led to capacity and resources issues and latterly stakeholder frustrations. This issue was not acknowledged in the literature on challenges of clinician-led innovation and managing Hub collaboration.

Thus, due consideration was needed to address issues that stemmed from decisions that tasked clinicians with leadership during the product development process. As the innovation process progressed a misalignment emerged between the key skills required for the project leader and the contributions clinicians could make. Furthermore, clinicians became stressed by management tasks. Thus, working to reassign these responsibilities to Hub staff restored clinician's momentum so they could continue to motivate, influence and excite future collaborators into supporting the Hubs objectives.

However, part of the appeal of the Hub was the influential position of lead users as informants of the development process. This differentiation helped attract external stakeholder participation and provision of resources due to interest in accessing clinician's knowledge in a hospital innovation space. Combining these resources mobilised the innovation process with equipment, funding and potential production routes to market. However, as the collaborative process progressed the influential role of clinicians in how the process functioned contributed to challenges in retaining collaborative partners. Differing stakeholder as expectations about pace of development and innovation priorities created tensions and doubts about eventual project outcomes. Similar challenges are discussed in the literature relating to stakeholder disagreements, limited understanding of the complexity of the innovation process and a lack of clinician time (Tang et al, 2018:91). This thesis research adds to these results by illustrating how stakeholder tensions emerged from clinician-led collaborative innovation. Data explored how unmet collaborator expectations, a lack of accessible information and fixed processes created a lack of transparency about how stages of the multi-stakeholder process would contribute to generating new products. As explored in section 6.3.2, overtime changes to the Hub process were partly driven by a need to manage stakeholder expectations. This thesis analysed the importance of justifying elements of clinician-led innovation as part of Hub culture that was different from their own organisational background.

The way in which clinicians informed the Hub changed over time. Clinicians' knowledge spanned the social and practical elements of the design process, which can position users as visionary leaders due to their potential to change how and why healthcare innovation products were designed and developed confirming findings elsewhere (Oliveira, 2016:162,

Savory, 2009:261,300). Yet during data collection, the patient voice was not present. Anticipated inclusion of patient feedback had been accounted for use of a patient experience bedroom where patients would test a prototype in the intended environment. The complexity of overseeing the collaborative process and addressing the growing number of challenges in managing clinical user participation had taken away Hub staff focus away planning how to include patient perspectives. The practical and ethical complexities of involving paediatric patients, already vulnerable due to their healthcare treatment (Geiger et al., 2015, Schwartz, 2014), had largely been omitted prior to the formal involvement of Hub staff who became increasingly involved in risk management associated with the development process. Thus, listening to clinician's and their represent patient needs had become a feasible way to operate user-led innovation process, albeit informed by a clinician-led perspective. Although this carried limitations, the potential contribution made by Clinicians working from their position as Embedded Lead Users in combination with exposure to different types of hospital stakeholder needs equipped them to act in some capacity as boundary spanners combining user and employee knowledge with a customer orientation (Schweisfurth and Rassch, 2015:175, Lettl, 2020:115). Clinicians understood the environment where the innovation would be used and so could inform and critique the work and ideas of others due to their professional experience and tacit knowledge. As part of balancing stakeholder needs and expectations, utilising clinical users to lead concept development meant that desired innovation outcomes could be assessed against requirements within the healthcare settings. Clinicians were able to inform concept development by aligning their suggestions to improve operational and functional outcomes with their view of what was suitable for the hospital system and intended user group.

Conversely, despite the logic for positioning users in a leadership role, practical challenges arose leading to questions about this approach as described. Clinicians increasingly needed support from the Hub team staff to become familiar with innovation practices and business concepts which were vital to managing the innovation process. Initially the clinician's priority of improving patient experience, informed by their focus in healthcare delivery to make patients better was championed, to the detriment of due-diligence considerations required to viably develop products that could prove socially and operationally feasible.

These challenges created a number of concerns for the effectiveness of the Hub as a space for collaboration. In addition to gaps in clinician's knowledge and a limited interest in commercial and strategic elements of the innovation process was an under appreciation of the functional importance of these elements for the innovation process. As commercial and research collaborators provided resources and funding to support Hub process their priorities for development of innovation concepts, and their priority attributed to assessing potential market demand for Hub products were also of fundamental influences within the innovation process. For the Hub to continue to function as both a space for experimentation and collaboration, the longer term outcomes of Hub activity needed to become part of the innovation process to meet the priorities of its multiple stakeholder groups. If the outcomes of Hub innovation did not seem to align with their priorities, the usefulness of a hospital based Hub could be questioned. Therefore, the skills and capabilities of the leader of concept development teams needed to be receptive and responsive to this. Clinicians had a specific reasons for becoming involved in innovation, and over time their narrow appreciation of and interest in accommodating the wider considerations of the innovation process compromised their suitability as leaders.

Growth in the Hub team outlined in figure 4.3, section 4.1, added capacity and externally acquired professional expertise to increase support, and take capacity to take on tasks initially assigned to clinicians out of necessity. Thus, in response to growth in Hub team resource it would be prudent to formally reconsider the role of users in project teams to alleviate current challenges. Clinicians' input in informing design made a distinctive contribution to recognising the needs of healthcare users during the development process. Thus, redefining how they informed the Hub process to focus use of their valuable time could bring strategic and operational benefits for elements of the collaborative process

6.2.4 Representing Hospital Requirements

During data collection it emerged that clinicians were the sole voice representing not only wider groups of hospital users, but also were the collaborator responsible for representing strategic hospital requirements during the innovation process. This was problematic in a number of areas. The conflicts of interest that arose as the innovation process progressed

forms the focus of this section. Although clinician's contributions were perceived to be of high value, it is not sufficient or appropriate for them to be relied upon as representative of the complex and diverse hospital requirements (Bessant at al., 2019:172). As acknowledged in the literature patients had a different 'lived experience' (c.f. McNichol 2012:220). But due to their lack of purchasing power had remained an under represented group of users (Pereno, 2020:9, Carstensen and Bason, 2012) An individual clinician's perspective was unlikely to be representative of the views of their clinical colleagues, patients or hospital managers. Therefore, relying on clinicians to guide alignment between product design and hospital requirements risks becoming problematic.

It is important to understand how clinician's contributions can be beneficial to the innovation process, and where their input may in fact cause a conflict of interest between their personal perspective and those of other hospital stakeholders like managers and patients. The area of compatibility between Hub products and the functionality of current NHS systems in an example of where clinicians cannot appreciate all due considerations. Clinicians were not immersed in financial and operational strategic decisions which also influenced the design of hospital systems. Therefore it was not realistic to expect clinicians to be aware of the extent of obligations and challenges facing the hospital as a complex institution.

However, the contribution clinicians made when representing hospital users formed an important bridge between the social and practical elements of the development process. Their perspective enabled a user perspective to be represented alongside other influential perspectives to inform the design of new health innovations. This was significant as the hospital environment posed a number of operational, regulatory and social challenges for innovators (Thimbleby, 2003). Data showed that hospital internal stakeholders interviewed, namely clinicians and hospital board members, were motivated by the notion of an innovation space that provided an environment to utilise patient and clinicians' knowledge as an asset to benefit the hospital. Providing capacity to respond to a lack of digital products, expected by patients aimed to address gaps in improving patient wellbeing, especially in paediatrics, (Liedtka et al, 2017:222-225, Zuckerman, 2016); along with improved operational efficiency as part of hospital objectives to deliver a quality patient

experience (Djellal and Gallouk, 2007, Dimitri, 2019). During data collection clinicians were able to voice their own perspectives on necessary areas for innovation, acting as a representative of the unmet needs experienced by patients and families. However, despite the complexity of managing its implementation, clinician's participation could not be considered a complete substitute for direct involvement of patients and families. As noted by Thimbleby (2003) perhaps there is an element of patients not being regarded as key stakeholders in the same manner as clinicians, managers and commercial organisations. Rather, extending the collaboration to include patients' and their families would supplement and potentially challenge clinicians' perspectives, strengthening the robustness of the Hub person centred innovation process. This argument aligns with literature on the particular needs of paediatric patients (Newman, 2017, Dimitri, 2019). The influence of clinicians helped inform the Hub staff team attempts to balancing operational needs of healthcare systems together with the social, emotional and practical needs of the users there are designed to serve. Clinicians' contributions were important in responding to pressure to understanding the importance of emotional wellbeing during healthcare treatment, and the role of end users to articulating these needs during the design process (Wilson et al, 2016, Lacy, 2016, Bauer et al., 2019, Mittelmark et al., 2017).

The small scale of the Hub studied is a relevant factor in this discussion. The various complex literatures on collaborative innovation, clinician-led innovation and the healthcare innovation process are being considered in relation to a new Hub environment. The concept of multi-stakeholder innovation in this hospital setting, and the use of clinicians to help inform innovation activity were still being explored by Hub stakeholders at the time of data collection. A sense of innovation actors' learning and reflection on participation within the evolving collaboration was evident in data collected. Such details from a Hub emerging from the start-up phase and beginning to implement changes from their experiences is not documented in the literature, which focuses on early stage start-ups or experimental pop up Hub spaces (Hyysalo and Hakkarainen, 2014, Saidi, 2017, Ciasullo et al., 2017). The Hub was working with a small minority of hospital staff, who made their recommendations based on their personal perception of user-needs. These clinicians who were early enthusiasts shared a number of characteristics and aspirations, confirming the characterisation of 'grassroots activists of healthcare' described in the literature (Funderberk and Polaha, 2017:105). I

observed a shared motivation to apply their clinical problem solving skills to improve paediatric care. This emerged from frustration with current systems, and is consistent with research on unmet patient expectations for access to digital interactive healthcare products (Dimitri, 2019). Studies into emerging technologies as a mechanism of improving patient experience and creating capacity in the health service (Lacy, 2016, Tettegah et al., 2016). Significantly, the perspective of clinicians I interacted with shared a socially motivated entrepreneurial commitment to public health and a distain for the pursuit of a financial return from commercial product sales (de Jong et al., 2016:68). This research makes an important contribution by identifying clinicians understanding of healthcare innovation also had areas of strength and weakness, like other stakeholder groups. Although clinicians were an essential group of users in the hub they also required support to overcome gaps in their understanding of hub operations e.g. necessary return on investment to support gaining investment from external collaborators and a naivety about business processes.

Elsewhere in the healthcare sector an evidence base is used to guide and inform decision making, yet in the Hub the use of experimentation and the importance of data to guide decision making was under development. Section 6.3 explores this issue further by considering the role of process and need for modifications as part of a due diligence process.

Data was collected as the Hub was moving out of the start-up phase, and Hub staff and collaborators had gained a better understanding how the Hub environment and innovation process could function. Thus, to effectively represent hospital requirements, the strengths and limitations of clinicians as embedded lead users needed to be reconsidered, to provide effective return on scare available time. Furthermore, role of user would be better represented if clinicians were joined by additional types of hospital user and key stakeholders. This would require an appropriate process to safely enable mobilisation of the patient voice, along with possible contributions from operational staff from in departments including procurement, finance, strategic planning and senior management. A further extension could include representation from parents and carers of patients who would likely also be key end users of Hub products and have distinct wellbeing and health literacy needs.

6.2.5 Concluding Remarks

This section has justified why clinical users are important stakeholders in the Hub environment, as they inform, direct and help refine the innovation process. However, their involvement must be a secondary activity due to the urgent nature of their clinical role. Therefore clinician's capacity for innovation is restricted by available time which in turn effects continuity of participation and pace of activity (Clark et al., 2019:542). The most appropriate way for clinicians to influence the Hub has been questioned as the demanding nature of the innovation process has become better understood. Requirements to competently lead the Hub process have extended far beyond their original enthusiasm to progress innovative experimentation and revelated limitations to areas where clinician' are happy and able to contribute.

As the Hub connected with a small proportion of clinical users, questions emerged regarding how accurately clinicians could represent the breadth of healthcare user needs and if there was a need for additional direct user voices data as evidence. Over time Hub staff capacity grew to provide staff experienced in managing the innovation process. Thus, the rationale for continuing with a process where the clinical users occupied a leadership role in project teams was considered increasingly problematic. Therefore Hub staff began to strategically direct clinicians time to make best use of their valuable insight, experience and knowledge.

The Hub remained committed to responding to needs identified by clinicians. Ethical challenges of working with patients meant clinicians were an important point of access to understanding these needs and potential solutions. Clinician's social motivation to improve patient experience created tension when they conflicted with the commercial priorities of other collaborators. These findings are consistent with research in other contexts that also involve socially, mission-driven and profit-driven innovation prioritised by different innovation actors working in collaboration (Komatsu Cipriana et al., 2020). This thesis examined these concerns in relation to potential patient impact, market generalisability and commercial potential of new MedTech products in development. Thus, the inclusion of clinicians in a collaborative innovation process introduced additional considerations of the complexity of representing user needs, perceptions of service quality and alignment with

hospital systems. This is both a beneficial and complicating factor that the Hub team sought to balance, with the aim of increasing product effectiveness and differentiation. The next section discusses the use of process in supporting the management of the Hub facility.

6.3 Enabling multi-stakeholder collaboration in a healthcare context

This section will answer RQ3 '*How is multi-stakeholder collaboration enabled in a healthcare context?*' The section will critically discuss elements that contribute to the operationalisation of a collaborative Hub process. The aim of the section is to assess the effectiveness of these contributory factors in facilitating multi-stakeholder collaboration in a healthcare Hub.

6.3.1 Space

The Hub space was important in facilitating key functions of Hub activity which in turn supported collaborative innovation. However the anticipated benefits of designing a Hub with a flexible floor space faced practical challenges. The main aim of the open plan Hub space was to enable collaboration, but this layout proved to be inefficient for people regularly working in the Hub space. Thus, emphasising the availability of collaborative Hub space to attract healthcare stakeholders inadvertently created compromises for other key innovation actors.

The Hub space was arranged to provide different spaces for collaboration (meeting rooms, break out space, open floor space for events, shared kitchen space etc) consistent with findings elsewhere (Saidi, 2017). However, data showed that most of the time these spaces were not used for their primary intended purpose, and when they were, due to the proximity to desk space Hub staff work was disrupted. Even the more specialist areas housing the patient experience bedroom, and VR software were rarely used for their intended purpose, despite external investment. Thus, apart from being shown to visitors as extraordinary spaces for innovation, the space in fact lay empty, or for quiet meeting space by staff. Therefore decisions about anticipated need for spaces, and their function, made before the collaborative process began had mis-envisioned the type and demand for space.

Notably, data showed how Hub staff needs received little attention or planning during the design of Hub space, and did not reflect consideration for differing space requirements of innovation actor 'nomads' and 'hi-touch' frequent Hub occupants (cf. Davenport, 2002:227).

During start-up founding clinicians were given freedom to be lead designers the Hub space, and initiate working relationships with other organisations. The outcome of some early interest in the Hub space can be seen through sponsorship which created the patient experience bedroom, and VR suite. This suggests that either the enthusiasm of founding staff to make external connections or receive available funding, was considered to be a more important display of Hub progress than considering the needs of staff working in the space on a daily basis. However, as data showed much of the collaborative process occurred remotely or virtually. It remains important to question whether having a physical Hub space is in fact a significant enabler of the innovation process as discussed by Osorio et al (2019). Perhaps access to Hub staff, and creation of novel and interesting spaces served a role to inspire collaborator investment in a new Hub facility. These designed spaces showed financial investment which represented commitment to the innovation process. Furthermore their novelty reinforced the message that the Hub environment presented a space with opportunity to experiment in contrast to other healthcare settings. This study illustrated the importance of enabling virtual collaboration for stakeholders in 'dispersed teams' (c.f. Osorio et al., 2019). Although this change was emergent rather than being designed, the physical hub space provided access to 'physical remote working facilities' alongside 'collaborative technologies'. This aligns with results regarding the importance of a Hub having both a physical and virtual hub presence (Sharma and Meyer, 2019:99).

The literature suggested how Hub physical and virtual space should provide resources and tools to form 'integrated' and 'enabling' spaces for innovation (c.f. Peschl and Fundneider, 2012:14) that 'nurture' and 'stimulate' collaboration (c.f. Caccamo, 2020:189). Moultrie et al (2007:57) stated the importance of connecting the 'strategic intent' of the Hub, with how space was designed to support the wider innovation process. There are some difference between results in the literature and findings from this study concerning the extent of pre-planning, and what was possible in a healthcare context. The Hub space studied helped to

enable collaboration, but it didn't enable it by following traditional patterns of collaboration outlined in the literature (Caccamo, 2020:181).

As noted earlier in section 6.1 the healthcare context has limited potential for the Hub to be a location for spontaneous interaction between otherwise disparate stakeholders and support new working relationships. In contrast to the literature which cited Hub physical space as a key enabler of innovation findings from this Hub case challenge this in some contexts (Bason, 2010:192, Saidi, 2017,). For example despite proximity to clinicians participating in the collaboration as lead users this Hub did not require the ability to host drop-in visitors as described as important for collaboration in the healthcare literature (Vespestad and Clancy, 2016:134). This was due to the ward based nature of users' jobs, off site development of most concepts and use of digital methods to manage stakeholder communications. Nor did the Hub need to provide a dynamic or creative environment for innovation on a regular basis. However the Hub space needed to show collaborators the types of dedicated spaces to enable stages of the innovation process, and access to relevant technology that was anticipated to feature in Hub products. In retrospect, early stages decisions on how to divide up the Hub space showed some errors in judgement in terms of actual regularity of use. Their primary purpose seemed to be as a way to influence potential external partners considering working with the Hub, as Hub staff used these spaces to articulate Hub objectives and spark the interest in collaborative opportunities. These spaces became important during events as there was a limit to what could be shown as examples of work occurring due to an absence of practical development activities in the Hub space. Therefore, these dedicated spaces did contribute to enabling the multi-stakeholder process but not as directly or practically as anticipated.

In fact, the role of space in enabling collaboration had been reassessed after hosting in person events generated a huge volume of ideas consistent with results elsewhere (O'Hare et al., 2008:976). Founding Hub staff began to appreciate the complexity of managing multi-stakeholder innovation, and responded through recruitment of professional experienced colleagues. Increased Hub staff capacity and expertise meant there was recognition of a need for their contribution to support the collaborative process. The literature noted the importance of designing space to suit the process and workers operating in the space (Duffy

et al., 2011). In this study as demands of Hub space differed from those anticipated in the initial design, growth in the Hub staff team was not accounted for and resulted in ad-hoc workspace in the main open plan collaborative area of the hub using groups of open plan desks. Although this use of space didn't suit Hub staff office based working requirements it did enable them to be a visible presence in the Hub environment.

During data collection the main use of the Hub space was as a silent office space. This was a necessary use of space to support the wider collaborative process. Thus, despite the lack of dedicated innovation space in healthcare, a key enabler of early stage collaborative innovation came from clinicians having access to available desk space in the Hub. This is comparable to results elsewhere regarding the importance of having space away from the distractions present in the main workplace (Magadley and Birdi, 2009:322). This is significant as the solution Hub space provided for this need was not acknowledged openly. In fact daily Hub use contrasted to how the Hub was promoted - as a collaborative, practical innovation space that supported multi-stakeholder collaboration.

The literature states that for a Hub space to become enabling the function and design of space should support concept development and needs of the multi-stakeholder collaboration. Yet collaborators' space requirements in a healthcare innovation context differed from requirements in other sectors (Magadley and Birdi, 2009, Toivonen and Friederici, 2015:3). Furthermore, the importance of quiet space, and virtual space became more important to the innovation process than provision of social space for informal meetings.

This study showed how Hub space can be an enabling factor for the collaboration process, highlighting particular requirements at the early stage of a health innovation Hub. The literature on public sector innovation hubs notes the importance of providing a home for innovation (Björklund et al., 2019:587) which aligns with findings from the hub studied in this research. However, this thesis makes an important contribution to the literature, by suggesting that at the time of data collection a physical hub on the hospital campus was important but not vital for collaboration, as stakeholder interaction was not reliant on 'in person' use of Hub space. Findings demonstrated how the importance of using space to

enable innovation in a healthcare setting, despite this being a more complex process than is often understood at the outset of Hub creation. In a comparable manner to research by Claudel et al (2018:45), this study showed how the use of Hub space evolved over time.

Thus, the way in which space was actually used aligns with the notion described in the literature that space is more than just having a dedicated physical space. Peschl and Fundneider (2012:14-15) suggest that for a Hub space to enable innovation, the differentiating factors of Hub environment must be considered in conjunction the social, cultural, emotional, and physical/architectural use of Hub space. These findings correspond with how Hub space was used in this thesis study, and the role of space in supporting different key innovation actors. Emerging challenges stemming from the lack of planning and strategy during the initial design of Hub space can be understood using existing literature. Outcomes of a study by Moultrie et al (2007) proposed an interesting model which acknowledged the importance of a link between how Hub space is used to support concept development, and the stakeholders who enable them. Findings from the early stage of the Hub in the current study can be explained by this model which suggests that the challenges which emerged due to a lack of coherence between hub space, hub strategy, stakeholder needs and process.

Therefore findings from this research suggest that it important to anticipate that Hubs will use space differently at various stages in their development. The designed spaces that stood largely unused during early stages of Hub activity could prove key in enablement of latter stages of the innovation process, and support a closed feedback loop relying on clinicians' feedback and collective stakeholder 'critical revision' (Garud et al., 2013: 784-5). However, data indicated that at an early stage, it was important to use space to inspire collaborators with a view to encouraging participation, and to provide space to house staff who focused on managing the complexity of a multi-stakeholder process.

Adding to literature on how a virtual space enables teamwork, this Hub provided an example of how stakeholder collaboration was functioning without sole reliance on in-person interaction (Moultrie et al 2007:61, Peschl and Fundneider, 2012:14). In a healthcare context enabling factors of clinician-led innovation required Hub space, but not for purposes

that were anticipated at the outset of Hub design. Therefore, appreciating that clinician's will likely only be present in the Hub for specific purposes, like pre-arranged meetings or to contribute to pieces of work, meant that enablement of clinician-led innovation relied on facilities for Hub staff work, and space to develop processes to support all Hub collaborators, who commonly worked part-time on Hub innovations. Hattori and Wycoff (2002:27) drew similar conclusions in their research which presented two stages of Hub operations, therefore it is reasonable to expect that Hub space usage will change over time to accommodate different types of enabling hub activity.

Therefore, to understand the connection between Hub space, and enabling collaboration it became increasingly important to consider how process was used to structure collaborative innovation and manage space as a Hub resource. Hub staff learnt that designing space to enable collaboration involved more considerations that they had initially expected. Activity at this time in the Hubs development had no real designed innovation process. The Hub was using its space to promote the concept of clinician-led collaborative innovation, and host collaborators during events and in follow up meetings as a way of initiating multi-stakeholder concept development teams. But there was no over-arching process to provide a framework to guide, standardize, support or regulate multi-stakeholder innovation. This can be attributed to a lack of resource to appreciate and implement the importance of such structures as a component of effective collaboration. This underestimation of the complexity of multi-stakeholder innovation was further complicated by characteristics of the healthcare setting which compromised the potential effectiveness of Hub activity. Having recognised the importance using space to meet collaborators needs, the next stage was to combine the use of Hub space, resources and innovation actors to enable collaboration to occur, taking into consideration factors that complicated this process. By combining the peer influence of founding clinicians, with contributions from external organisations, Hub staff focused on facilitating collaborative working that sought to accommodate differing work commitments, priorities and expectations. This approach is comparable with the digital imprinting approach described by Crupi et al (2020) where the inner characteristics of the Hub were represented to influence the innovation process. The enabling role of intermediaries is explored in section 6.3.3. Prior to the inclusion of Hub staff in the Hub, the longer term conflict of interest between clinicians and commercial

organisations was supressed by initial excitement over a new type of working relationships. This led to Hub commencing without due consideration being paid to how the process would work, resources needed and expectations for innovation outcomes.

Furthermore, understanding how to enable user-led collaborative innovation in a healthcare context required Hub staff to acknowledge practical restrictions on timing. Collaborators worked in different organisations, so scheduling meetings whether in person or virtual were important. Yet anticipating the availability of clinicians was complicated by their changeable clinical obligations. Therefore, successfully anticipating the timing of when and where clinicians input was needed was often subject to last minute change. This unpredictable availability of key knowledge-led contribution caused disruption for the collaborative process consistent with findings elsewhere in the literature (Clark et al., 2019:542). Therefore the development of processes were needed to manage stakeholder expectations of how stakeholder participation in the Hub space would function. In particular access to clinicians, who although were a limited presence in the Hub space, held a key role in the innovation process.

6.3.2 Process

Over time process became an increasingly necessary enabler of Hub collaboration to manage and support varying stakeholder needs. The formation of concept development teams typically comprised of a clinician, commercial and university academic researcher. Motivation to participate came from a common interest in the novelty of a hospital based Hub that used MedTech, but differing priorities in terms of output, patient experience, commercial revenue generation and generation of research data. By combining stakeholders differing areas of expertise, and access to supporting resources including knowledge, funding and equipment contributions were made which progressed experimental development of Hub innovation concepts. Interestingly, collaborators most often exchanged contributions virtually, via email or phone, prompted by a need to response to a differing opinion. This occurred in parallel with longer term work to collaborate on designing the technical functionality of the product. Due to an absence of strict process at the outset of initial projects, role responsibilities, timescales and reportable

objectives could not be used to guide continual engagement. The digital nature of MedTech product development contributed to a reduce need to meet in person, in the Hub space. Therefore individual collaborators made contributions from different work spaces, at different times of day subject to demands of collaborators working schedules aligning with results elsewhere (Tang et al., 2018:91). Although this working pattern enabled innovation activity to be added to existing workloads and schedules the process suffered from poor communication, misunderstandings and a lack of pace.

During the start-up phase the absence of established innovation processes to guide collaboration added further complexity to the Hub's organisational development. This was evident through stakeholder frustration regarding a lack of clarity and unmet expectations from the collaborative process. Progression of product development was impacted by efficient communication methods, linked to time required to receive responses to emails, due to a scarcity of in person meetings. However, as innovation actors were working in a new type of collaboration, it is reasonable to expect some tension and complexity as they established how to work together effectively.

Over time Hub staff became more involved in an attempt to mobilise their skills to address problems in stakeholder relationships and improve patterns of communication aligning with findings of Dedehayir et al (2018:22-23). Thus, increased attention was given to how the implementation of bespoke innovation processes could enable collaborative innovation to function more effectively. Modifications made to the Hub process demonstrated Hub team response to increased stakeholder demand for support. Revising process provided greater access and efficiency to extend resources for early concept development. Using process in this way helped protect Hub resource and provide criteria to justify Hub decision making. Supporting multi-stakeholder collaboration became an increasingly resource intensive task for the Hub. Therefore, the innovation process required integration of additional capacity and knowledge of external partner organisations to varied demands of the collaborative process. Thus, to operate using an effective innovation process it was necessary to revaluate stakeholder needs to ensure that the innovation process aligned with Hub objectives and collaborator needs.

By modifying stages of the process efficiency and concept progression was improved by applying insights of Hub staff to better align the focus of process stages stakeholder needs consistent with findings by Crupi et al (2020:1278). Hub staff began using process as a strategic tool to manage the collaborative process, and enrich the type of support available for collaborators. The creation of multiple Hub pathways was implemented to attempt to address capacity issues and respond to user expectations for Hub support, extending what could be managed using finite Hub staff resources.

Reworking the main innovation process, 'the Innovation Governance Process' see figure 5.1, acknowledged application of recent growth in understanding the complexity of multi-stakeholder collaboration in a healthcare context. Process was used to implement structure and define the Hub's position within multi-stakeholder collaborations. Prior to this, a lack of understanding regarding Hub priorities for innovation, combined with inexperience in managing collaborative working had resulted in a lack of Hub leverage during negotiations with stakeholders. The inexperience of founding Hub staff in multi-stakeholder working, and innovation management led to an over-designed Hub space motivated by enthusiasm to show opportunity and creative use of space. Over time, requirement of the space, and its function became more complex than anticipated, in addition to the central role virtual space occupied as a key mechanism to enable collaboration. Therefore, seeking stability and a method by which to manage multiple aspects of the innovation process it became necessary to design processes that helped to sustain Hub activities. Founding clinicians valued the concept of experimentation and creative thinking, and therefore were not concerned by an initial lack of guiding processes. This could stem from enthusiasm to develop a space that operated differently from the highly controlled hospital organisational culture . Perhaps clinicians misinterpreted how process could be used beneficially in an innovation space, as their experience was formed in the highly bureaucratic healthcare sector in a comparable manner to a study by Carstensen et al (2012:3-5). Implementing processes to govern and manage collaborative working demonstrated to stakeholders that the Hub staff understood the power of its internal resources, consistent with findings by Djellal and Gallouj (2007:190). Therefore, Hub collaboration was able to become a mutually beneficial process in which the needs of the Hub facility and collaborators became increasingly well balanced due to improvements in Hub processes. Overtime where both knowledge and resources

were more fairly exchanged and collaborators priorities became better balanced in relation to pursuit of new intellectual property and product creation. This is consistent with findings of Crupi et al (2020). This replaced the initial passive view of founding Hub staff, 'we let them (external stakeholders) have it all as we can't do anything else' (Tim, Senior Clinical).

Hub staff anticipated that written documentation of Hub processes would allow stakeholders to gain a better understanding of stages of the innovation process. During data collection this task was a work in progress. A significant change to managing multi-stakeholder innovation saw process be used to guide Hub contact with collaborators from the outset. This provided an opportunity to manage the complexity of collaborative innovation identified in the literature and communicate more clearly with potential collaborators about the stages of the innovation process, forming agreements prior to stakeholder participation commencing (Garud et al, 2013:793).

Over time the use of process in the Hub changed to reflect what were considered to be key Hub activities, in a comparable manner to findings by Carstensen et al (2012:19). Thus, although stakeholders were not involved in the development of new process, Hub staff had taken steps to change their behaviour towards communicating with potential collaborators, in line with the guiding stages of Hub process. Such process modifications improved of clarity of communication which helped address reducing stakeholder tension, that originated from unrealistic expectations of the Hub collaborative process. The decision to implement Hub processes was used to help explain the Hub's focus and justify differences between the Hub organisational culture and those stakeholders were used to. Hub staff were able to protect Hub objectives by using a structured approach. This replaced a situation where the priorities of powerful Hub stakeholders influenced decision making. Over time the use of process was developed as a tool for implementing a fair, consistent and systematic approach to supporting stakeholders through stages of the innovation process. Building in time for Hub staff to consider suitability of collaborators and their desired innovation outcomes supported the reciprocal nature of collaboration work where there should be some balance between stakeholder's contribution and derived benefits, their give and take.

Garud et al (2011:740) argue that process must be 'appropriate' to the context. This is consistent with the way process emerged in the Hub by accommodating different innovation cultures and processes, the healthcare context and the availability of Hub capacity and resources. In addition, the lack of comparable hospital Hubs with similar motivation, focus and mix of collaborators meant that Hub process was designed in response to Hub needs once it became active. Although this had disadvantages, Hub process became a bespoke tool to be continually modified to enable collaboration, rather than a preconceived rule book.

Unlike healthcare delivery settings, healthcare Hubs were not able to access well developed policy to informed good practice (Farchi and Salge, 2017). Due to the novel use of MedTech as part of a collaborative process, there was an absence of policy to guide Hub staff through operational complexities. This impacted the collaborative process from the early design stages through to correct testing and implementation considerations. Therefore thorough configuration and constant review of internally developed Hub process became the principal way Hub staff protected innovation activity when navigating sensitive ethical and legal areas.

Despite use of process in other familiar settings Hub collaborators showed a lack of tolerance when Hub staff began to introduce the use of process to manage Hub activity, as it was perceived to obstruct their previously held freedoms. Hub staff used their increased practical knowledge of the Hub and the relationship between space and process to address initial failings. During operationalisation of new processes innovation actors were educated on the importance of unfamiliar issues that were of imperative importance in healthcare yet don't apply in other sectors, averting potential issues when considering details of concept design (Garud et al., 2013:797).

6.3.3 The contribution of Hub staff as enabling Innovation Actors

As discussed the healthcare innovation process required participation and interaction between innovation actors including clinicians, hospital managers, industrialists and the Hub staff (Dedehayir et al., 2018). The healthcare innovation literature cites the contribution of

intermediary actors as a way of managing the complexity of healthcare innovation and the related innovation process (Howells, 2006, Clark et al., 2019). However, as fieldwork gathered most data on Hub staff as one type of innovation actor, their contribution will be the focus on this discussion in this section, and provide a response to a gap in the literature on the role of intermediaries in innovation hubs (Howells, 2016:725).

In section 5.1.2 an overview of the Hub staff role was presented, although the nature of their contribution progressed overtime to support additional ways of Hub process enablement. As described in section 4.3 the growth in the Hub staff team during the start-up phase demonstrated their importance in supporting collaborative healthcare innovation. Hub staff based in the Hub worked in a semi-autonomous manner. This enabled some control and flexibility in managing workload. As managing the collaborative process became more demanding Hub staff were able to become involved, and diversify their role in respond to changing stakeholder demands consistent with findings of Dedehayir et al (2018:26-27). In the literature the importance of intermediaries in assisting with multi-stakeholder communication and bridging gaps in collaborative teams is acknowledged (Howells, 2006, Lauritzen, 2017). This study critically analyses examples of where and why intermediaries were required to use leadership skills to take ownership of communication methods between collaborators. This aligns with findings that show scope for multiple innovation actors to undertake different types of leadership role to help manage the complexity of collaborative working (Dedehayir et al., 2018:27). This study illustrated the need for Hub staff to resolve operational and strategic challenges whilst improve stakeholders' experiences. Despite the number of different innovations actors in the Hub, no other group was able or available to take on these tasks. Gaps such as this are also acknowledged in the literature on early stage development of innovation hubs (Fecher, 2020, Björklund et al., 2019). This research contributes to the literature on intermediaries, by providing additional examples of the importance of role ambidexterity and role multiplicity as enabling factors of the collaborative process (Hakkarainen et al., 2016:56, Lauritzen et al., 2017:307, Nystrom et al., 2014: 487-88). Findings from this research concurred with the literature by acknowledging the complexity of healthcare innovation (Fleuren et al., 2004). In particular within multi-stakeholder collaboration and the necessity of taking multiple roles that each make a distinct contributions. In the healthcare context

this was important where other management and specialist innovation knowledge was not otherwise available (Nyström et al, 2014:487-89).

The healthcare context of the Hub prompted a growing need for intermediaries to navigate the operational and cultural differences between the healthcare sector and other organisational settings which led to misinformed stakeholder expectations of the Hub process. The literature details the challenges of doing innovation in the healthcare sector (Savory and Fortune, 2015, Miller and French, 2016; Hertzlinger, 2006) and the specific role of hospitals (Djellal and Gallouj, 2005, Thune and Mina, 2016). Yet there is a lack of literature on how this complexity impacts innovation actors with no healthcare sector knowledge, prompting calls for further research (Thune and Mina, 2016:1555).

Although Hub process relied on stakeholders combining their different competencies to develop innovation concepts, gaps in competencies emerged. In the absence of alternative Hub management to oversee stakeholder management during the collaborative process, Hub staff began working directly with and between collaborators. Consistent with findings by Nyström et al (2012:487) their intermediary roles fitted with the categories of 'coordinator', representing and forwarding information, building trust and organizing information about stakeholder needs, and 'orchestrator' guiding and supporting activities. This work was particularly important in areas where a lack of informed leadership neglected to direct discussions in concept development teams relating to ethical and commercial matters.

The literature acknowledges the role of Knowledge Brokers who 'mediate interactions' between innovation actors (Burt, 2007) with the intention of leveraging external knowledge source to improve innovation performance (Crupi, 2020:3270). The influence of an intermediary also helped mitigate challenges to collaborator engagement resulting from reliance on use of virtual space to host meetings and dialogue. The healthcare context of this thesis makes an important, focused contribution to this literatuer, emphasizing how challenges in a competitive, highly regulated context are addressed. This research explores how, through representing differing perspectives, by 'identifying and reflecting' them in conversations with individual stakeholders, Hub staff prompted collaborator interaction

aligning with findings by Giannopoulou et al (2013:38). Working as intermediaries Hub staff helped enable improved frequency and criticality of stakeholder engagement by focusing on key ideas and challenges. In the absence of suitable process to better support collaborative working this method served as a way to monitor contribution and project progress.

An absence of in person meetings was a contributory factor that led to a need for third-party representation and facilitation. Acting as a discussant created opportunities for Hub staff to use insights gained from working with collaborators to influence incorporation of increased strategic decision making into the Hub process. This is evident in early stages of the Innovation Governance Process where Hub staff influenced the outcomes of meetings between with collaborators by including otherwise under-represented perspectives in discussions. Although it can be argued that innovation actors best represent themselves, clinicians meeting with industrialists were inexperienced in navigating operational, financial and legal aspects of these meetings consistent with findings elsewhere (Usai et al., 2018: 1644). Therefore Hub staff working as knowledge brokers contributed to avoiding problematic situations arising due to gaps in clinicians commercial experience. Similarly, in the absence of other suitable innovation actors, Hub staff led knowledge brokering between Hub collaborators to formalise the protection of knowledge created during the development process, in an effort to retain value to support continued Hub enablement.

Hub staff helped collaborators understand the importance of knowledge in relation to the Hub process, concurring with findings elsewhere (Lauritzen, 2017:298, Caccamo, 2020:187-88). Thus, building collaborator receptiveness for viewing the opportunity to creatively collaborate and combine knowledge as a tool to support needs-led innovation (Giannopoulou et al., 2013:39). Hub staff intermediaries advocated for collective decision making in place of leaving stakeholders opportunities to push pursuing their own priorities (Garud et al, 2013:783, Longo and Giaccone, 2017:892.) Furthermore, deepening collaborator understanding of Hub staff decision making, helped justify why it had become necessary to implement suitability detailed negotiations regarding working agreements. Investing resource in brokering knowledge between collaborators, helped establishing the Hub as an environment where innovation actors' knowledge was acknowledged as an enabling asset that required protection.

Due to the inexperience of hospital managers in negotiating with commercial and research orientated collaborators Hub staff use their professional backgrounds to represent the hospital requirements (incorporating those of hospital managers and clinicians). This enabled Hub staff to strength the Hub position when seeking to reach fair multi-stakeholder agreements by using clinician's knowledge as a form of leverage, consistent with approaches identified by Nambisan and Sawney (2011:46). Elsewhere in the hospital there was a lack of experience in such matters, therefore the commercial background of some Hub staff meant that they were aware of the value of collaborator knowledge, and thus unlike clinicians, appreciated that agreements were necessary to protect it (Brem et al., 2018:18). As collaborator knowledge underpinned the innovation process, discussions beyond normal areas of hospital competence were needed to confirm how knowledge would be exchanged and protected as a key asset during the innovation process (Usai et al., 2018). Although it is likely that some elements of representing such a complex position as 'the hospital' would be compromised. At the current stage of development Hub staff seemed best placed to undertake this activity and in doing so reassure stakeholders that knowledge assets were being actively managed and protected (Nambisan and Sawney, 2011:51,54). This research justified why it was necessary to provide dedicated Hub staff resource to provide necessary expertise not found elsewhere within the existing hospital staff knowledge base, this is a findings which has relevance for other operational contexts.

The extent to which Hub staff could be effective when representing the opinions and needs of one collaborator to another is questionable as noted in outcomes of previous research (Bullinger, 2012:172, Svensson and Hartmann, 2018:285). However, when considering the deeply ingrained position of the other key innovation actors, the relative impartiality of Hub staff combined with experience of the healthcare sector and commercial innovation processes provided a stabilising contribution. Efforts to project manage multiple concepts benefitted from increased involvement from Hub staff who provided a constant resource to oversee the fragile and unfamiliar dynamics of collaborative working relationships. Reliance on collaborators to effectively communicate and collaborate at a consistent pace had proved problematic, due to a lack of time and experience in innovating in a healthcare context. Therefore an intermediary influence helped to improve the experience of collaborators by combining strategic vision and personable communication to guide

stakeholders through the innovation process, seeking to build common purpose and retain active participation consistent with results that skills of intermediaries could help enable collaboration through facilitating improved collaborator discussion and 'managing the mood' in complex situations (c.f. Magadley and Birdi, 2009:321). Thus using the management and leadership skills of Hub staff combined with experience in innovation management enhanced the service that the Hub were able to offer collaborators, to follow a similar approach to that of managing a digital project team presented by Guinan et al (2019) which suggested team composition, goal setting, continuous learning and talent management supported effective collaborative hub innovation. This study showed how consideration to wider management principles such as these proved important to uphold a positive image of the Hub as a place for multi-stakeholder innovation.

Whilst working in an intermediary capacity Hub staff used the knowledge they acquired to consider how revisions to Hub process and use of space could align best with developing stakeholder needs. Their perspective differed from that of individual stakeholder groups who were more focused on the medium to long term, and return on investment, thus overlooking many of the individual problems which contribute to reaching a deployed product. Hub staff were positioned differently, as they were invested in enabling stakeholders to complete the innovation process. So their use of micro perspective, and inclusion of management tools to inform their approach helped to manage and resolve Hub operational problems. Practical, process related and stakeholder relationship based issues were complex, and required dedicated and available staff resource with time to unpick the detail and dynamics within the collaborative relationships. These findings concur to conclusions in Osorio et al (2019) regarding the importance of understanding how mediating actions of intermediaries supported collaborative innovation.

During early stages of Hub development there was a limit to the new skills other innovation actors were able to acquire. Therefore introducing responsibility for improving stakeholder management by acting as intermediaries and knowledge brokers helped Hub staff implement emerging structures and encourage inclusion of types of thinking to improve Hub process efficiency, effectiveness and longevity. The particular ethical and organisational, patient and clinical user requirements warranted consideration during the innovation process (Geiger and Hirschl, 2015). When using technology as a mechanism for

addressing patient experience the balance of social, operational and commercial innovation outcomes added further complexity. Therefore, in the absence of time and inclination to become educated in matters relating most to a particular stakeholder group, Hub staff were important to form a bridge between stakeholders to generate understanding unfamiliar concepts which they initially oppose e.g. clinicians objecting to the idea of commercial outputs using intellectual property developed in the Hub as opposed to sharing it within the health service. These findings are comparable to those of Caccamo (2020:188) who found intermediaries were important influencing innovation actors' opinions during the innovation process.

During knowledge brokering Hub staff used their strategic experience to represent stakeholder requirements with a view to sustaining stakeholder relationships, by balancing opposing priorities prior to overseeing the development of shared stakeholder goals for innovation projects. Although their involvement as a third party could in fact misrepresent and confuse this process, since Hub staff had begun undertaking these tasks clarity and understanding had begun to improve. Thus overtime, the extent of their involvement may be able to be reduced as collaborators become more familiar with elements influencing healthcare Hub process, and less anxious to see tangible outcomes as an indication of progress and a return on investment during early stage concept development.

The collaborative process was enabled, at various stages, because of the work of the Hub team who worked to identify, acknowledge and respond to stakeholder needs whilst defining the role, purpose and process of innovation within the Hub consistent with findings of Crupi et al (2020). Their work improved transparency of Hub innovation, and the participation of different stakeholder groups. This was important as collaborative engagement between commercial organisations and hospitals was uncommon.

6.3.4 Concluding Remarks

This section examines key aspects of managing a multi-stakeholder hub, and provides a detailed critical analysis of these factors within an sector that was previously unfamiliar with responding to these challenges. This research suggests that collaborative innovation was

supported by a combination of dedicated space, bespoke innovation process and management oversight of Hub staff. However, significantly, it was the effectiveness of how these three key components were managed that influenced how efficiently collaborative innovation could be sustained. The healthcare context introduces unfamiliar ethical, practical and operational considerations for collaborators in addition navigating the role of a Hub facility and virtual innovation space. Working with differing priorities, expectations and available time meant that stakeholders all sought a bridging, informative, stabilizing influence to guide their interaction and contributions. Therefore the contribution of Hub Staff working as intermediaries contributed practical and strategic expertise, and tailored support which was used to structure and rationalise decisions taken in the Hub. Stakeholders were attracted by the high risk, high reward user-led approach used in the Hub studied. However, this approach presented challenges in when finding a suitable approach to manage early stage multi-stakeholder concept development. During the collaborative Hub process meeting stakeholder expectations was challenging when their lack of knowledge about healthcare processes resulted in disillusionment due to a perceived lack of progress, in some cases resulting in withholding further investment.

Yet through competent deployment of key Hub resources; space, innovation process and Hub staff the method used to pursue experimental innovation concepts can become less risky and erratic. Hub staff were important in meeting challenges within the collaborative process, from securing resources to sustaining stakeholder participation in a Hub that used an untested innovation process and an uncommon hospital based setting.

Stakeholders entered the collaborative innovation process with an eagerness to increase their access to the healthcare sector. Hub collaborative activity was not merely about experimentation, rather the effective combination of skills and resources to create a tangible innovation outcome that meets a need. The process of achieving this will include periods of creative thinking and experimentation, but to promote the Hub as a place for unfocused creativity was misleading. Therefore effectively using dedicated Hub space, process and Hub staff to help reconcile stakeholders misplaced preconceived ideas about Hub and collaboration was necessary. Access to these resources enabled effective collaboration by enriching the innovation process with layers of support, focus and

justification. These resources helped focus and strategically guide stakeholders' expectations of and contribution to the innovation process, whilst actively managing arising challenges.

6.4 Chapter Summary and Concluding Remarks

This chapter was presented three sections, each providing answer to one of the three research questions. In section 6.1 the development of Hub was critically evaluated. The healthcare context of this research challenged stakeholder expectations in ways that impacted Hub operation and innovation culture, highlighting limitations of stakeholders understanding about innovation culture, process and pace. The chapter critically examines approaches used to develop the Hub, and the importance of an increased appreciation for understanding how Hub space could be used to support stakeholder needs. The proximity of the Hub to the hospital did not provide a solution to accessing the valuable knowledge of clinicians due to work pressures in their clinical role challenging previous assumptions regarding Hub location. Adding to prior research on the importance of innovation space, this study agreed that the use of space rather than its accessibility was the most significant issue to address. This study provides a focused analysis on the function of the Hub space in a healthcare context, and justifies the need to employ intermediaries to manage virtual collaboration between stakeholders and lead changes to the physical design of Hub space.

This thesis makes an important contribution to the literature by highlighting differences in innovation and organisational process, pace and expecations. This section critically analysed how the working relationship between the Hub and the hospital emerges as a fundamental influence on the effectiveness of Hub development. Differences in expected behaviours and approaches to working between the hospital and Hub environments was a challenge for hospital managers and clinicians seeking to understand aspects of innovation culture. Thus, the development of the Hub involved understanding and managing stakeholder tensions arising from differing priorities and expectations of the Hub. Hub staff began working as intermediaries to improve communication and clarity regarding Hub space and purpose. This activity formed an important part of a management approach which sought to acknowledge and balance differing stakeholder expectations. Hub development required careful consideration of how the Hub space would best function to support the inclusion of

clinician's knowledge in the design of new innovation concepts. Supporting collaboration between commercial firms, research organisations and hospital clinicians required the Hub staff to become an active in discussions regarding project pace, the role of creativity, access to clinical knowledge and anticipated innovation outcomes. The study demonstrated how their role emerged as critical to managing Hub assets to improve and sustain the role of the Hub and oversee the collaborative process and ongoing Hub development.

Section 6.2 considered the role of clinicians within the Hub and how their skills and wider responsibilities impacted their availability and effectiveness. The section explained in detail how clinicians contributed to the innovation process through idea generation, application of knowledge and as concept development team leaders. Findings were consistent with previous studies regarding the extent of patient-related insights that clinicians were able to contribute. A recognition of the limited time available for involvement in project meetings led to refocusing their role towards concept development. Data aligned with previous research that found clinicians were able to influence difference types of stakeholder due to their knowledge, position and respect from peers.

The reliance on clinicians to voice the views of hospital users was analysed to highlight limitations of this approach. The chapter discusses issues arising from reliance on individual clinicians as accurate representatives of hospital requirements given the vast difference and depth of the often single category of hospital user needs. When appreciating the specific priorities and requirements of patients, hospital managers and other clinical colleagues the importance of integrating their views into the Hub process became increasingly apparent. Thus, as other areas of the Hub became more organised, the management of their participation in the innovation process could be addressed by Hub staff. The section evaluated how clinicians informed the Hub environment and how their role evolved over time. Investment into Hub staff roles enabled clinician's contributions to become knowledge focused, and removed responsibility for project management tasks. Hub staff took responsibility for managing conflicting stakeholder views regarding the anticipated patient, commercial and research focused innovation outcomes. Hub staff were aware of the importance of clinician's involvement as a differentiating factor of the Hub innovation process. The thesis crucially reflections on the changing role of clinicians contribution in this

hub. This section studies the changing influence of clinicians in the hub through critically examining how overtime, the growing importance of developing a self-sustaining hub facility prompted hub staff to reflect on the most effective way to use clinicians available time. This finding is significant more broadly in the development of user-led Hubs, as it acknowledges limitations when working with users employed elsewhere. Overtime, focusing clinicians contributions to specific aspects of the innovation process, explored in this section demonstrated a recognition of importance of using clinicians time strategic, to benefit hub sustainability.

The discussion in section 6.3 explained how collaboration was enabled by focusing on the particular requirments of a healthcare innovation Hub, highlighting the importance of understanding the sector in which the hub is operating. The section analysed the relationship between use of Hub space, collaborative processes and management oversight of stakeholders involved in concept development. Significantly, differences between anticipated and actual use of Hub space were analysed. Providing a quiet work space for Hub staff and clinicians emerged as a key finding in this context, and proved very important to support the collaborative process. The contribution of Hub staff working as intermediaries was discussed as a key part of managing collaborative healthcare innovation. Hub staff developed processes that better supported stakeholder needs. Over time stakeholder requirements and resources to sustain different stages of the collaborative innovation process became better understood by Hub staff. This informed a change in management behaviours and how process was used to support collaborators. By increasing clarity regarding stages of the innovation process, the management of stakeholder expectations became more effective.

The following chapter concludes this thesis. The chapter presents areas of contribution to innovation hub academic literature and practical implications for Innovation Hub managers. Recommendations are made to guide future studies by providing areas of further research which arose during this study.

Chapter 7 - Conclusion and Recommendations

7.0 Introduction

This chapter is organised into four main sections. In section 7.1 where the structure of the thesis is outlined, summarising the purpose of each chapter. The main conclusions draw from this study are given in section 7.2 which presents key contributions to the literature on Innovation Hubs. Practical implications for Hubs are given in section 7.3. Finally, limitations and recommendations for further research are suggested in 7.4.

7.1 Thesis Overview

This thesis has critically explored the development of a Hub in a healthcare setting. The research made a significant contribution to understanding the meaning of a Hub facility in a hospital setting through examining the role of space, culture, process and innovation actors adding to Hub research by Magadley and Birdi (2009) and Carstensen and Bason (2012). The study has focused on clinicians as a key group of users in collaborative healthcare innovation, and has critically reflected on their role within the Hub contributing to research elsewhere (e.g. Garibyan et al., 2020, Herstatt et al., 2012, Bullinger, 2012. The thesis has addressed the importance of process in supporting collaborative healthcare innovation and providing a response to managing expectations that emerged during the innovation process.

The research questions were generated from an extensive review of the literature which emphasised the complexity of innovation in the healthcare context, alongside a lack of research focused on understanding Innovation Hubs in hospitals. Key innovation drivers including pressure to increase digitalisation and improve patient experience were studied extensively in the literature. Drawing on research on the collaboration process, the role of users and the importance of dedicated innovation space, research questions were designed to understand their place in the development of a paediatric NHS hospital Hub. A paediatric hospital was selected because this provided an opportunity to study user-led innovation and the use of digital products within a hospital serving a particular group of patients. Access

was granted through a founding Hub staff member who contributed to the original CASE studentship research outline.

The empirical aspect of the thesis involved collecting data in a healthcare Hub. This demonstrated the challenges of navigating a multi-stakeholder innovation process. Data was collected using semi-structured interviews and observational research. This allowed a gathering of different perspectives from key stakeholders on broad themes of innovation management. A thematic analysis approach was employed in conjunction with relevant literatures to identify key themes that provided insight to answer the research questions.

Chapter one introduced the research aim and research questions in relation to gaps in the literature and issues raised in the CASE research brief. The empirical setting of the healthcare sector was presented, outlining drivers of healthcare innovation, followed by a justification for using a hospital Hub to study the process of collaborative MedTech innovation, and challenges facing NHS hospital stakeholders.

Chapter two provided an in-depth review of the literatures informing this study. Subjects reviewed included the types of innovation space, and the connected literatures which examined the of role of Hubs in providing a location, environment and culture to facilitate multi-stakeholder innovation. The motivations and challenges of innovating in the context NHS hospitals were considered. Issues of particular relevance to healthcare innovation, including the role of knowledge and types of hospital user in informing the innovation process were reviewed. Chapter three provided a rationale for the methodology used in this study. This chapter outlined how stages of the research process were conducted, including a detailed explanation of the thematic analysis process.

Chapter four, the first findings chapter, presented a case history of the Hub. Rich descriptive findings illustrated the Hubs development. Beginning by understanding factors behind its creation, the chapter presented a chronology of early operations in relation to how space was used to support collaboration. A focus on the growing role of the Hub staff and their increased use of innovation processes are presented as key developments in response to challenges experienced during initial collaborative working.

The main empirical findings were given in chapter five, presented in five sub-sections: Hub management, collaborative space, collaborative process, impact of NHS culture and climate on the Hub and innovation outcomes to align with the main themes emerging from the analysis. Each section provided a detailed analysis of empirical data, additional themes that emerged were considered to understand their relationship to answering the research questions.

Chapter six provided a critically reflective discussion, that combined empirical findings presented in chapters four and five and the literature review were synthesised to answer the research questions. The thesis concludes in chapter seven which identified key contributions from the thesis by reflecting on interesting research findings and how these add literatures informed this study along with practical implications for the management of healthcare innovation Hubs. Recommendations were given for further research outlining areas emerging from this study.

7.2 Contribution to literature on Innovation Hubs

This thesis has presented a detailed case study of a Hub within a paediatric, public sector hospital which makes a significant contribution to understanding the challenges associated with collaborative innovation in Hubs (e.g. Djellal and Gallouj, 2007, Savory, 2009, Miller and French, 2016). The management of conflicting external stakeholder priorities became increasingly well balanced with healthcare objectives, and this enabled a functional process to develop. The study is concerned with the topical interest of increasing the use of technology in healthcare settings, by using digital technology to pursue improving patient experience, wellbeing and operational efficiency (Dimitri, 2019, Aakus et al., 2019, Tettegah and Garcia, 2016.). The paediatric context of this particular healthcare setting provided a number of user-led drivers and diverse priorities drawn from staff working in clinical and management roles in the hospital environment. The Hub offered dedicated innovation space to enable experimental collaboration focused on addressing needs within the hospital environment. This research illustrated a key point of stakeholder tension found within healthcare settings which brought together commercial and research interests of external stakeholders with those of internal hospital managers and clinicians. The differing priorities

explored revealed multiple areas of the hospital organisation seeking innovative solutions. Some stakeholders prioritised operational issues, seeking to use innovation to increase capacity, process efficiency and service quality whereas, clinicians were motivated by social factors they experienced in their medical work. The focus on clinician-led innovation contributed to understanding clinicians' areas of strength and limitation as one type of healthcare user. Clinicians approached innovation from a needs-led person-centred perspective, seeking to use their knowledge to improve patient experience by informing the design of MedTech products. Their intention was to rectify issues they experienced, in particular improving patient wellbeing and developing digital resources to develop patients' health literacy. Through studying a hospital innovation Hub, this research made a significant contribution to providing evidence of early stage challenges experienced by innovation actors, collaborating in a newly established space and unfamiliar environment.

The changing role of innovation actors provided insight into unforeseen innovation challenges effecting healthcare hubs (Nicolopoulou, 2017, Liedtka, 2020, Svensson et al., 2018). The proximity between the Hub facility and the hospital provided dedicated space to encourage clinicians to experiment with radical ways of addressing needs they encountered in the hospital. This research illustrated that the location of a Hub on the hospital campus was not sufficient to facilitate clinician's participation in the innovation process. Rather, the complexity of understanding how the contribution of their role could inform the innovation process emerged as a key challenge for the Hub. Balancing limitations of using clinicians as representatives of the hospital needs, and those within broader patient, clinical user groups were explored. This helped to develop an understanding of the role of clinicians as embedded lead users in the collaborative innovation process and contributes to research elsewhere (e.g. Herstatt et al, 2016, Schweisfurth and Raasch, 2015). This study critically analysed the complexity of healthcare innovation, and the breadth of issues requiring management. The research contributed to research examining the response to the operational challenges, including factors which led to changes in the composition and number of staff working from the Hub (e.g. Howells, 2006, Guinan et al., 2019).

This thesis contributed to understanding the function of dedicated innovation space, and the challenges in using such space to meet different stakeholder needs (e.g. Peschl and

Fundneider, 2012). Managing the Hub space involved anticipating stakeholder needs, followed by reconsidering early decisions of how space should be used. In practice, the way collaborators and Hub staff used the space meant that the original Hub design needed to be reviewed. Once the had Hub become operational a better understanding of the types of space needed to support the wider collaborative process developed. Hub space provided a location for internal and external stakeholders to work together on the hospital campus, and collaborate to combine specialise knowledge within an experimental innovation culture (c.f. Saidi, 2017). The Hub environment was distinct from the tightly regulated, risk averse hospital setting. Yet developing the Hub space, to create and oversee a physical and virtual environment, that supported the needs of different stakeholders became an ongoing challenge for Hub staff, especially prior to the introduction of formalised Hub processes (e.g. Sharma and Meyer, 2019, Barlow, 2017).

A significant contribution of this research is offered by considering why changes were made to the management of Hub space, process and collaborators. Exploring these challenges contributed to existing research by demonstrating the complex dynamics of a healthcare Hub, through an analysis of the difference between anticipated requirements and actual needs and expectations (e.g. Gryszkiewicz and Friederici, 2014, Magadley and Birdi, 2009). To understand this, data focused on two groups of Hub stakeholder, Hub staff and clinicians. Over time their role and contribution became more defined as they both learnt how to work closely together to improve the longer term sustainability of the innovation process. This required consideration of the suitability and limitations of Hub staff working as knowledge brokers to improve stakeholder collaboration, and reliance on clinicians as representatives of diverse hospital user groups; the hospital as an organisation, patients and clinical colleagues. Hence, the research contributes to the literature by analysing the complexity of developing a collaborative healthcare innovation hub, including the different objectives, priorities and roles of stakeholders over time.

The concurrence of this research with the early stages of the launch of a Hub led to a better understanding of how growth in learning and staffing numbers were used to implement changes to the use of space and process. These changes reflected a growing appreciation for structure and strategic thinking as a necessary component of the collaborative process.

The relationship between the Hub and main hospital were explored. Hub staff, in particular, had to navigate the challenge of remaining connected with the main hospital and the hub, each having differences in terms of processes, space and operational culture. The use of digital technology as a mechanism for designing new products, in conjunction with a tolerance of risk taking and creative thinking, differentiated the Hub from other healthcare environments in the hospital. Introducing these points of difference without sufficient communication raised questions amongst hospital staff about the purpose and function of the Hub. The research explored the consequence developing a collaborative process when working with a novel Hub space, group of collaborators and absence of imposed process requirements adding an additional healthcare hub case study to existing hub research (e.g. Carstensen et al, 2012, Nystrom et al., 2014, Bjorklund et al., 2017).

The position of the Hub, and its lack of governance and managerial structure created ongoing challenges when designing a collaborative process. For a Hub collaborative process to be effective it was necessary to balance differing stakeholder expectations regarding the role of process in influencing the pace and anticipated outcomes of the development process. The thesis contributes to research on changes to Innovation Hub processes demonstrating the role played by Hub staff in effecting such changes. (e.g. Liedtka et al., 2017, Crupi, 2020). The innovation culture of the Hub, healthcare context and needs of collaborators meant generic innovation processes were ineffective. Rather, it was necessary to appreciate the connection between how Hub space helped enable collaboration, before Hub staff could design a suitable collaborative process.

Implementing process was further complicated by stakeholder preference to use virtual rather than physical Hub space to facilitate collaborative working, due to work-related time constraints impacting the suitability of in person meetings in the Hub space (Peschl and Fundneider, 2012). Thus, understanding how to support development of innovation concepts when collaborators rarely met face-to-face, but held strong often conflicting opinions, expectations and priorities became a key issue. The growing influence of Hub staff provided an interesting contribution made by this study, demonstrating that it was not sufficient to rely on the knowledge and resources of stakeholders to sustain healthcare

innovation. The contributions made by Hub staff in their role as intermediaries provided a feasible solution to addressing emerging issues (e.g. Savory, 2009, Guinan et al., 2019).

Hub staff stabilised Hub development by the combined use of their skills in project and innovation management. They used process as a tool to improve Hub management and provide a structure to multi-stakeholder collaboration. They began working as intermediaries to positively influence the negotiating position of the Hub in collaborative meetings, with a view to protecting Hub assets, particularly relating to clinician's knowledge (Howells, 2006). The influence of strategically-minded Hub staff enabled the Hub to form mutually beneficial working relationships with external organisations. Through combining their skills and resources, novel and potentially financially-lucrative products were pursued, using digital technology to find new ways of supporting patients. Experience of forming relationships with commercial organisations was outside the job experience for founding clinicians. Therefore, requiring clinicians to represent the Hub in these unfamiliar circumstances had left the Hub vulnerable to stakeholder's opportunistic behaviours (cf. Longo and Giaccone, 2017).

Hub staff invested time to learn how to collaborate effectively with clinicians, before using this knowledge to influence Hub process and management. Hub staff became an integral source of functional, strategic and stakeholder support for collaborators. Their role evolved to become a necessary cohesive influence to remedy problems caused by an initial disjointed approach to collaboration. The importance of a needs-led approach to Hub activity remained a key aspect of the Hub purpose (c.f. Aakus et al., 2018, Svensson et al., 2018:277), even though over time, the suitability of continuing to have clinician-led concept development teams was questioned. As the operational responsibilities of leading a concept development team grew, clinicians' limited interest and abilities in this area became apparent. This caused stakeholder tension and impacted their suitability as leaders of concept development teams which needed project management rather than visionary enthusiasm. Led by the Hub staff, Hub collaborators became involved in understanding the link between the role of process and Hub management as contributory factors in viable concept development (Howells, 2006). Thus, initial emphasis on experimentation and creative thinking latterly were appraised during early stages of the development process

contributing to research elsewhere on the role of user participation in healthcare innovation (e.g. Schiavone, 2020, Wrigley, 2020).

A key contribution made by this thesis concerns findings on the management of the multi-stakeholder development process in a healthcare hub (e.g. Sharma and Meyer, 2019). Initially, stakeholders were excited about how the provision of distinctive Hub space, process and collaborative methods would support new ways of working. Over time, stakeholders realised that innovation outcomes stemming from Hub collaboration held potential value beyond provision of a new location for innovation in a hospital setting. Hub team introduced the idea that aspects of the Hub environment and process could be leveraged to strengthen the effectiveness and functionality of the Hub process. Thus, the thesis contributes a detailed analysis which tracked changes in how use of clinicians' time, and functionality of the Hub space were used to attract commercial and research partners to become collaborators (cf. Nicolopoulou, 2017, Savory, 2009, Hyysalo and Johnson, 2013). Over time, tensions emerged between aspects of innovation culture and managing the innovation process so the Hub could seek to operate in a self-sustaining manner. The Innovation Governance Process sought to provide sufficient capacity and focused support to collaborators, whilst providing a transparent structure for the innovation process.

To summarise this thesis makes five main contributions to the literature. First, the thesis provides a case study to help understand the role and development of Innovation Hubs in a healthcare setting. This detailed approach has enabled an analysis that fills a gap in our knowledge, illuminating the variety of motivations for stakeholder involvement in a hub. Hence, research on hubs, in whatever setting, need to consider the various reasons for stakeholder involvement, their motivations and constraints which will inevitably influence the particular pathway of development.

Second, the case study has allowed an in-depth analysis of hub development in a specific context, a healthcare setting. The research provided an analysis of the dynamics of managing a collaborative innovation process in a paediatric NHS healthcare Hub with a focus on better understanding evolving operational, process and stakeholder requirements. With origins in the founding motivations of the Hub and access to novel types of resource,

the collaborative process evolved to require increased structure and formalised management to be an effective. This focus on a hub within a hospital is both unique and highly relevant when developing an understanding of innovation in a highly regulated environment. This has implications for sectors where user and operational needs require dedicated space and resource to balance the demands of ongoing service delivery whilst being innovative and experimental at the same time.

Third the thesis captured the point at which the innovation process is recognised as important in sustaining the development of viable products, that are capable of meeting diverse stakeholder priorities. Hence this research has shown how process supports and tempers stakeholders' individual expectations for the benefit of hub sustainability. Hitherto, there has been little research on this aspect of hub development.

Fourth, the thesis examined the suitability of a hospital healthcare Hub as a facility to lead collaborative innovation. The thesis documented and critically analysed changes made during the Hub's development which seek to resolve issues that emerged from the start up stage of the operation. Although longitudinal research on the process of innovation is plentiful, a focus on the process in a healthcare context hub is scarce. This contribution highlights in particular, the importance of planning, communication and negotiation between stakerholder and hub management staff.

Finally, the thesis critically analysed the importance of key innovation actors: clinicians and Hub staff. The role and contribution of clinicians, acting as representatives of hospital users in the collaborative process, highlighting limitations and strengths of responding to user needs. The role and contribution of Hub staff were examined, demonstrating the importance of their innovation management experience to support Hub development and the collaborative process. Hub staff led attempts to resolve stakeholder tensions through the implementation of processes to improve the transparency and structure of decisions made in the hub. Their influence as intermediaries provided opportunities to address otherwise unallocated areas of Hub management. This included addressing opportunistic stakeholder behaviour, protection of Hub assets and improved stakeholder knowledge of organisational issues within the healthcare sector. Investment into skilled Hub resource

enabled improvements to be made to the use of process, strategy and relationship management which in turn improved clarity of stakeholder contribution during stages of the collaborative process. However it is expected that Hub collaboration will continue to require further changes to process and management as the needs of the Hub space, process and stakeholders continue to evolve. This analysis contributed a detailed understanding of the management processes required in such a context.

7.3 Contribution to Practice - implications for Healthcare Innovation Hub management

The findings from this research make a valuable contribution understanding user-led healthcare innovation Hubs. The study has also raised important practical questions regarding how hospital-based innovation space was actually used. Specifically, the provision of a dedicated facility raises practical questions for internal and external stakeholders on how the available space will be used. Development of an onsite Hub can be an effective indication to employees that the hospital values their contribution to improving healthcare delivery and service quality. The Hub can provide clinical staff with opportunities to explore their ideas for an improved public health service. Thus, access to a hub could be used as a tool for recruitment and job enrichment benefitting clinicians and hospital managers. The addition of the Hub on the hospital campus represented new ways for clinicians to use experiential and tacit knowledge gained in the medical and social aspects of their roles.

In a hospital setting a Hub also represented opportunities for new collaborations, as external stakeholders were now able to access the hospital campus. This created excitement for potential innovation outcomes made possible through collaboration between commercial and research organisations and hospital stakeholder and user groups. The location of the Hub enabled the hospital to influence the innovation process and affect product development through providing a suitable environment for collaborative innovation. The Hub located was intended to inform the development process and increase alignment between the functionality of new products and existing hospital processes and stakeholder needs. Therefore it became important to manage the expectations of internal and external stakeholders who sought different innovation outcomes following their engagement in the Hub space. Unlike Hubs described elsewhere (e.g. Sharma and Meyer,

2019:89), this Hub was not functioning as a dynamic location for casual stakeholder interaction, within a space for creative experimentation. Nor was valuable clinical knowledge easily accessible to external stakeholders seeking access by visiting the Hub space. Thus finding a way to balance stakeholder tensions was identified as a key challenge for Hub management to ensure a collaborative process.

This research justified the importance of understanding the types of resources needed to support early stage concept development. The healthcare context introduced issues of conflicting stakeholder innovation drivers in which the clinician-led design of aspirational products to support patient experience were challenged from commercial and operational perspectives. The development of a Healthcare Hub brought together different stakeholders from the healthcare sector in a new way. Despite their different priorities, stakeholders valued the Hub as a facility which enabled user knowledge to become a resource to inform the design of products. Furthermore, the potential to increase operational, social and commercial alignment between the design of new products and the with specific needs of hospital users and systems were highly regarded.

However, this study emphasised that establishing an onsite Hub was not a simple solution to overcoming the challenges to healthcare innovation. Rather, as the analysis showed, the complexities of hospital organisational culture present distinct management challenges in relation to innovation. Therefore, careful consideration was needed to understand how the Hub facility could function as an environment to support a collaborative innovation process in which the skills and resources of different innovation actors with differing priorities and expectations became intertwined. The Hub environment was not able to apply generic innovation or healthcare processes to manage this innovation process. Furthermore, the distinctive element of being 'user-led' contributed to the challenges as the innovation process progressed. In a Hub environment experimentation, failure and novel approaches are an accepted part of the concept development process. This study showed the importance of contextualising these differences within the wider structured innovation process so clinicians appreciated the place of creative thinking as an initial stage of the innovation process. Differences between necessary elements of the highly regulated

environment of the hospital and innovation culture of the Hub required explanation due to their stark differences which were difficult for stakeholders to understand.

This thesis concludes that although establishing a Hub has the potential to extend hospital activities in a positive way, it required a different approach to management and use of process from the main hospital environment. Often these requirements were outside the usual areas of competency of hospital staff. Therefore careful consideration was needed to ensure the Hub was staffed by a team with the necessary innovation, stakeholder and project management experience. It was important that Hub staff took ownership of a key series of Hub functions. Their role considered how to coordinate the contributions and requirements of stakeholders as part of a management approach that successful supervised the collaborative innovation process. As part of this task it was vital that the Hub developed a distinct operational culture, management style and operational process. These characteristics were necessary to provide clarity to stakeholders on the purpose and approach were used in the Hub as a way of managing their expectations on pace, stakeholder contributions and innovation outcomes. The thesis demonstrated how developments in Hub management contributed to an ongoing process of developing these characteristics.

This research explored how clinicians had been of central importance to the creation and start-up phases of the Hub. The freedom granted to founding clinicians to explore ways for the Hub to develop, enabled them to become involved in aspects of project leadership that were outside their conventional areas of interest and competence. This led to an underappreciation of the administrative and strategic aspects of Hub development by founding clinicians who were focused on pursuing collaborative opportunities granted access to resources to support product development. The evidence found that hospital managers and founding clinicians had underestimated the complexity of the collaborative innovation process. Thus, despite increased opportunities work in a less regulated manner in the Hub facility, it was important to work methodically to avoid becoming involved in costly, unsustainable collaborative projects which risked damaging relationships with important commercial and research focused collaborators.

The thesis critically analysed the suitability of clinicians as representatives of other user needs. This provided insight for hospital managers who are interested in improving patient experience by using a knowledge led person centred approach. Despite personal motivation to overcome challenges faced in the hospital environment, the demanding work schedule of clinicians restricted their time for innovation activity. The study showed how flexibility in the Hub organisational culture had found a way through challenges that emerged, initially using clinicians and latterly Hub staff as resources to respond to emerging issues in the innovation process. However, as the use of process enabled the Hub to function in a more organised manner, weaknesses in the initial approach were becoming more apparent. Therefore Hub staff were seeking to better define and coordinate the contributions of different innovation actors. A current gap that had been acknowledged was the importance of responding to user needs, and improving the process so different types of user could become involved in a safe and ethical manner.

This research drew attention to the complexity of innovating in healthcare and why a collaborative approach requires sufficient resource to sustain the non-linear lengthy process of development. Thus, understanding the challenges associated with innovating, especially when pursuing development of radical new products requires acceptance that innovation outcomes will be evident in the longer rather than shorter term. Therefore expectations at a hospital organisational level should be considered to see if it is realistic for the non-linear, resource intensive innovation process to be accommodate within a sector already experiencing a number of significant challenges. Finally, prior to developing a hospital based Hub it is important to reflect on the relationship between the Hub and the hospital. Exploring hospital management perspectives on the amount of autonomy, financial support and access to hospital resources the Hub will be given are important considerations. Additionally new relationships with external organisations require forethought in terms of the extent and type of contribution, and what will be agreed in return in terms of intellectual property and anticipated sales revenue. As illustrated in this study, the hospital should anticipate requests to make adjustments to hospital process and workload models to enable user involvement. These factors will all impact how and at what pace the Hub develops.

Practitioners are advised to consider the potential scope and breadth of opportunities which can arise from pursing a collaborative approach to healthcare innovation. Healthcare Hubs can provide opportunities to enrich and extent capabilities the hospital managers can draw on when responding to operational and service quality challenges that impact healthcare delivery. However, developing and managing a Hub in a sustainable manner requires due consideration of the challenges highlighted in this thesis. Therefore, it is important for hospital managers to spend time reflecting on the role and contribution stakeholders within a multi-stakeholder innovation process prior to and at regular intervals during Hub development. This will provide opportunities for Hub and Hospital staff to discuss differences approach between hospital and innovation management, and how this links to the design and use of process. Building understanding of the Hub approach to healthcare innovation is important as a way to balance stakeholder expectations. As this study has shown, beginning this dialogue prior to commencing Hub activities can avoid creation of misunderstanding and unrealistic expectations. Rather than the Hub replicating linear processes, an understanding of the nature of the innovation process will develop and require time to become appreciated given the differences to approaches used in the hospital. Although challenges will continue to emerge, awareness of issues raised in this thesis will contribute to helping hospital and Hub managers will learn how to work together. This relationship will rely on a willingness to regularly re-evaluate how effectively the hospital and Hub are working together. Development of a healthcare Hub requires a critical approach to reassessing how the innovation process aligns with Hub purpose and anticipated innovation outcomes in light of emerging limitations and challenges.

7.4 Recommendations for further research and limitations

Although this thesis has made a significant contribution to a number of elements of healthcare innovation Hubs, each with a connected literature many opportunities exist to make further contributions to these literatures. However this study is subject to several limitations which could be addressed in future studies. Firstly this thesis focuses on one example of a healthcare Hub. Therefore future studies which are designed to collect data from multiple Hubs would provide an opportunity to assess the generalisability and potential bias in findings that are collected from one case example. Secondly, due to

difficulties accessing patients as an important group of healthcare users, their perspective on how their needs could be best represented as part of a collaborative innovation process could not be included. Similarly, due to time constraints associated with the duration of a PhD data collection process it was difficult to secure time to interview all relevant Hub staff and clinicians working in this Hub facility. Furthermore, as a limited amount of clinicians were involved in this Hub, it is possible that the perspectives included in this study would not be reinforced in the event of being able to sample a larger proportion of hospital staff.

Thus, a number of opportunities exist to make further contributions to the literature. During this thesis two specific areas for further research emerged as important to understand collaborative healthcare hubs. The first relates to the contribution of Hub staff as boundary spanners. The importance of Hub staff in sustaining the Hub emerged as a key finding, adding to calls for research to understand their contribution (e.g. Howells, 2006, Guinan et al, 2019). Further work is needed to explore how stakeholder connectivity and knowledge is supported by intermediaries who address barriers to effective collaboration in healthcare settings (e.g. Long et al 2013). This includes managing the innovation process and facilitating collaboration between clinicians, commercial partners and university researchers. Second, additional research on documenting job roles and responsibilities during stages of the concept development is required. Of particular importance is developing an understanding of the nature of their working relationships with and between different stakeholder groups, and how this contributes to the innovation process. Hence, research may explore how boundary spanners seek to overcome challenges experienced by stakeholders. These challenges include time constraints, knowledge and skills gaps and the development of stakeholder relationships. Potential research questions could include:
- How effectively do boundary spanners contribute to addressing key challenges in multi-stakeholder healthcare collaboration?
- How do the aims of boundary spanning activity mitigate collaborative innovation challenges in a hospital, or broader healthcare settings?

A second area for further research relates to the suitability of digital space to support user-led collaborative healthcare innovation projects. The complexity of locating dedicated innovation spaces in hospitals raises questions about how types of space support particular

stakeholders and collaborators. The literature introduced the concept of digital innovation hubs (Crupi et al 2020) and how using different types of space contributed to the innovation process (Peschl and Fundneider 2012). There is a gap in understanding the function and uses of digital spaces as part of collaborative health innovation. This thesis suggests that physical location and in person interaction were not sufficient to sustain collaborative healthcare innovation. Thus the use of digital space emerged as an approach to manage clinician's involvement. Further work is needed to explore the suitability and challenges of using digital space to interact with different stakeholders in this context. Research could explore and document:

-An understanding of the balance between physical and digital space in healthcare innovation.

- The anticipated and actual role of physical and digital spaces to support innovation.

- How the function and importance of these spaces change during stages of the innovation lifecycle.

Potential research questions could explore the balance of using physical and digital spaces in hospital-based innovation including:

- How are ethical factors in healthcare innovation (e.g. data management) managed in physical and digital spaces?

- How are types of space used to support the management of stakeholder expectations (e.g. project pace)?

- How do the use and function of digital spaces develop to respond to health innovation challenges (e.g. hub visibility, stakeholder availability)?

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Appendices

Appendix One Template Analysis Stage One.

Organisational Culture - OC	Policy and Strategy - PS
o Hub creates new ways to engage with stakeholders. OC o Hub vision & culture is seen as empowering for hospital. OC o Difference between NHS and External Culture - Processes - Expectations – Pace OC ▪ Differences in clinical evidence based problem solving and innovation problem solving approaches; different conceptualisations and levels of risk/failure. OC ▪ Hospital studied is seen as innovative within the NHS. NHS focused on serving the public as patients and their continually changing needs. IH vision to support young people achieve their potential, and remain engaged with health services as adults. OC ▪ Stakeholder disagreement about purpose of innovation. OC ▪ Broader NHS climate of cost saving, stream-lining, cutting back, reducing staff positions where possible leads to reluctance from staff to share ideas if they fear they would result in job losses. OC ▪ Capacity pressures; rise of self-care, at home monitoring, user finding information – links to prevention rather than treatment at point of crisis. OC	o Topical nature of health innovation – multiple stakeholders interested in the multiple potential outcomes/benefits. PS o Needs Led approach to projects to locally serve and patients and staff. PS o Balancing stakeholder needs, direction of projects and processes. PS ▪ Difference between clinical evidence based prioritisation perspective, and project prioritisation from externally informed rationale. PS ▪ Using internal knowledge and expertise in health to inform innovation. PS ▪ Connection/alignment between NHS Quality Criteria and work of the Hub; link to broader aims and measurements of quality – value linked to the provision of 'opportunity to play' whilst in hospital. PS ▪ Different strategic vision of Hub requires different management style; value gained from being opportunistic? PS ▪ Improve patient experience and add capacity through introduction of digital health innovations. PS

Key
o   1st draft template analysis themes (4 transcripts)
▪   2nd draft template analysis themes (10 transcripts)
◊   3rd draft template analysis themes (all transcripts)

324

◊ Wider organisational culture within the hospital broadly 'kills innovation' – started for wrong reason, unrealistic expectations, lack of resource and lack of achievable strategy. OC ◊ Other NHS Bodies and Trusts are also potential customers for innovations created in IH - nothing is free/freely shared. NHS has locally managed budgets and local decision making around resources. OC ◊ Issue of longer term project work which has to fit in with annually allocated NHS budget and financial reporting cycles/measurement. OC ◊ Analogy of Hospital as a theme park – scary but with right access to information, enables you to deal with the scary bits and doesn't stop you returning. OC ◊ Fragmented nature of the NHS leading to reinvention of the wheel and not invented here syndrome issues. OC ◊ Broader NHS digitalisation strategy – way behind, lack of infrastructure, outdated processes and pathways, ability to absorb current technology operational requirements from new systems/innovations. OC	◊ Importance of approaching Innovation from Problem based/Needs Led angle rather than Solutions Perspective (deep understanding is vital). PS
People - P o People working in healthcare and connected organisations have specialised expertise and skills, important for innovation. P o Time vs Task – understanding that the time spent on innovation projects could also be spent working as part of the hospital	**Value/Impact Signs and Measurement - VIM** o Potential to: - Capitalise on/use tacit knowledge – create change/problem solve. VIM o Value of intangible outcomes of innovation to demonstrate value/impact (especially pre-evaluation) VIM o Impact on improving the Patient Experience. VIM

Key

o 1st draft template analysis themes (4 transcripts)

▪ 2nd draft template analysis themes (10 transcripts)

◊ 3rd draft template analysis themes (all transcripts)

employees main job, constantly pressure and short term vs longer term benefits of choices over where time is spent. P o Importance of Tacit knowledge for the Innovation Process P o HR functions of IH staff within their role. P ▪ Importance of Leadership, and Compassionate Leadership to help with staff engagement. P ▪ Clinical staff not motivated by potential financial gains from innovation, they want fair treatment, to share best practice and to be valued in NHS. P ▪ Personal connection between staff and why they work for the NHS, and why they are involved in Innovation. P ▪ Value of internal staff networks for progressing with innovation amid the challenges of NHS bureaucracy. P	▪ Value and Impact expressed as 'benefits' in terms of money, improved quality, improved patient experience and improved health literacy (learning and understanding) Recent internal involvement of Business Intelligence team with Hub – extracting value from data collected. VIM

Process - PR
 	
o Hub History and IH staff recognition of distinct developmental stages. PR
o Pioneer Challenges – initial challenges in Hub process:
  - Lack of established policy   - Position vs similar dept
  - Securing Finance   - Sustainability
  - Est. new processes including due diligence
  - Lack of thought re adoption processes. PR
o Barriers to IH process
  -   NHS Process – Pace of Progress – Time vs Staff demands. PR
▪ Not just about invention, also about deployment (adoption/diffusion), high rates of funding for invention, low
	Purpose - PU
	
	o Need to create IH processes and structures. PU
	o IH is a way to realise Hospital aspirations of innovation through Hub as dedicated resource. PU
	o IH as a Space for – Collaboration – Development of Innovation Culture. PU
	o IH space has the capacity to - Motivate – Educate – Manage and Define Innovation. PU
	o IH aims to improving Health Literacy and Health Outcomes (mental and physical). PU

Key
o 1st draft template analysis themes (4 transcripts)
▪ 2nd draft template analysis themes (10 transcripts)
◊ 3rd draft template analysis themes (all transcripts)

rates for deployment. Effective diffusion needs to be set up and then closely managed – counterproductive external pressure from stakeholders for pace, and to see tangible results. PR ▪ Issues meeting criteria to receive grants based funding. PR ▪ Clinicians involvement redirected as professional team members have been hired. PR ▪ Early stage development of Hub aided by lack of understanding from Hospital staff which gave scope for unmonitored decision making/progress. PR ◊ Need for project management of projects by IH staff, especially in early stages. PR ◊ Barrier – retrospectively trying to resolve project issues to enable qualification for continued finance (lack of strategic management of some early projects). PR	▪ Innovation as a method to assist in preventative health care – avoid crisis points being reached which pressurise NHS. PU ▪ Hopes to move from NHS treating illness to NHS which benefits from investing in patient journey, meeting broader holistic patient needs, improving access to and provision of information, supporting prevention agenda. PU ▪ Innovation to provide support to patients and families transitioning from paediatric to adult services. PU ◊ Changes in patient expectations – care options, use of tech/digital. PU ◊ Hub holding a role as a key communicator and space for communication between stakeholders. Hub as a neutral space which is accessible for external stakeholders. PU
Product - PRD o Digital/Technology based approach to innovation. PRD o Portfolio based approach – joint revenue focus and social focus. PRD o Need to adhere to regulatory standards, ethics codes, effective testing. PRD o Needs Led, Person Centred approach to designing new products. PRD	**Performance - PRF** o Stakeholder tension related to several main issues/differences of opinion regarding – pace – hub role – hub purpose – demonstration of hub progress. PRF o Current management review of IH by hospital with a view to a formalisation of Hub activities and processes. PRF o Importance of Needs Led approach to meet clinicians' objectives. PRF

Key
o 1st draft template analysis themes (4 transcripts)
▪ 2nd draft template analysis themes (10 transcripts)
◊ 3rd draft template analysis themes (all transcripts)

o Useful to showcase Products still under development when possible, especially with high app base/tech focus of innovation products. PRD
 	
o IH staff Work to maximise adoption requires change in mindset
  - Innovations are additional cost – require process change
  - Staff, parents and patients need educating as to the benefits PRD
 	
▪ Products focused in Digital and MedTech underpinned by Artificial Intelligence, Augmented Reality or Virtual Reality with corresponding consulting stream linked to a clinician. PRD
 	
▪ Importance of adherence to Quality and Compliance standards. PRD
 	
▪ Information from interviewees related to current projects in progress. PRD
 	
◊ Products developed through support delivered by Hub as part of larger collaborative funded project. PRD
	o Value of clinicians' involvement to steer, critique, and align ideas in development to NHS needs for easy adoption. PRF
	
	o Value of additional clinical skills brought into NHS by clinicians attracted to work in IH team. PRF
	
	▪ Issue regarding Hospital staff not realising the commercial value of their clinical knowledge. PRF
	
	▪ Expectation of patients to be able to personalise their health care journey. PRF
	
	◊ Socially motivated aims of staff desires need to be balanced with operational needs for IH to be a self-sustaining department. PRF
	
	◊ Lack of ability to meet expectation generated from open events like Hackathons, creates damage to external relationships. PRF
	
	◊ Opinion that Innovation should be designed and managed to meet the Tenants of Healthcare; safe, effective, timely, equitable and patient focused. PRF
	
	◊ Recognition of level of resources needed to execute proposed idea vs resources that are already available. PRF
	
	◊ Innovation can produce scalable resources, allowing for the prioritisation of human resource, and extending and enhancing service provision/hospital capacity. PRF

Promotion - PRO	**Partnerships and Collaboration - PC**
o Appropriately direct external interest from organisations by having opportunity to work with and within the IH. PRO	o Managing differences in organisation operational cultures and connected expectations. PC

Key
o 1st draft template analysis themes (4 transcripts)
▪ 2nd draft template analysis themes (10 transcripts)
◊ 3rd draft template analysis themes (all transcripts)

o Existing need to address current issues with effective internal visibility and communication of IH activities and purpose. PRO o IH need to interact internally within hospital to: Educate, Inspire and motivate staff and patient users to get involved with Innovation Hub Activity. PRO ▪ Issues resulting from a current lack of Hub Communications Plan. PRO ◊ Existing need to overcome misrepresentations of Hub with Internal Staff. PRO ◊ Broader issue regarding innovation in healthcare and how it is managed linked to the stress caused for staff when changes are introduced (lack of time to manage process, train and be trained). PRO	o Value of the Hub and the collaboration relationships that are developed – Access to skilled staff etc for external organisations. PC o Skills needed to build, support and sustain partnerships: - Protect value of knowledge – Negotiate contracts and IP protection – Navigate issues for externals with NHS Processes. PC ▪ Advantages/Disadvantages of collaborations for NHS. PC ▪ Benefits for NHS/IH to be gained from partner organisation's skills (trade-off between added complexity and gains in skills) PC ▪ Different challenges arising from partnering with SME's and larger organisations. PC ▪ Partnerships currently in progress (Inc Virtual Reality Project, Innovation Health Exchange, Hartree Chatbot and Acorn). PC

Key
o 1st draft template analysis themes (4 transcripts)
▪ 2nd draft template analysis themes (10 transcripts)
◊ 3rd draft template analysis themes (all transcripts)

Appendix Two Template Analysis Stage Two.

Management of Innovation Hub
- Stakeholder disagreement about purpose of innovation. OC   - Needs Led approach to projects to locally serve and patients and staff. PS   - Balancing stakeholder needs, direction of projects and processes. PS   - Different strategic vision of Hub requires different management style; value gained from being opportunistic? PS   - Analogy of Hospital as a theme park – scary but with right access to information, enables you to deal with the scary bits and doesn't stop you returning. OC   - Time vs Task – understanding that the time spent on innovation projects could also be spent working as part of the hospital employees' main job, constantly pressure and short term vs longer term benefits of choices over where time is spent. P   - HR functions of IH staff within their role. P   - Importance of Leadership, and Compassionate Leadership to help with staff engagement. P   - Value of internal staff networks for progressing with innovation amid the challenges of NHS bureaucracy. P   - Pioneer Challenges – initial challenges in Hub process: - Lack of established policy   - Position vs similar dept - Securing Finance   - Sustainability – Establishing new processes including due diligence. - Lack of thought re adoption processes. PR   - Not just about invention, also about deployment (adoption/diffusion), high rates of funding for invention, low rates for deployment. Effective diffusion needs to be set up and then closely managed – counterproductive external pressure from stakeholders for pace, and to see tangible results. PR   - Issues meeting criteria to receive grants based funding. PR   - Barrier – retrospectively trying to resolve project issues to enable qualification for continued finance (lack of strategic management of some early projects). PR   - Clinicians involvement redirected as professional team members have been hired. PR   - Need to create IH processes and structures. PU   - Digital/Technology based approach to innovation. PRD   - Portfolio based approach – joint revenue focus and social focus. PRD   - Need to adhere to regulatory standards, ethics codes, effective testing. PRD   - Needs Led, Person Centred approach to designing new products. PRD

- IH staff Work to maximise adoption requires change in mindset PRD
- Innovations are additional cost – require process change PRD
- Staff, parents and patients need educating as to the benefits PRD.
- Socially motivated aims of staff desires need to be balanced with operational needs for IH to be a self-sustaining department. PRF
- Opinion that Innovation should be designed and managed to meet the Tenants of Healthcare; safe, effective, timely, equitable and patient focused. PRF
- IH need to interact internally within hospital to: Educate, Inspire and motivate staff and patient users to get involved with Innovation Hub Activity. PRO
- Issues resulting from a current lack of Hub Communications Plan. PRO
- Existing need to overcome misrepresentations of Hub with Internal Staff. PRO
- Managing differences in organisation operational cultures and connected expectations. PC
- Skills needed to build, support and sustain partnerships. PC
- Protect value of knowledge – Negotiate contracts and IP protection – Navigate issues for externals with NHS Processes. PC

Collaborative Spaces

- Hub creates new ways to engage with stakeholders. OC
- Hub History and IH staff recognition of distinct developmental stages. PR
- Early stage development of Hub aided by lack of understanding from Hospital staff which gave scope for unmonitored decision making/progress. PR
- Need for project management of projects by IH staff, especially in early stages. PR
- IH is a way to realise Hospital aspirations of innovation through Hub as dedicated resource. PU
- IH as a Space for – Collaboration – Development of Innovation Culture. PU
- IH space has the capacity to - Motivate – Educate – Manage and Define Innovation. PU
- Hub holding a role as a key communicator and space for communication between stakeholders. Hub as a neutral space which is accessible for external stakeholders. PU
- Useful to showcase Products still under development when possible, especially with high app base/tech focus of innovation products. PRD
- Appropriately direct external interest from organisations by having opportunity to work with and within the IH. PRO

Collaborative Processes
• Difference between NHS and External Culture - Processes - Expectations – Pace OC
• Differences in clinical evidence based problem solving and innovation problem solving approaches; different conceptualisations and levels of risk/failure. OC
• Wider organisational culture within the hospital broadly 'kills innovation' – started for wrong reason, unrealistic expectations, lack of resource and lack of achievable strategy. OC
• Difference between clinical evidence based prioritisation perspective, and project prioritisation from externally informed rationale. PS
• Using internal knowledge and expertise in health to inform innovation. PS
• Importance of approaching Innovation from Problem based/Needs Led angle rather than Solutions Perspective (deep understanding is vital). PS
• Importance of Tacit knowledge for the Innovation Process P
• Products focused in Digital and MedTech underpinned by Artificial Intelligence, Augmented Reality or Virtual Reality with corresponding consulting stream linked to a clinician. PRD
• Importance of adherence to Quality and Compliance standards. PRD
• Information from interviewees related to current projects in progress. PRD
• Products developed through support delivered by Hub as part of larger collaborative funded project. PRD
• Stakeholder tension related to several main issues/differences of opinion regarding – pace – hub role – hub purpose – demonstration of hub progress. PRF
• Importance of Needs Led approach to meet clinicians' objectives. PRF
• Different challenges arising from partnering with SME's and larger organisations. PC
• Partnerships currently in progress (Inc Virtual Reality Project, Innovation Health Exchange, Hartree Chatbot and Acorn). PC

Innovation Outcomes
• Hub vision & culture is seen as empowering for hospital. OC
• Hospital studied is seen as innovative within the NHS. NHS focused on serving the public as patients and their continually changing needs. IH vision to support young people achieve their potential, and remain engaged with health services as adults. OC
• Topical nature of health innovation – multiple stakeholders interested in the multiple potential outcomes/benefits. PS
• Improve patient experience and add capacity through introduction of digital health innovations. PS

- Other NHS Bodies and Trusts are also potential customers for innovations created in IH - nothing is free/freely shared. NHS has locally managed budgets and local decision making around resources. OC
- Clinical staff not motivated by potential financial gains from innovation, they want fair treatment, to share best practice and to be valued in NHS. P
- Potential to: - Capitalise on/use tacit knowledge – create change/problem solve. VIM
- Value of intangible outcomes of innovation to demonstrate value/impact (especially pre-evaluation) VIM
- Impact on improving the Patient Experience. VIM
- Value and Impact expressed as 'benefits' in terms of money, improved quality, improved patient experience and improved health literacy (learning and understanding) Recent internal involvement of Business Intelligence team with Hub – extracting value from data collected. VIM
- IH aims to improving Health Literacy and Health Outcomes (mental and physical). PU
- Innovation as a method to assist in preventative health care – avoid crisis points being reached which pressurise NHS. PU
- Hopes to move from NHS treating illness to NHS which benefits from investing in patient journey, meeting broader holistic patient needs, improving access to and provision of information, supporting prevention agenda. PU
- Innovation to provide support to patients and families transitioning from paediatric to adult services. PU
- Value of additional clinical skills brought into NHS by clinicians attracted to work in IH team. PRF
- Lack of ability to meet expectation generated from open events like Hackathons, creates damage to external relationships. PRF
- Innovation can produce scalable resources, allowing for the prioritisation of human resource, and extending and enhancing service provision/hospital capacity. PRF
- Value of the Hub and the collaboration relationships that are developed – Access to skilled staff etc for external organisations. PC
- Benefits for NHS/IH to be gained from partner organisation's skills (trade-off between added complexity and gains in skills) PC

Organisational Context/Climate

- Broader NHS climate of cost saving, stream-lining, cutting back, reducing staff positions where possible leads to reluctance from staff to share ideas if they fear they would result in job losses. OC
- Capacity pressures; rise of self-care, at home monitoring, user finding information – links to prevention rather than treatment at point of crisis. OC
- Connection/alignment between NHS Quality Criteria and work of the Hub; link to broader aims and measurements of quality – value linked to the provision of 'opportunity to play' whilst in hospital. PS

- Issue of longer term project work which has to fit in with annually allocated NHS budget and financial reporting cycles/measurement. OC
- Fragmented nature of the NHS leading to reinvention of the wheel and not invented here syndrome issues. OC
- Broader NHS digitalisation strategy – way behind, lack of infrastructure, outdated processes and pathways, ability to absorb current technology operational requirements from new systems/innovations. OC
- Personal connection between staff and why they work for the NHS, and why they are involved in Innovation. P
- Barriers to IH process due to broader NHS Process – Pace of Progress – Time vs Staff demands. PR
- Changes in patient expectations – care options, use of tech/digital. PU
- Issue regarding Hospital staff not realising the commercial value of their clinical knowledge. PRF
- Expectation of patients to be able to personalise their health care journey. PRF
- Recognition of level of resources needed to execute proposed idea vs resources that are already available. PRF
- Existing need to address current issues with effective internal visibility and communication of IH activities and purpose. PRO
- Broader issue regarding innovation in healthcare and how it is managed linked to the stress caused for staff when changes are introduced (lack of time to manage process, train and be trained). PRO
- Advantages/Disadvantages of collaborations for NHS. PC

First order theme initial categories

Organisational Culture - OC
Policy and Strategy - PS
People – P
Value/Impact Signs and Measurement – VIM
Process – PR
Purpose - PU
Product – PRD
Performance – PRF
Promotion – PRO
Partnerships and Collaboration - PC

Appendix Three Template Analysis Stage Three.

Template Analysis Stage 2	Template Analysis Stage 3
Management of Hub (Stage 2 Categories ex Literature)	Management of Hub - Sub-categories
- Stakeholder disagreement about purpose of innovation. OC - Needs Led approach to projects to locally serve and patients and staff. PS - Balancing stakeholder needs, direction of projects and processes. PS - Different strategic vision of Hub requires different management style; value gained from being opportunistic? PS - Analogy of Hospital as a theme park – scary but with right access to information, enables you to deal with the scary bits and doesn't stop you returning. OC - Time vs Task – understanding that the time spent on innovation projects could also be spent working as part of the hospital employees' main job, constantly pressure and short term vs longer term benefits of choices over where time is spent. P - HR functions performed by IH staff as part of their role. P - Importance of Leadership, and Compassionate Leadership to help with staff engagement. P - Value of internal staff networks for progressing with innovation amid the challenges of NHS bureaucracy. P - Pioneer Challenges – initial challenges in Hub process: - Lack of established policy - Position vs similar dept - Securing Finance - Sustainability – Establishing new processes	**Managing Internal Relationships** - HR functions performed by IH staff as part of their role. P - Importance of Leadership, and Compassionate Leadership to help with staff engagement. P - IH staff work to maximise adoption of innovations which requires creating a change in mindsets. PRD - Value of internal staff networks for progressing with innovation amid the challenges of NHS bureaucracy. P **Balancing stakeholder and project requirements – the roles of Hub staff** - Balancing differing stakeholder needs in conjunction with projects objectives and the connected processes. PS - Time vs Task – understanding that the time spent on innovation projects could also be spent working as part of the hospital employees' (clinicians/nurses) main job. This creates a need for management of this constant pressure point, and short term vs longer term benefits of choices over where hospital employees time is spent. P - Hub staff need to sustain Hub performance by balancing the socially motivated needs-led aims of hospital staff with the

including due diligence. - Lack of thought re adoption processes. PR

- Not just about invention, also about deployment (adoption/diffusion), high rates of funding for invention, low rates for deployment. Effective diffusion needs to be set up and then closely managed – counterproductive external pressure from stakeholders for pace, and to see tangible results. PR
- Issues meeting criteria to receive grants based funding. PR
- Barrier – retrospectively trying to resolve project issues to enable qualification for continued finance (lack of strategic management of some early projects). PR
- Clinician's involvement redirected as professional team members have been hired. PR
- Need to create IH processes and structures. PU
- Digital/Technology based approach to innovation. PRD
- Portfolio based approach – joint revenue focus and social focus. PRD
- Need to adhere to regulatory standards, ethics codes, effective testing. PRD
- Needs Led, Person Centred approach to designing new products. PRD
- IH staff Work to maximise adoption requires change in mindset PRD
- Implementing Innovations result in additional costs – requires wider process change PRD
- Staff, parents and patients need educating as to the multiple benefits of innovation PRD.

Hub's operational needs in order for the IH to be a self-sustaining department. PRF

- Hub staff need to use specific skills to build, support and sustain partnerships:
Protect value of knowledge – Negotiate contracts and IP protection – Navigate issues for externals with NHS Processes. PC

Developing internal awareness around purpose of Hub and innovation projects

- Staff, parents and patients need educating as to the multiple benefits of innovation PRD.
- IH need to interact internally within hospital to: Educate, Inspire and motivate staff and patient users to get involved with Innovation Hub Activity. PRO
- Existing need to overcome misrepresentations of Hub with Internal Staff. PRO

Innovation Culture

- Needs Led approach to projects to locally serve and patients and staff. PS
- Different strategic vision of Hub requires different management style; value gained from being opportunistic? PS
- Analogy of Hospital as a theme park – scary but with right access to information, enables you to deal with the scary bits and doesn't stop you returning. OC
- Clinician's involvement redirected as professional team members have been hired. PR

- Socially motivated aims of staff desires need to be balanced with operational needs for IH to be a self-sustaining department. PRF
- Opinion that Innovation should be designed and managed to meet the Tenants of Healthcare; safe, effective, timely, equitable and patient focused. PRF
- IH need to interact internally within hospital to: Educate, Inspire and motivate staff and patient users to get involved with Innovation Hub Activity. PRO
- Issues resulting from a current lack of Hub Communications Plan. PRO
- Existing need to overcome misrepresentations of Hub with Internal Staff. PRO
- Managing differences in organisation operational cultures and connected expectations. PC
- Skills needed to build, support and sustain partnerships: Protect value of knowledge – Negotiate contracts and IP protection – Navigate issues for externals with NHS Processes. PC

- Digital/Technology based approach to innovation. PRD
- Portfolio based approach – joint revenue focus and social focus. PRD
- Needs Led, Person Centred approach to designing new products. PRD
- Opinion that Innovation should be designed and managed to meet the Tenants of Healthcare; safe, effective, timely, equitable and patient focused. PRF
- Managing differences in organisation operational cultures and connected expectations. PC

Developing Hub Capabilities

- Pioneer Challenges – initial challenges in Hub process: - Lack of established policy   - Position vs similar dept - Securing Finance   - Sustainability – Establishing new processes including due diligence. - Lack of thought re adoption processes. PR
- Not just about invention, also about deployment (adoption/diffusion), high rates of funding for invention, low rates for deployment. Effective diffusion needs to be set up and then closely managed – counterproductive external pressure from stakeholders for pace, and to see tangible results. PR
- Issues meeting criteria to receive grants based funding. PR
- Barrier – retrospectively trying to resolve project issues to enable qualification for continued finance (lack of strategic management of some early projects). PR
- Need to create IH processes and structures. PU

	• Need to adhere to regulatory standards, ethics codes, effective testing. PRD • Implementing Innovations result in additional costs – requires wider process change PRD • Issues resulting from a current lack of Hub Communications Plan. PRO
Collaborative Spaces	**Collaborative Spaces - sub-categories**
• Hub creates new ways to engage with stakeholders. OC • Hub History and IH staff recognition of distinct developmental stages – from empty to zoned space. PR • Lack of zoned space - Early stage development of Hub aided by lack of understanding from Hospital staff which gave scope for unmonitored decision making/progress. PR • Changes in space usage in the Hub - Need for project management of projects by IH staff, especially in early stages. PR • IH is a way to realise Hospital aspirations of innovation through Hub as dedicated resource. PU • IH as a Space for – Collaboration – Development of Innovation Culture. PU • IH space has the capacity to - Motivate – Educate – Manage and Define Innovation. PU • Hub holding a role as a key communicator and space for communication between stakeholders. Hub as a neutral space which is accessible for external stakeholders. PU • Useful to showcase Products still under development when possible, especially with high app base/tech focus of innovation products. PRD	**Hub as a Communication Space** • Hub holds a role as a key communicator providing a neutral space for interaction and collaboration between stakeholder groups. PU • IH space has the capacity to - Motivate – Educate – Manage and Define Innovation. PU **Hub as an Engagement Space to inspire and support Users** • IH as a way to realise Hospital aspirations of innovation using Hub space to explore and develop user-led innovation. PU • IH as a Space for collaboration and development of Innovation Culture responsive to user needs. PU **Hub as Space to engage with stakeholders** • Hub space creates new ways to engage with stakeholders. OC • Hub as a neutral space which is accessible for external stakeholder groups. PU

• Hub as space to appropriately direct external interest from organisations by having opportunity to work with and within the IH. PRO	• Hub as space that is can accommodate direct external interest from organisations, and provide space for collaboration within the IH. PRO Useful to showcase products still under development when possible, especially with high app base/tech focus of innovation products. PRD **Changing use of Hub Spaces** • Hub History and IH staff recognition of distinct developmental stages – from empty space to zoned space . PR • Lack of zoned space - Early stage development of Hub aided by lack of understanding from Hospital staff which gave scope for unmonitored decision making/progress. PR • Changes in space usage in the Hub - Need for project management of projects by IH staff, especially in early stages. PR
Collaborative Processes	**Collaborative Processes - sub-categories**
• Difference between NHS and External Culture - Processes - Expectations – Pace OC • Differences in clinical evidence based problem solving and innovation problem solving approaches; different conceptualisations and levels of risk/failure. OC • Wider organisational culture within the hospital broadly 'kills innovation' – started for wrong reason, unrealistic expectations, lack of resource and lack of achievable strategy. OC	**Process and Current Collaborative Project examples** • Progress of current projects. PRD • Partnerships currently in progress (Inc Virtual Reality Project, Innovation Health Exchange, Hartree Chatbot and Acorn). PC • Products developed through support delivered by Hub as part of larger collaborative funded project. PRD

• Difference between clinical evidence based prioritisation perspective, and project prioritisation from externally informed rationale. PS • Using internal knowledge and expertise in health to inform innovation. PS • Importance of approaching Innovation from Problem based/Needs Led angle rather than Solutions Perspective (deep understanding is vital). PS • Importance of Tacit knowledge for the Innovation Process P • Products focused in Digital and MedTech underpinned by Artificial Intelligence, Augmented Reality or Virtual Reality with corresponding consulting stream linked to a clinician. PRD • Importance of adherence to Quality and Compliance standards. PRD • Information from interviewees related to current projects in progress. PRD • Products developed through support delivered by Hub as part of larger collaborative funded project. PRD • Stakeholder tension related to several main issues/differences of opinion regarding – pace – hub role – hub purpose – demonstration of hub progress. PRF • Importance of Needs Led approach to meet clinicians' objectives. PRF • Different challenges arising from partnering with SME's and larger organisations. PC • Partnerships currently in progress (Inc Virtual Reality Project, Innovation Health Exchange, Hartree Chatbot and Acorn). PC	**Process and Approach/Method** • Wider organisational culture within the hospital broadly 'kills innovation' – started for wrong reason, unrealistic expectations, lack of resource and lack of achievable strategy. OC • Importance of approaching Innovation from Problem based/Needs Led angle rather than Solutions Perspective (deep understanding is vital). PS • Differences in clinical evidence based problem solving and innovation problem solving approaches. OC • Different conceptualisations and levels of risk/failure. OC • Importance of Tacit knowledge for the Innovation Process. P • Importance of Needs Led approach to meet clinicians' objectives. PRF **Managing expectations about the Innovation Hub Process** • Difference between NHS and External Culture, Processes, Expectations and Pace. OC • Stakeholder disagreement about purpose of innovation. OC • Stakeholder tension related to several main issues/differences of opinion regarding pace, hub role, hub purpose and methods to demonstration of hub progress. PRF • Using internal knowledge and expertise in health to inform innovation. PS • Difference between clinical evidence based prioritisation perspective, and project prioritisation from externally informed rationale. PS

	• Different challenges arising from partnering with SME's and larger organisations. PC
	Process and Technology
	• Products focused in Digital and MedTech underpinned by Artificial Intelligence, Augmented Reality or Virtual Reality with corresponding consulting stream linked to a clinician. PRD
	Process and Compliance
	• Importance of adherence to Quality and Compliance standards. PRD
Innovation Outcomes	**Innovation Outcomes - Sub-categories**
• Hub vision & culture is seen as empowering for hospital. OC • Hospital studied is seen as innovative within the NHS. OC • NHS focused on serving the public as patients and their continually changing needs. IH vision to support young people achieve their potential, and remain engaged with health services as adults. OC • Topical nature of health innovation – multiple stakeholders interested in the multiple potential outcomes/benefits. PS • Innovation can improve patient experience through access to new products and care pathways. PS • Innovation can add capacity through introduction of digital health innovations. PS • Other NHS Bodies and Trusts are also potential customers for innovations created in IH - nothing is free/freely shared. NHS	**Patient Benefits** • Innovation can improve patient experience through access to new products and care pathways. PS • Impact on improving the Patient Experience. VIM • IH aims to improving Health Literacy and Health Outcomes (mental and physical). PU • Hopes to move from NHS treating illness to NHS which benefits from investing in patient journey, meeting broader holistic patient needs, improving access to and provision of information, supporting prevention agenda. PU • Innovation to provide support to patients and families transitioning from paediatric to adult services. PU

- has locally managed budgets and local decision making around resources. OC
- Clinical staff not motivated by potential financial gains from innovation, they want fair treatment, to share best practice and to be valued in NHS. P
- Potential to: - Capitalise on/use tacit knowledge – create change/problem solve. VIM
- Value of intangible outcomes of innovation to demonstrate value/impact (especially pre-evaluation) VIM
- Impact on improving the Patient Experience. VIM
- Value and Impact expressed as 'benefits' in terms of money, improved quality, improved patient experience and improved health literacy (learning and understanding) Recent internal involvement of Business Intelligence team with Hub – extracting value from data collected. VIM
- IH aims to improving Health Literacy and Health Outcomes (mental and physical). PU
- Innovation as a method to assist in preventative health care – avoid crisis points being reached which pressurise NHS. PU
- Hopes to move from NHS treating illness to NHS which benefits from investing in patient journey, meeting broader holistic patient needs, improving access to and provision of information, supporting prevention agenda. PU
- Innovation to provide support to patients and families transitioning from paediatric to adult services. PU
- Value of additional clinical skills brought into NHS by clinicians attracted to work in IH team. PRF
- Lack of ability to meet expectation generated from open events like Hackathons, creates damage to external relationships. PRF

Reputational Benefits - Vision/Aspirations for healthcare service delivery

- Hub vision & culture is seen as empowering for hospital. OC
- Hospital studied is seen as innovative within the NHS. OC
- Value of additional clinical skills brought into NHS by clinicians attracted to work in IH team. PRF

Operational Benefits for Health service

- NHS focused on serving the public as patients and their continually changing needs. IH vision to support young people achieve their potential, and remain engaged with health services as adults. OC
- Innovation can add capacity through introduction of digital health innovations. PS
- Potential to: - Capitalise on/use tacit knowledge – create change/problem solve. VIM
- Innovation as a method to assist in preventative health care – avoid crisis points being reached which pressurise NHS. PU
- Innovation can produce scalable resources, allowing for the prioritisation of human resource, and extending and enhancing service provision/hospital capacity. PRF

Current Barriers/Challenges

- Other NHS Bodies and Trusts are also potential customers for innovations created in IH - nothing is free/freely shared. NHS

- Innovation can produce scalable resources, allowing for the prioritisation of human resource, and extending and enhancing service provision/hospital capacity. PRF
- Value of the Hub and the collaboration relationships that are developed – Access to skilled staff etc for external organisations. PC
- Benefits for NHS/IH to be gained from partner organisation's skills (trade-off between added complexity and gains in skills) PC

has locally managed budgets and local decision making around resources. OC
- Clinical staff not motivated by potential financial gains from innovation, they want fair treatment, to share best practice and to be valued in NHS. P
- Lack of ability to meet expectation generated from open events like Hackathons, creates damage to external relationships. PRF

Intangible Innovation Outcomes

- Topical nature of health innovation – multiple stakeholders interested in the multiple potential outcomes/benefits. PS
- Value of intangible outcomes of innovation to demonstrate value/impact (especially pre-evaluation). VIM
- Value and Impact expressed as 'benefits' in terms of money, improved quality, improved patient experience and improved health literacy (learning and understanding). VIM
- Recent internal involvement of Business Intelligence team with Hub – extracting value from data collected. VIM
- Value of the Hub and the collaboration relationships that are developed – Access to skilled staff etc for external organisations. PC
- Benefits for NHS/IH to be gained from partner organisation's skills (trade-off between added complexity and gains in skills). PC

Organisational Context/Climate	Organisational Context/Climate - Sub-categories
• Broader NHS climate of cost saving, stream-lining, cutting back, reducing staff positions where possible leads to reluctance from staff to share ideas if they fear they would result in job losses. OC • Capacity pressures; rise of self-care, at home monitoring, user finding information – links to prevention rather than treatment at point of crisis. OC • Connection/alignment between NHS Quality Criteria and work of the Hub; link to broader aims and measurements of quality – value linked to the provision of 'opportunity to play' whilst in hospital. PS • Issue of longer term project work which has to fit in with annually allocated NHS budget and financial reporting cycles/measurement. OC • Fragmented nature of the NHS leading to reinvention of the wheel and not invented here syndrome issues. OC • Broader NHS digitalisation strategy – way behind, lack of infrastructure, outdated processes and pathways, ability to absorb current technology operational requirements from new systems/innovations. OC • Personal connection between staff and why they work for the NHS, and why they are involved in Innovation. P • Barriers to IH process due to broader NHS Process – Pace of Progress – Time vs Staff demands. PR • Changes in patient expectations – care options, use of tech/digital. PU • Current management review of IH by hospital with a view to a formalisation of Hub activities and processes. PRF	**Quality of health service** • Changes in patient expectations – care options, use of tech/digital. PU • Expectation of patients to be able to personalise their health care journey. PRF • Capacity pressures; rise of self-care, at home monitoring, user finding information – links to prevention rather than treatment at point of crisis. OC **Efficiency of health service and connected issues** • Broader NHS climate of cost saving, stream-lining, cutting back, reducing staff positions where possible leads to reluctance from staff to share ideas if they fear they would result in job losses. OC **Staff and their Personal Motivation for Healthcare work** • Personal connection between staff and why they work for the NHS, and why they are involved in Innovation. P **Resource Issues** • Issue regarding Hospital staff not realising the commercial value of their clinical knowledge. PRF • Recognition of level of resources needed to execute proposed idea vs resources that are already available. PRF

• Issue regarding Hospital staff not realising the commercial value of their clinical knowledge. PRF • Expectation of patients to be able to personalise their health care journey. PRF • Recognition of level of resources needed to execute proposed idea vs resources that are already available. PRF • Existing need to address current issues with effective internal visibility and communication of IH activities and purpose. PRO • Broader issue regarding innovation in healthcare and how it is managed/linked to the stress caused for staff when changes are introduced (lack of time to manage process, train and be trained). PRO • Advantages/Disadvantages of collaborations for NHS. PC	**NHS Culture and Systems** • Issue of longer term project work which has to fit in with annually allocated NHS budget and financial reporting cycles/measurement. OC • Fragmented nature of the NHS leading to reinvention of the wheel and not invented here syndrome issues. OC • Barriers to IH process due to broader NHS Process – Pace of Progress – Time vs Staff demands. PR • Existing need to address current issues with effective internal visibility and communication of IH activities and purpose. PRO • Broader issue regarding innovation in healthcare and how it is managed/linked to the stress caused for staff when changes are introduced (lack of time to manage process, train and be trained). PRO • Advantages/Disadvantages of collaborations for NHS. PC **Links to wider health policy objectives** • Connection/alignment between NHS Quality Criteria and work of the Hub; link to broader aims and measurements of quality – value linked to the provision of 'opportunity to play' whilst in hospital. PS • Broader NHS digitalisation strategy – way behind, lack of infrastructure, outdated processes and pathways, ability to absorb current technology operational requirements from new systems/innovations. OC

First order theme initial categories	Code
Organisational Culture	OC
Policy and Strategy	PS
People	P
Value/Impact Signs and Measurement	VIM
Process	PR
Purpose	PU
Product	PRD
Performance	PRF
Promotion	PRO
Partnerships and Collaboration	PC

Appendix Four Template Analysis Summary Table.

Stage 2 Template Analysis Headings	Stage 3 Template Analysis Headings
Management of Hub	**Management of Hub**
	Managing Internal Relationships
	Balancing stakeholder and project requirements – the roles of Hub staff
	Developing internal awareness around purpose of Hub and innovation projects
	Innovation Culture
	Developing Hub Capabilities
Collaborative Spaces	**Collaborative Spaces**
	Hub as a Communication Space
	Hub as an Engagement Space to inspire and support Users
	Hub as Space to engage with stakeholders
	Changing use of Hub Spaces
Collaborative Processes	**Collaborative Processes**
	Process and Current Collaborative Project examples
	Process and Approach/Method
	Managing expectations about the Innovation Hub Process
	Process and Technology
	Process and Compliance
Innovation Outcomes	**Innovation Outcomes**
	Patient Benefits
	Reputational Benefits - Vision/Aspirations for healthcare service delivery
	Operational Benefits for Health service
	Current Barriers/Challenges
	Intangible Innovation Outcomes
Organisational Context/Climate	**Organisational Context/Climate**
	Quality of health service
	Efficiency of health service and connected issue
	Staff and their Personal Motivation for Healthcare work
	Resource Issues
	NHS Culture and Systems
	Links to wider health policy objectives