# Addressing the Decline in Clinical Interactions Due to Continuous Change in Health Consumer Digital Health Behaviours – A Clinician and Health Consumer Action Research Design.

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## ABSTRACT

Health consumer behaviours related to the rising Quantified-self-movement using Wearable Activity Tracker (WAT) derived Patient-Generated Health Data (PGHD) has empowered self-health, diminishing the need for clinicians (Lupton, 2013; Lupton, 2016; Lupton & Jutel, 2015). This trend, along with the acceleration caused by COVID-19, has impacted the sustainability of clinical practice. The Researcher is the CEO and business leader of The Centre for Diabetes and Endocrinology (CDE), a clinician network management company of circa 2500 clinicians contracted to manage patients living with non-communicable diseases (James & Poulsen, 2016). CDE relies on continuous doctor-patient engagements to ensure sustainable risk management and quality care (Distiller, Brown, Joffe & Kramer, 2010). The CDEs circa 700 healthcare practices have followed global socio-behavioural and economic trends (Ganguli et al., 2020), showing a steady decline in patient visits related to consumer self-diagnosis (Swan, 2009; Swan, 2012). The Researcher engages in discourse shaping self-empowered, self-quantified consumers using clinically isolated digital individualisation (Levina, 2017) to self-manage, placing warm-body practice at risk. To solve this, this research deepens our understanding of evolving consumer needs and presents a co-designed, first-of-its-kind, digital solution to help arrest the problem of declining patient visits. Data collection involved a cohort of clinicians and their patients to design an artefact as a solution using cycles of Action Design Research (ADR) and Human-Computer Interactive studies (HCI) leveraging Design Thinking (DT). The study draws on two pre-thesis data collection phases to establish rigour and context then uses qualitative data from CDE patients and clinicians representing super-specialist Physicians (endocrinologists and Psychiatrists), Family Practitioners, allied professionals, including nurses, dieticians and biokinetisists. The substance of the study lies in semi-structured interviews involving 24 participants in the co-design of the Artefact that captures meanings, sensitivities and users' needs from an understanding of their evolving digital behaviours. The Artefact proposes harvesting PGHD and other clinical data, delivering clinical interpretations into a novel digital treatment plan accessible to both clinicians and health consumers, fostering a new clinical symbiosis. The Artefact Treatme.health forms a part of a class of the practices knowledge management systems strategy but deals specifically with this research problem of finding ways to reunite clinician and patient (Maier & Hadrich, 2011).

Authors note: The terms patient, consumer, health consumer and client have been used interchangeably to express context. The term Artefact represents the digital tool designed as the carrier to share the "bearer of meanings" derived from user needs and merging it with clinical practice (Orlikowski, & Iacono, 2001; Krippendorf & Butter, 2008; Johansson-Sköldberget al., 2013).

## DECLARATION

I, Grant Sean Newton, hereby declare that this thesis's contents are solely my original work. Except for works cited and for which credit has been duly given or the author's permission has been granted, this work is entirely my own. I declare that no part or the whole of this thesis has been presented to any other university for consideration for an award of a DBA or any similar degree.

Signed: Grant Sean Newton Dated 15th March 2022

I also confirm that:

The thesis, including Abstract, Declaration, Table of Contents, footnotes, intext citations, Acknowledgements, Definitions and Appendices is 54 616 words (extra word count approved).

The list of references 10 989 words.

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On the 4th of December 2021, the Researcher experienced the tragic passing of Professor Larry Distiller – Executive Chairman of the CDE, mentor, colleague, and friend. This thesis is dedicated and, Treatme.health will be executed in practice in his memory.

## DEFINITION OF KEY TERMS AND CONCEPTS

Table of Abbreviations

| | |
|---|---|
| ADR | Action Design Research |
| AI | Artificial Intelligence |
| AMA | American Medical Association |
| AmHI | Ambient Health Intelligence |
| AmI | Ambient Intelligence |
| AMIA | American Medical Information Association |
| AR | Action research |
| BIE | Building-intervention-evaluation |
| BMJ | British Medical Journal |
| CALC | Continuous Action Learning Committee |
| CAGR | Compound annual growth rate |
| CDE | Centre for Diabetes and Endocrinology |
| CGD | Consumer-generated data |
| CIS | Computer-integrated system |
| CISTI | Canada Institute for Scientific and Technical Information |
| COVID–19 | Corona Virus Disease of 2019 |
| CPD | Continuous professional development |
| DBA | Doctor of Business Administration |
| DPS | Diabetes Prevention Study |
| DR | Design research |
| DT | Design Thinking |
| ECG | Electrocardiogram |
| EHR | Electronic Health Record |
| EMR | Electronic Medical Records |

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|---|---|
| ERP | Enterprise Resource Planning |
| HCI | Human-computer interaction |
| HICSS | Hawaii International Conference on System Sciences |
| HMI | Human-Machine Interaction |
| ICHOM | International Consortium for Health Outcomes Measurement |
| IoHT | Internet of Health Things |
| IoT | Internet of Things |
| IT | Information Technology |
| JAMA | The Journal of the American Medical Association |
| JMIR | Journal of Medical Internet Research |
| KM | Knowledge management |
| MRC | Medical Research Council |
| PAR | Participatory Action Research |
| PGHD | Patient-Generated Health Data |
| QHC | Quantified-self health consumers |
| SAMJ | South African Medical Journal |
| SME | Small Medium Enterprise |
| UI | User Interface |
| UOL | University of Liverpool |
| UX | User experience |
| WAT | Wearable Activity Tracker |

# 1 Introduction

## 1.1 Research CONTEXT

As CEO and business-leader of the practice, the Researcher realised that health consumer behaviours in Health 4.0 (Chute & French, 2019) was changing the health system and he could no longer assume that the clinician-patient interaction is a "naturally occurring interaction" (Maynard & Heritage, 2005). The CDE relies on its integrated network of clinicians to see and manage patients to fulfil agreements with payors to improve patient outcomes and reduce costs. Revenue is derived from savings generated from effective consumer health risk management. Reduced engagements with health consumers directly impact practice service level agreements and profitability.

This chapter introduces the problem statement of declining face-to-face clinical visits elucidating the research question in context of self-health consumer-behavioural changes. It draws on the significance of the work being done by the Christensen Institute on the impact of disruptive innovation formed by evolving health consumer behaviours and positions the need for innovative ways to leverage health consumer behaviours and stem the decline in healthcare visits. CDE Clinicians raised the risk that customers were engaging more with their PGHD (Cohen, Winstanley & Greene, 2016) and the iDoctor than themselves. Karches (2018), defines this as health consumer needs being addressed by "a machine theoretically capable of replacing the judgement of primary care clinicians." The Researcher aligned the Christensen, et al., (2015) disruptive innovation theories applied to health consumers embracing health digitisation - Health 4.0 (Chute & French, 2019) to find a practical solution to a problem being faced by clinicians globally.

Competitiveness relies on us understanding our health consumers' changing character and how we adapt business knowledge systems (Butler et al., 2008) to address these. The Researcher as CEO reflected on projects that he initiated to work with current vendors of Electronic Medical Records (EHR), Big Data Artificial Intelligence (AI), and analytics to address the problem, and realised that they had failed. He concluded that these systems are most often process driven and developed without insights into the changing needs of the health consumer (Mountford et al., 2016). Current platforms lack the critical element of human-centricity. More concerningly evident from experience and confirmed in the literature, interaction systems are designed to be transactional and the patient presenting as a human is often ignored (Chen et al., 2021).

The Researcher scoured the literature discussing the exponential rise of "the Quantified-self"[1] (Lupton, 2013; 2016) as a patient and, agreed with the anecdotal view of his clinicians, that this behavioural change is a cause of clinical disintermediation. Armstrong and Lorch (2020) brought attention to another layer of disintermediation where AI, as an example diagnoses diabetic retinopathy more accurately and efficiently than ophthalmologists. Seemingly the increased effectiveness of AI, access to Dr Google and accuracy of PGHD from WAT's may end up coinciding with self-care behaviours adding to the displacement of the clinician as the essential source of clinical knowledge. Astrup (2018) shows that almost half of all Americans are periodically engaged with Dr Google at any one time. West et al., (2020) add that one in five consumers will use Dr Google to check their clinician's diagnosis or treatment plan.

The Researcher reflected and realised that unintentional distancing was occurring. The practice had historically been positioning patients as elements to extract data from instead of seeing them as evolving and maturing digitally empowered participants to the clinical solutioning process. The practice lacked any strategies to address these consumer-behavioural changes negatively impacting the organisation's vision statement of "becoming a gentle part of health consumers' everyday lives." The practice had found no solutions that could merge and synchronise digitally empowered patients PGHD into treatment plans.

COVID-19 embedded digital self-care adding a *fear to be treated* and a *fear to treat* by consumers and clinicians, respectively. Industry attempts to "digitise" clinical workflows showed only asynchronous processes that excludes the patient (Bouchard,

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[1] http://quantifiedself.com/guide

2019) or Electronic Medical Records (EMRs) to which patients have no access or, telemedicine and clinical remote monitoring (Liddy et al., 2019). These platforms are isolated from health consumers and have been imposed on clinicians by insurers, hospitals or managed care organisations alienating the clinicians creating "clinician burnout" due to belabouring EMR administration (Gardner et al., 2019; Shanafelt et al., 2016).

This research explores the increasing digital chasm created by smart technologies forging closer relationships with patients (Powles & Hodson, 2017) and seeks to add new knowledge to the field of HCI studies by finding ways of stimulating health consumer-clinician digital-design collaboration. It lays a knowledge foundation for finding novel ways of leveraging consumer behaviours around PGHD (Pramanik et al., 2017) and other ubiquitous data sources available to the health consumer. It culminates in using collaborative co-inquiry to design an artefact (Hadaya & Cassivi, 2012) that embraces new consumer behaviours to reunite health consumers with warm-body clinical assets.

The outcome of this study links the findings of multiple layers of socio-digital and socio-economic behaviours and, captures them in the co-design of a novel artefact (El Morr, & Subercaze, 2010). The solutioning relies on insights from Gregor and Hevner (2013): "where little current understanding of the problem context exists”, and no effective consumer-based digital-artefacts are available as solutions."

### 1.2 Problem formulation – the Action Research Cycles Process

Following on from the preliminary insights from Christensen, the practice sources and the literature, The Researcher as depicted in Figure 1.1, addresses the need for knowing used to interrogate and discover the problem, then began the way of knowing that moves through to the ADR methodology (Bell, Bryman & Harley, 2018; Bryman & Bell, 2014; Trehan, 2011). He stimulated internal debate using what became known as “Grants CALC (Continuous Action Learning Committee)” made up of Clinical and Business leads within the practice. This process initiated the need for new thinking by showing clinicians the value of working with empowered consumers (Astrup, 2018).

Grants CALC was continually engaged to ensure research rigour drawing on the process of triple-loop (Raelin, 2011; Raelin, 2003; Raelin & Coghlan, 2006) reviews, reflection, and an organisational learning process (Figure 1.2). This reinforced the existential nature of the research allowing a generalisability of its findings (Chevalier & Buckles, 2019).

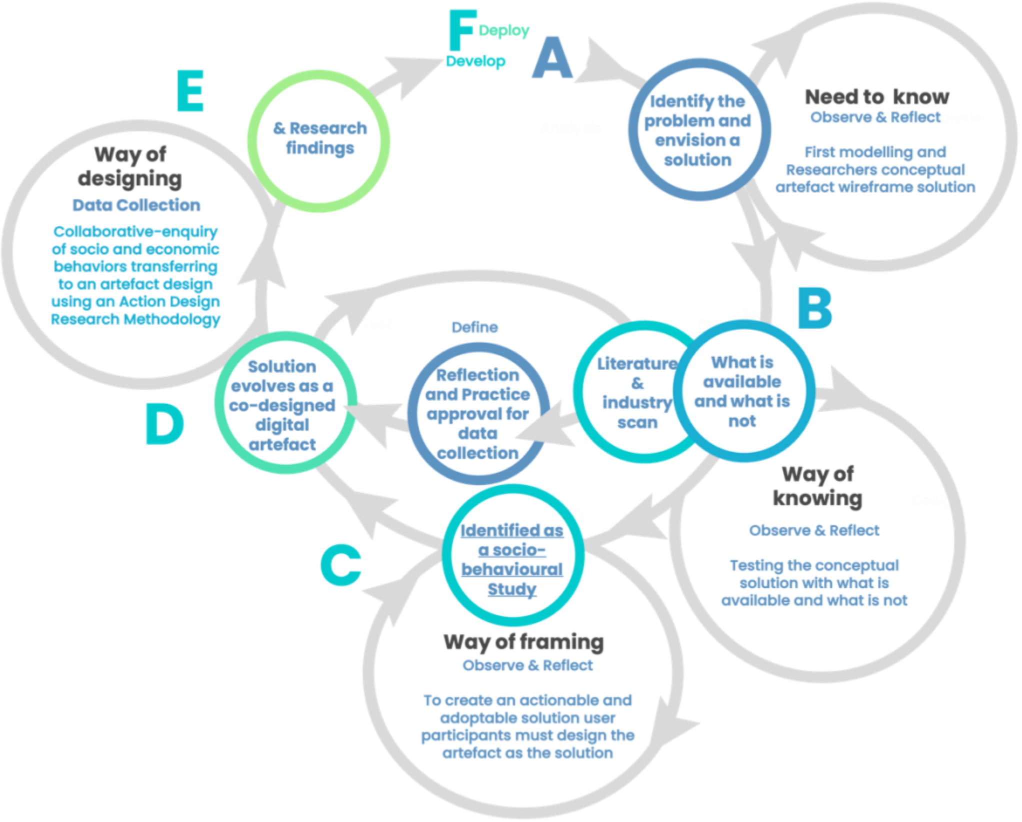

Figure 1. 1: **Action Research Cycles Adapted by the Researcher from (Trehan, 2011)**

### 1.2.1 Forming the Problem Statement in Practice

The Researcher drew on theory either supporting or challenging emerging thematic elements defining the problem statement and, established their relevance within of a HCI studies as its foundational philosophy. These were then retested in CALC with the Researchers practice stakeholders resolving that the problem could not be solved with current solutions but that it also was not belaboured by the unactionable traps of a "wicked problem" (Schein, 2010).

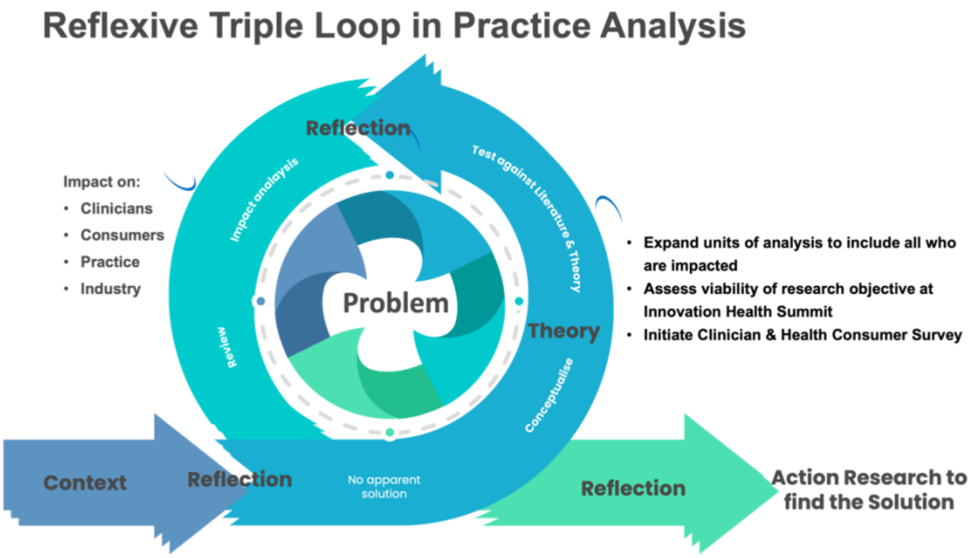

**Figure 1.2 Triple-Loop Learning and Analysis for Problematisation developed by the Researcher**

Figure 1.2 introduces how the problem was formed using reflexive learning, guiding the CALC through cycles that strengthened the habitual data to model an actionable research project. Continuous looping was also used in research as the designing of the artefact emerged from an ensemble from data inputs of three separate data collection phases (two supporting and one primary) moving the project from conceptual co-design to development in practice. CALC resolved that the reunification of clinicians and health consumers can be achieved if we could find an actionable solution that embraced the changing consumer digital behaviours.

### 1.3 Contextualising the PROBLEM within the Theory

While Crosswell (2020) using expert testimony, identified the opportunity for personal wellbeing platforms to disrupt, Sultan (2015) shows how evolving health and wellbeing wearables and, the impact thereof is aligned to Harvard Business School's Clayton Christensen's theories on disruptive innovations. The Researcher however argued that these and other scholars had not yet fully explored the magnitude of the disruption through the lenses associated with clinical practice. There is little evidence of identifying the change as an opportunity to mitigate clinical disintermediation. Added, little has been done to seek leverage of evolving consumer digital behaviours that reincorporate and repositions the clinician in this changing consumer world. There is no apparent evidence in the literature of wearables and PGHD becoming *the* informing elements to treatment plans and, there are no digitised treatment plans that actively navigate a patient's journey taking into consideration changes in consumer behaviours driven by disruptive technologies.

The CDE realised that it was following trends (Abelson, 2020) disenfranchising clinicians from behaviours encouraged by technology agents who are either intentionally or inadvertently replacing clinicians (Horgan et al., 2019). COVID-19 further exposed the practice to these disruptive changes allowing the iDoctor, a "machine theoretically capable of replacing the judgement of primary care clinicians" (Karches, 2018 p91), to circumvent and disintermediate many of the CDE's healthcare services. Furthermore, literature shows self-quantified consumers, or 'iPatient's, becoming empowered by WAT's and IoT tech causing a gravitation to alternative care sources (Birnbaum et al., 2015; Lupton, 2013; Verghese, 2011). Added, Stein (2011) presented that health consumers have been made inherently lazy by Dr Google supported by the large study, LetsGetChecked2, which found that 65% of people polled relied on self-diagnosis using WAT's and Dr Google. The Researcher framed it for the business as follows: "Dr Google is now doing our house calls." This research triggered a change in CDE strategy from - disrupted defender to a disruptive innovator (Christensen et al., 2015).

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[2] https://www.letsgetchecked.com/us/en/about-us/

This thesis builds on the body of work that forms the most common drivers of user digital behaviours (Cilliers, 2020; Finkelstein et al., 2016; Shih et al., 2015), exploring adoption metrics (Lee et al., 2020; Maher et al., 2017; Shin et al., 2019), and popular features (Gupta et al., 2020; Tully, Dameff & Longhurst, 2020) important to consumers. While Alpert et al. (2020) conclude that leveraging PGHD using interfaces are viable, there are research gaps offering practical solutions. Added, there are no apparent credible studies using leveraging behaviours to co-design patient-centric solutions that incorporates treatment plans or, repurposes data from devices, pathology laboratories and other empirical sources into usable and relevant formats in a single bespoke patient view.

Digital consumer devices most often present as a smartwatch, a "general-purpose, networked computer with an array of sensors" (Reeder & David, 2016). WATs like the Apple Watch™, Fitbit™ and Garmin™, among others, are ubiquitous, and the sensors cover a vast array of activities (Swan, 2012). They have the potential to transform healthcare by supporting, monitoring, and managing health in everyday living because they

1. are familiar to most,
2. are prolifically accessible,
3. enable near-real-time continuous monitoring of physiological data points,
4. support tailored messaging and reminders,
5. enable communication between health consumers and their supportive communities, and
6. behaviour modifications based on sensor-based measures.

Ease of use makes diagnostic and sensor measuring technologies compete for first-line diagnosis and health consumer support (Ip, 2019). However, the Researcher argues, these technologies offer an opportunity to clinicians to use PGHD with machine learning from convergent data points. These may include but are not limited to, a composite assortment of algorithms and markers, aggregated compendiums of peer-reviewed clinical research from PubMed and, multitudes of electronic clinical records to define patient conditions. Tran, Riveros & Ravaud, (2019) adds, that pervading AI can interpret pathology data, electrocardiograms, diagnose cardiovascular disease, including diabetic retinopathy, from fundus photographs (Yu et al., 2018) better than most clinicians adding a dimension to this study that can leverage this to empower rather than disintermediate clinicians.

Initially, health and fitness tracking devices were adopted by sportspeople and fashionistas birthed out of curiosity (Pal et al., 2020). However, now WAT is managing personal health is ubiquitous (Shin et al., 2019). As an infusing part of people's daily lives, WATs have become a source of behaviour change linked to wellness and loyalty programs measuring steps and calories, amongst other PGHD. However, they remain disconnected from the clinician (Ryan et al., 2019). Payor driven wellness and loyalty programmes require patients to use WATs to measure and manage themselves with rewards for continued use (Patel et al., 2018; Raber et al., 2019). These behaviours change methods, shown by Mercer et al., (2016), have embedded devices into the consumers' everyday lives. The health tracker market is growing at a compound annual growth rate "CAGR" of 19.6% (2017)[3]. Consumers acquire devices for immediate gratification and feedback to manage "individual wellbeing" (Bhavnani et al., 2017; Majmudar, Colucci & Landman, 2015; Swan, 2013). Wearable devices are becoming more "personable" as an immediate go-to measurement of physiological metrics (Seshadri et al., 2020).

Considering that COVID-19 has made CDE doctor practices no longer a haven for the sick, ensconcing these global trends (Wong, Hawkins & Murrel, 2020). Resultantly, the practice has had to reposition its clinicians in a digital world married with Smart

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[3] https://www.alliedmarketresearch.com/fitness-tracker-market

Ambient Intelligent (AmI) WAT (Arnold & Wilson, 2017). Gabriels and Moerenhout (2018) conclude that the health-tech revolution will replace the caregiver's role. So far, any attempts to include the clinician have been in asynchronous messaging (Bouchard, 2019), EMR’s, telemedicine, and specialised remote monitoring (Liddy et al., 2019) while, Google, Amazon, Apple, IBM4, amongst others, are forming closer bonds with health consumers using consumer technologies. Bassett, Freedson, and John (2019) highlight the emergence of the "Studywatch" which is at the centre of Google's Alphabet innovation health research projects. Powles and Hodson (2017) show that these initiatives allow technology giants to forge stronger relationships with health consumers as they show the empirical value of replacing clinical services with self-care. However, there is still no universal platform for health consumers to present PGHD to clinicians. While disease symptoms are similar, every patient has a unique biophysical response. Therefore, this study presupposes that PGHD requires equally individual clinical responses to inhibit complications.

The problem was now being contextualised in the practice within a universal problem setting. Continuously baselining and reflecting, using the work by Christensen (et al., 2017), assimilating and showing the stakeholders how the disruption theory in healthcare can also empower the emergence of new models to integrate with those deployed by global big business, (Peppard & Rylander, 2006). The Researcher studied the aggressive strategies deployed by disruptive health-tech innovators like Google5. He learned that innovative solutions are best deployed within disruptive business strategies (Davila, Epstein & Shelton, 2012) that leverage big budget innovations.

Insights from the literature (Ip, 2019) showed the practice how AI and machines were already offering consumers diagnostic and care support, which helped the CDE stakeholders realise that it is not if but when will machines have a better relationship

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[4] https://www.cbinsights.com/research/report/google-strategy-healthcare/

[5] https://www.cbinsights.com/research/report/google-strategy-healthcare/

with our health consumers if we don’t act now (Arnold & Wilson, 2017). Topol (2019) framed it by stating that machines are becoming so profound that it "threatens the core of human endeavour in medicine."

The literature had begun opening practice thinking and, started stimulating questions exploring how we could make CDE clinical services an integral part of the Quantified-self-movement (Lupton, 2013).

Sensemaking within cycles of reflection, helped make it apparent that to meet this challenge and, become an intrinsic part of consumers' lives, it was crucial to find ways of leveraging health consumers behaviour and the pervasive presence of PGHD. It was agreed, we needed to find a way for consumers to present their PGHD into our clinicians' warm-body or digital interactions. It was concluded that we needed to harmonise all health data points with the fast-changing consumer-behaviour. Further, it was agreed that we would create generality and extended this study’s findings to be of interest to industry stakeholders including funders and corporates seeking new ways to access quality cost-effective care (Arnold & Wilson, 2017). To achieve this, the Researcher conceived and conceptualised an artefact that could leverage consumer behaviours around PGHD and other data sources and create consumer dependencies on clinicians (Cohen et al., 2016).

Generalisability in this study is represented by a cross-section of clinicians; Physicians (Endocrinologists, Internal Physicians, and Psychiatrists), Family Practitioners and allied professionals, including nurses, dieticians and biokineticists as well as, a random sample of health consumers representing different ages, genders, and ethnicities. The research question emerged by realising the need for new thinking that finds a digital solution that reunites clinicians with consumers evolving self-care digital behaviours.

The Research problem was now vivid and could be framed as follows:

**Research Problem:** *Behaviours associated with self-quantified consumers using WAT PGHD and other knowledge points is causing a disintermediation of warm-body clinicians.*

## 1.3 Elements informing the research question

Having identified the problem, the Researcher went on to unpack the elements of the proposed study. These ranged from potential participants to other components necessary to consider what may impact an actionable outcome.

### 1.3.1 The Clinician

Literature supports maintained, improved, and augmented doctor and patient interaction, essential to align with value-based healthcare (Distiller et al., 2010; Porter, 2009; 2016; Porter & Lee, 2013). Nevertheless, we operate in a system where doctors are caught in the paradigm of "sausage factory care" (Pulis & Victoria, 2014). Health consumers are commoditised to extract revenue from payors (Smith, Spiggle & McConnell, 2017). Adler-Milstein et al. (2017) highlight an "IT chasm" between the health consumer and clinicians that makes value-based care implausible.

Studies demonstrate that clinicians are not focused on consumer demand for patient-centricity (Blandford, 2019; Yeoman et al., 2017). However, small to medium private health practice enterprises' SMEs (Auer & Jarmai, 2018) do not leverage knowing their customer (Blandford, 2019; Yeoman et al., 2017). Being disconnected from customers makes it difficult for clinicians to service patients (Kravitz & Melnikow, 2001).

Academic structures, paternalism and hierarchical behaviours have made clinicians ambivalent to change (Braithwaite et al., 2018; Greenhalgh, Swinglehurst & Stones, 2014; Greenhalgh et al., 2017). As a result, clinicians have not, until COVID-19, had a compelling trigger to remodel businesses. Added the threat to private practice is the psycho-social burnout of clinicians dealing with technostress and COVID-19 front line challenges (Remuzzi & Remuzzi, 2020; Rosenbaum, 2020).

These findings support the notion that clinicians are unaccustomed to adapting to recognised innovations (Bernarda & Exworthy, 2020). Oh, et al. (2019) surveyed 669 doctors in Korea's high-tech environment, showing that only 5.9% of doctors had any real awareness of machines operating in healthcare delivery. However, ironically, 83.4% of the respondents agreed that AI would help make a diagnosis. As devices become more powerful, the gap grows, and clinicians are disenfranchised from frontline care (Kapoor et al., 2020).

### 1.3.2 The Health Consumer

Healthcare consumer paradigms change more rapidly, as an example, there is a habitual, almost hourly, interaction with their WAT (Tang & Kay, 2017). There is evidence of growing consumer autonomy stimulated by machines. COVID-19 has aggravated consumers to see their clinicians as "infantry" in frontline battle (Buckingham, 2011; Kapp, 2007; Sharon, 2017). Patients now stay away from clinical practice and explore options not to see their clinicians. Norman (2017) showed that the proliferation of WAT has created a growing health consumer narcissistic self-confidence to self-manage.

Timmermans, (2020) argue that the single most powerful element in medicine remains the conversation between doctor and patient. Through the end of the last century, clinicians were at the apex of healthcare (Light, 2000; Pescosolido, Tuch, & Martin, 2001). The social and digital transformation has created consumer parity among unequal's (Starr, 2008). Today patients see doctors as inconvenient scripting and referral agents. Doctors wait for patients to arrive and be treated evidence, of a crumbling delivery model (Feng & Liu, 2016). Digitally interconnected care models that are not subject to the paternal "white coat effect" (Padwal & Wood, 2020) are accelerating consumer change towards digital self-care (Chute & French, 2019). With PGHD at their fingertips, consumers become non-compliant with their clinician-driven treatment plans (Wyatt et al., 2020). Ganguli et al. (2020) showed a pre-COVID-19 statistical decline in standard follow up visits to doctors. Topol (2019) in *Deep Medicine* states that Health 4.0 is so profound that the emergence of big medical data, robotics and AI threatens the foundations of human endeavour in medicine. The PGHD revolution has begun restructuring how consumers will consume care (Gabriels & Moerenhout, 2018). Trends show that intuitive self-management from PGHD is diminishing clinical visits (Rozenblum et al., 2015). There is little evidence of health consumers and clinicians engaging digitally (Hollander & Carr, 2020), so what is the clinician's role?

### 1.3.3 Health Payor's

Payors have moved a portion of the health risk back to the consumers through risk management tools like Health/Medical Savings Accounts "HASs/MASs" (Matisonn, 2000), and require members to manage their diseases when not in contact with a clinician. When patients are not adherent, payors look at alternatives encouraging members to interact more actively with their data. Payor's wellness and loyalty programmes, like Vitality®6, reward members for measured self-care (Patel et al., 2018; Raber et al., 2019). These programmes use financial subsidies and behaviour-recognition rewards to embed WATs like the Apple Watch®, Garmin® and Fitbit® into people's lives (Maher et al., 2017).

At the Innovation Health Summit, the largest South African payor's Chief Contracting Officer made it clear that payors encourage consumer autonomy and self-quantification. It was concluded that as cost and access remain a challenge, payors will look to the iDoctor as a cost-effective alternative to clinician centric care.

### 1.3.4 Digital Enterprise Systems

Big business has attempted to digitise the health system (Erdmier, Hatcher & Lee, 2016; FitzGerald & Hurst, 2017; Khayamian Esfahani et al., 2019). Big Data platforms are intended to operate as an integrative system that captures patient data and stores it for the payor, hospital, and clinician. However, this back-end functionality remains isolated from the patient (Mgudlwa & Iyamu, 2018) and adds little value to the doctor-patient relationship.

Most current EHR platforms are not conceptually patient-centric and are forced upon clinicians by insurers, hospitals, or managed care organisations. Instead of bridging the divide between clinicians and patients, big business platforms have made clinicians reticent to digital change. Shanafelt et al. (2016) showed that clinicians were also dissatisfied with the clerical impedance EMRs had on them to the extent that some considered it a contributing factor to clinician burnout (Gardner et al., 2019). As a result, EHRs are negatively perceived among clinicians, and health consumers are not given access to them.

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[6] www.vitality.co.za

### 1.**3.5** Are Consumer Based Technologies Reliable?

The Strain et al. (2020) large study of 96,476 UK Biobank participants (the Medical Research Council (MRC) at the University of Cambridge Epidemiology unit) used WAT to measure activity intensity profiles and their relationship to all-cause mortality. This shows confidence and credibility in the data sources. Top global researchers are bypassing clinicians using WAT to study the impact of the activity on health. They are dispelling notions that only the young and tech-savvy use WATs to manage their health. The average age of participants in the Strain study was 62 and considered all people living with comorbidities. We can deduct from Norman (2017) that health consumers are increasingly more engaged with their WAT devices and from Strain et al. (2020) that technology credibility is becoming a moot point.

### **1.3.6 Consumer Digitisation Empowering Communities**

Consumers can access personal DNA analysis[7] and home pathology tests[8]. These, among other digital health and social media services, are empowering growing health consumer-based support communities[9,10,11](Christie, 2013). These digitally agile services that leverage data, text and online communication have been effectively used during the effect of COVID-19 forced isolations (Kapoor et al., 2020; Keesara, Jonas & Schulman, 2020; Rubin, 2020; Wong et al., 2020) encouraging the rise of WAT Quantified-self-movements, fuelling the slogan "self-knowledge through numbers" (Lupton, 2016; Lupton & Jutel, 2015). At face value, this sounds progressive. However, Sharon (2017) cautions on the dangers associated with “blind belief” and that they have no clinical basis to interrogate or reflect on the context of PGHD. The business

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[7] https://www.23andme.com

[8] https://www.labcorp.com

[9] https://www.patientslikeme.com

[10] https://www.meetup.com

[11] https://www.bigwhitewall.com/?lang=en-us

had to find ways of merging clinical care with consumerism requiring a shift to ensure the ongoing protection of our communities (Smith, 1997). Zhu et al. (2016) show practical challenges in clinicians leveraging self-quantified PGHD and introducing clinical oversight into communities. Patterns show consumers relying more on managing their health with their WAT "Quantified-self" data[12] then on their clinicians (Lupton, 2016; Lupton, 2013). Furthermore, Google trends, as a free service, will aggregate population data for symptoms and report the experience in a trend analysis to help cross-reference and test the rigour of individual data (Russo et al., 2020).

Hierarchical paternal clinical structures cannot support these communities (Kaplan & Porter, 2011; Porter, 2016; Porter & Kaplan, 2014; Porter, Larsson & Lee, 2016). Not much has been done to make health consumers feel that their evolving digital worlds are relevant to their clinicians.

### 1.3.7 COVID-19

In the early stages of this research, the industry was hit by COVID-19. Wong et al. (2020) observed that clinical practice changed from safe havens of care to hotspots for infection. COVID-19 protocols and consumer-behaviour patterns made patients stay at home (Rubin, 2020). Promoting the use of WAT to manage comorbidities and those living with COVID-19 ensconced relationships with WATs and other devices for measuring management and monitoring disease (Seshadri et al., 2020), the Researcher addressed this problem in a Journal article13;labelling the phenomenon as "Driverless Healthcare" (Newton, 2020).

Other than telemedicine, none of the current systems addressed the inability to engage health consumers outside of bricks and mortar clinical practice. The traditional practice model broke down under COVID-19 as private practice reliant on patient visits went into further decline. Patients turned to WAT's capable of extracting and analysing biometric, scientific, and clinical data in a fraction of the time it would take a clinician (Kapoor et al., 2020; Nagy & Sisk, 2020). Clinicians were caught unawares and,

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[12] http://quantifiedself.com/guide

[13] https://issuu.com/boardofhealthcarefunders/docs/bhf-healthjournal2020_4online?fr=sZGEyNzIzMzU4NDU

commercially and technically under-resourced to respond to the pandemic (Goldsmith, 2012). Clinicians remain wary of seeing patients, and patients have stayed away from vulnerable environments like our practices (Remuzzi & Remuzzi, 2020). The 4th Industrial Revolution is quietly disrupting healthcare delivery, COVID-19 exponentially accelerated it. If we do not reinvent health delivery, digital models will supersede it (Briganti & Le Moine, 2020; Shah, 2019).

## 1.4 The Research Question

The Researcher as an insider was mandated to find an actionable solution to the problem. Figure 1.3 captures the narrative from the practice and peripheral reflection processes positioning the flow of the problem through the theoretical, then the conceptual, and resultantly through to the impact the research question and the study may have on the practice and society.

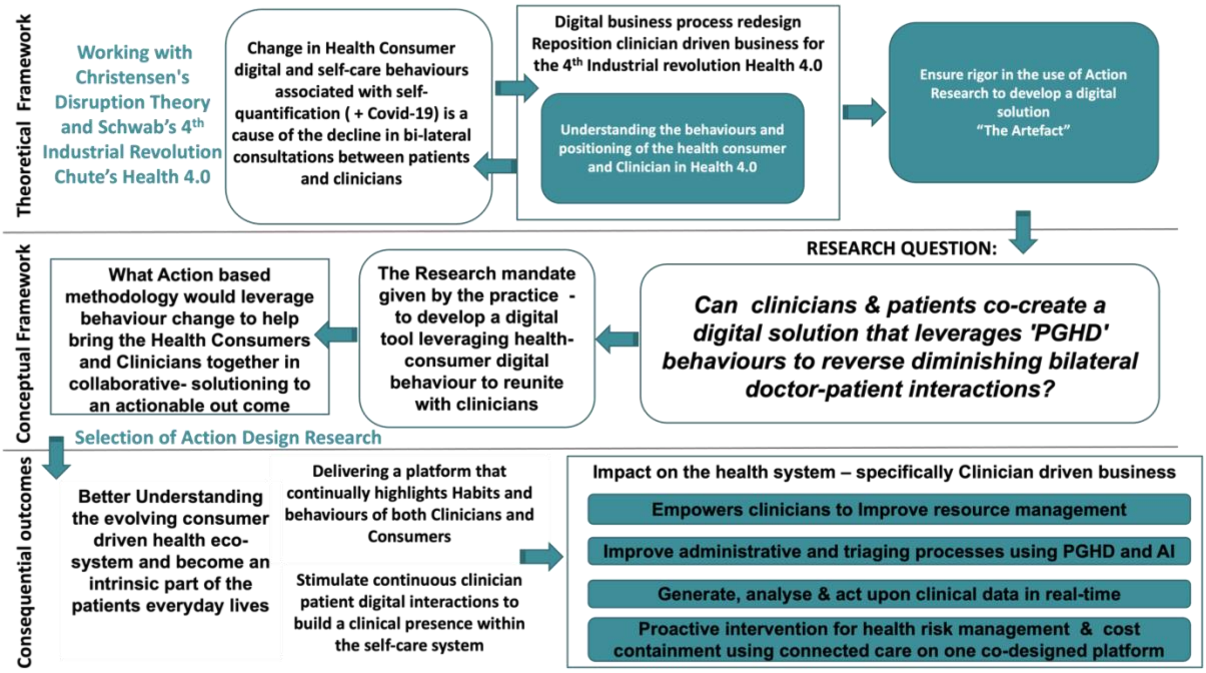


**Figure 1.3 The Integrated Theoretical and Conceptual Framework developed by the Researcher**

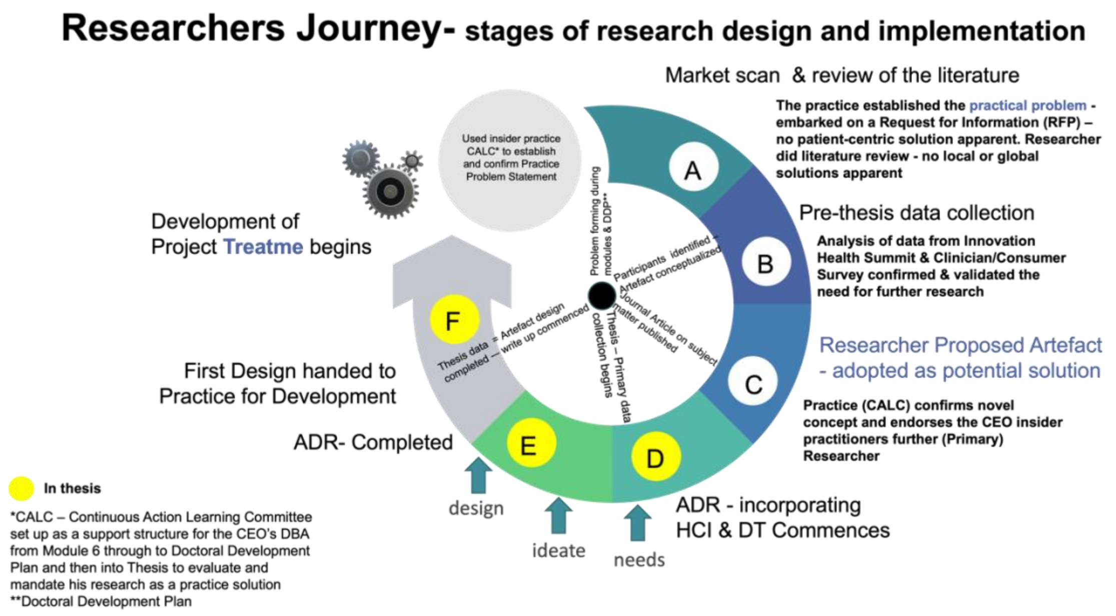
**Research Question:** *Can clinicians and patients co-create a digital solution that leverages 'PGHD' behaviours as a way of addressing diminishing bilateral doctor-patient interactions?*

## 1.5 Moving Peripheral Stakeholders to Research Partners

Firstly, the Researcher confirmed the viability of the research by exploring the participants needs who through active participation evolved into research partners (Stephens, et al., 2019) and designers (Hamzah & Wahid, 2016). Then, using guidance from Plattner, H., Meinel, C., and Weinberg, U. (2009) and Leifer, L., Plattner, H and Meinel, C., (2013) the Researcher embarked on sampling processes that included a broader set of ancillary clinical disciplines. This allowed the Researcher to build a well-balanced and unbiased, fair representation of the stakeholders. Despite COVID-19 restrictions and the data being collected sequentially, users were, as Reis et al., (2011) argued, treated as equals and, involvement was on parity. This, the Researcher believes, traversed the barrier of paternalism, and evolved what may otherwise have been conflicting perspectives to become, a non-hierarchical collaboration (Hamzah & Wahid, 2016).

## 1.6 Conclusions

Which builds from the identification of the problem in that is initially tested through a market and literature scan to see if there were available solutions. Evidently the Researchers practice was not the only organisation globally struggling with the problem evolved through disruptive change invoked by health consumers changing behaviours. The gap in studies on human behaviour around clinical disengagement in Health 4.0 (Chute & French, 2019) and how to leverage WAT generated PGHD convinced the practice for the need for a solution that firstly leveraged emerging health consumer behaviours and secondly, brought clinicians back into the continuum of care patterns to help address the reunification of self-quantified consumers with their clinicians. In Figure 1.4, A, B and C, demonstrates the Researchers quest for rigour in the setup of the study and D, E and F show the realisation of the research from concept phase to actionable outcome.



The practice established the practical problem - embarked on a Request for Information (RFP) – no patient-centric solution apparent. Researcher did literature review - no local or global solutions apparent

Analysis of data from Innovation Health Summit & Clinician/Consumer Survey confirmed & validated the need for further research

Practice (CALC) confirms novel concept and endorses the CEO insider practitioners further (Primary) Researcher

*CALC – Continuous Action Learning Committee set up as a support structure for the CEO's DBA from Module 6 through to Doctoral Development Plan and then into Thesis to evaluate and mandate his research as a practice solution
**Doctoral Development Plan

**Figure 1.4: Research Journey**

The chosen Research Methodology (D) presents an ADR model that leverages HCI & DT, that addresses these growing socio-behavioural gaps.

Findings in Chapter 4 (E) articulates the basis for preparing a robust design of an artefact as the best solution to solving the Research Question and the Researcher believes adds insights for fellow researchers seeking novel digital solutions for practice problems. The Researcher argues that when a researcher deals with novelty there is a need for a more coherent understanding of their ontological, epistemological, methodological approach. He offers that novelty-based problem-solving brings about an increase in latent and subthemes that researchers must be cautious don't lead to straying away from the research question.

The Reflections and Contributions Chapter 5, precis the analysis of the data sets and focuses on the actionable outcome (F) analysing the effectiveness of this study.

Conclusions in Chapter 6 reviews the actionable findings and highlights the impact on personal and organisational practice. The Researcher uses Chapter 6 to reflect on the new knowledge gleaned from the study and explores gaps that present opportunities for further study. He examines his role duality of researcher and professional, looking at positionality and considers bias and assumptions associated with preunderstanding of the problem. He looks at challenges he faced with insider research and the impact he had on the study’s outcome.

The research outcomes went beyond the Researcher's expectations, as the Artefact has been adopted as the businesses catalyst to bring more than just WAT PGHD into the core of consumer-centric care. The Researcher argues that it required adopting a malleable research design in this case using ADR, to effectively engage participants to understand user behaviours that would inform the build of a digital solution and allow for naturally occurring cycles of business process redesign in real-time. Anticipation of engaging the patient digitally and, connecting the clinician to the self-quantified consumer relied on the notion of Christensen et al., (2015) that when disruptive technologies are intrinsically linked to the business model and are embraced by all stakeholders it makes a practice more resilient. Furthermore, the study reinforced the findings of West et al. (2020) who cautioned that we must continuously monitor the consumer’s digital landscape and use agility to adjust actionable solutions accordingly.

Further research will measure the impact a collaboratively conceived solution (Artefact) has on organisational change and what has been the scale of reunification.

The Researcher intends to publish the outcomes of this study specifically related to what can be achieved through clinician and consumer collaboration and, will present a case to other scholars who are considering ADR and HCI/DT highlighting the successes and challenges of the integrated methodology to further in practice knowledge and scholastic approaches to this methodology.

# 2 Literature Review

## 2.1 INTRODUCTION

This review interrogates digital health system disruptors pulling clinicians and consumers apart (Ford et al., 2017). It addresses the confluence of themes and subthemes that look critically at the research question that informs the construct of the ADR to design of a digital solution that elucidates health consumer behaviours informing the artefact that is expected to catalyse the reunification of the parties. The review focuses on the themes and subthemes impacting primary data collection through semi-structured interviews and draws from the findings from the two pre-thesis data sets. Part 1 explores stakeholder human-computer interactivity and then presents established themes and subthemes to be explored in more depth in Part 2.

The sum of the Part 1 and 2 assisted the confidence in the Researcher and his practices choice of presenting a digital solution using ADR, incorporating HCI and DT, in the execution of the patient-centric design of the actionable solution.

### 2.1.2 Process of Clustering the Articles for Review

With guidance from Carr, 2006; Carr & Kemmis (2003), the Researcher shortlisted articles using themes, abstracts, keywords, and titles to inform the first two pre-thesis stages (Table 2.1). This baselined the critical review. Next, he applied the Tranfield et al. (2003) Systematic Literature Review methodology as defined in Newman and Gough, (2020).

**Table 2. 1: Example-Article Classification**

| Title | Journal | Rating | Citations | |
|---|---|---|---|---|
| What is disruptive innovation. | Harvard business review, 93, 44-53 | | | |
| **Author** | **Year** | **Approach** | **Focus** | **Key Findings** |
| CHRISTENSEN, C. M., RAYNOR, M. E. & MCDONALD, R. | 2015 | Multiple domains | Academic resource - Knowledge-Based Theory | Disruptive Innovation describes a process by which a product or service initially takes root in simple applications at the bottom of a market—typically by being less expensive and more accessible—and then relentlessly moves upmarket, eventually displacing established competitors. |

The chosen 943 articles were classified into sections addressing macro, meso and micro impacts on the research question (Greenhalgh et al., 2018). Articles were ranked and classified that was likely to provide insights which then excluded 455 unrelated or too obscure to be associated with the research question. These were then categorised according to the title, Journal, Journal rating per the Academic Journal Quality Guide (Belcher, 2019), leaving 314 that added poignant insights into the research problem and the associated methodology as shown in the PRISMA diagram (Moher & Liberati, 2009), (Figure 2.1)

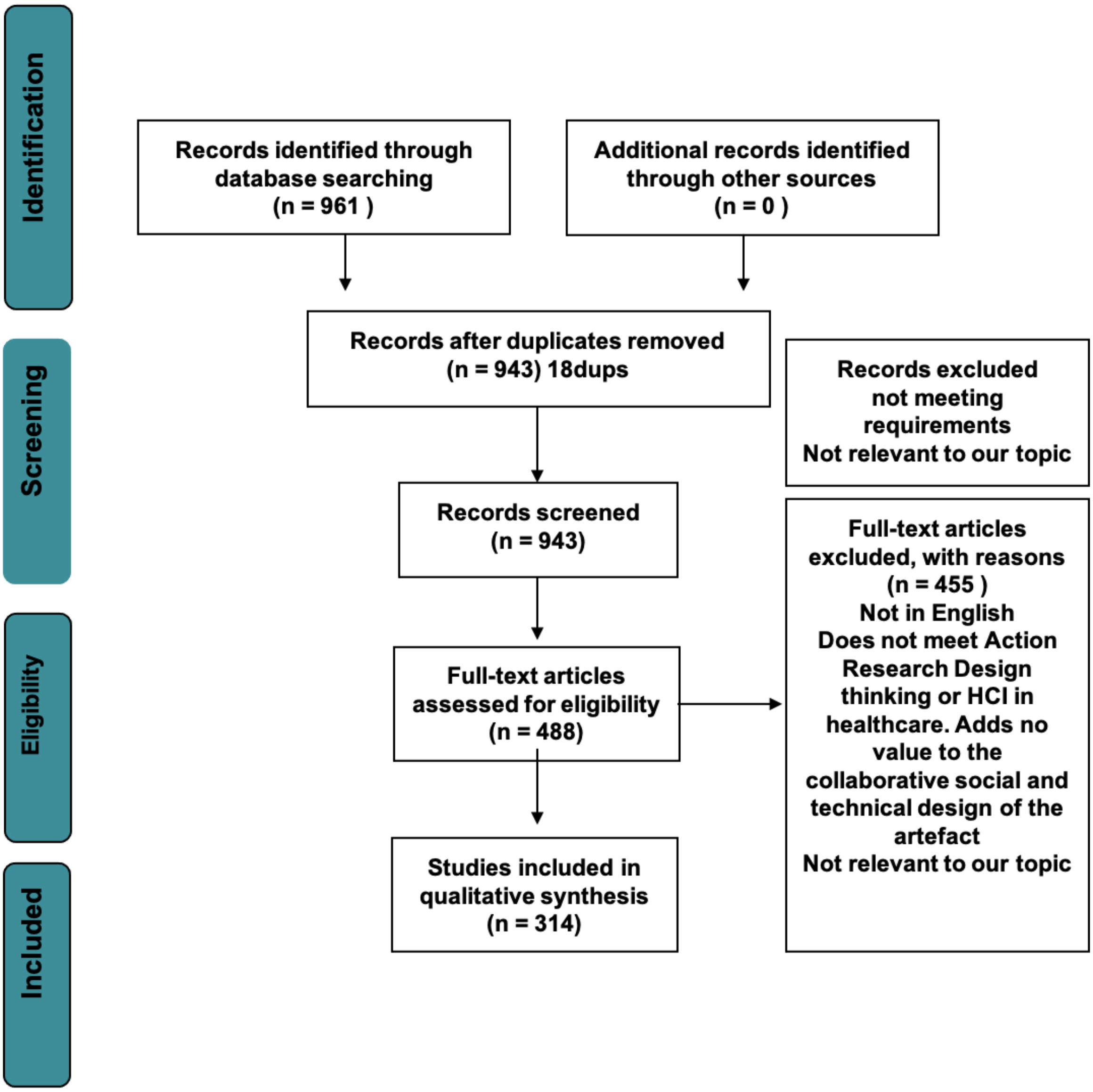


**Figure 2. 1 PRISMA Diagram adapted from Moher & Liberati (2009)**

While gaps were still evident, there was enough credible scholastic commentary to inform didactic research concepts and methodological processes (Angrist & Pischke, 2010). Most articles reviewed were published in journals rated in the top three rankings of the Academic Journal Quality Guide.

The search was conducted with Publish or Perish based on themes and keyword searches up to and including 2021 (Figure 2.2). Peer-reviewed publications and conference proceedings that addressed the main themes were considered. Comments on COVID-19 relevant to the study were included based on gravitas.

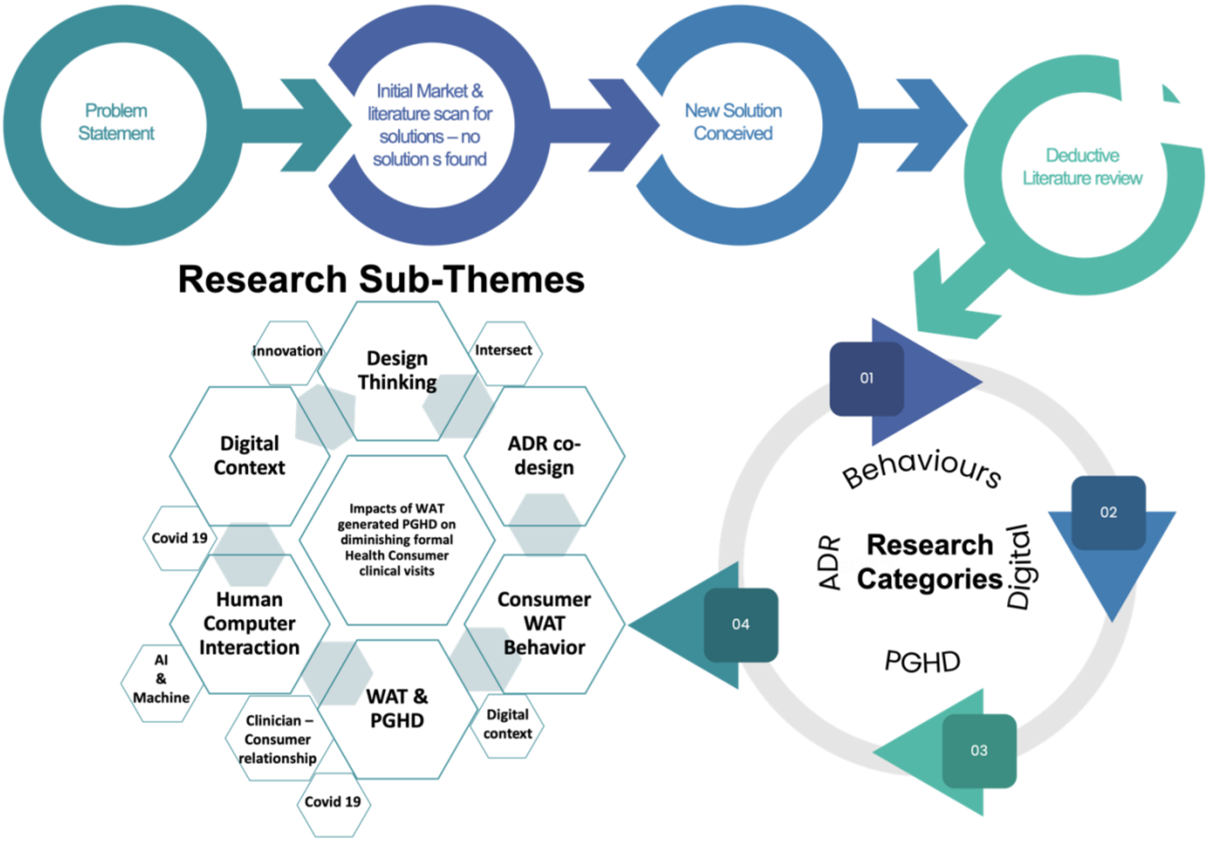


Figure 2. 2:Main Categories & Themes from the Literature

These themes and their associated subthemes are reviewed in more depth in Part 2 and 3 below.

## 2.2 Part 1

Part 1 explores academic insights addressing the phenomenon of digital disengagement between clinicians and health consumers. It draws on academic support for the Researchers notion that there are direct health benefits if we reunite the clinician and health consumer (Caiata-Zufferey et al., 2010; Dedding, et al., 2011; Seeman, 2013; Sommerhalder, 2009).

The Researcher incorporates academic insights into Quantified-self health consumers and their generation of PGHD, seeking evidence from previous studies to help position a digital solution and the participants as crucial stakeholders in the reunification (Yeoman et al., 2017). He reviews benefits of incorporating PGHD into clinical consultations (Lopes et al., 2015).

The Researcher as CEO and manager accountable for the decreasing clinical interactions, looked for guidance from the literature for innovation commentary on current and prospective patient-based solutions. While Fatokun et al., (2021) introduce an example of new age cutting edge solutions, the Researcher's CALC were left searching for a solution that was more human than transactional and, focuses on clinicians designing a knowledge sharing solution *with* their consumers instead of, *for* their consumers.

While Rinkus, et al (2005) acknowledge the need to disrupt the design and development of similar solutions, the Researcher sought help to reframe the clinician-consumer relationship (Rozenblum et al., 2015; Biglino et al., 2017). Breeman et al., (2021) illustrates the potential of a digitally intimate relationship conceptualised within the proposed artefact but the Researcher needed a more in-depth understanding of clinical consumer-behaviour using WAT's. Understanding COVID-19's impact on the system could also not be ignored. The Researcher found academic support for the trends of diminishing health visits to clinicians but, none identifying opportunities to help deter the departure. Because this research proposes less common use of co-inquiry within HCI paradigms (Dix, 2009; Dix et al, 2004; Dix, 2003; Kjeldskov, et al., 2003), Design Research and DT (Behrendorff, Bucolo & Miller, 2011; Brown, 2008; Brown & Katz, 2019), and using Action Design Research Methodology (ADR) (Bilandzic & Venable, 2011; Haj-Bolouri et al., 2017; Sein et al., 2011; Sein & Rossi, 2019) the Researcher draws on literature that de-risks the study and reinforces the model and methodology to solve a problem. It draws on support for innovation for competitiveness positioned with in an HCI study as framed by Hwang et al., (2018).

### 2.2.1 Human-Computer Interaction (HCI) Studies

The Researcher begins with positioning the study and its participants within HCI studies based on Rogers (2012) definition of HCI - a research area focusing on designing, evaluating, and implementing interactive computing systems for human use. Studies have shown that HCI, to discover new knowledge (Holzinger, 2013), has become the umbrella term for fields that overlap with interaction design (Rogers, 2008; Rogers, 2012). Harrison et al., (2007) showed that HCI is useful when applied to multidisciplinary clinical fields where the interaction between consumers and the clinical environment requires a deeper understanding of social and contextual frameworks. Since HCI expands over various disciplines, it is never safe to assume that all the participants share a similar set of values or paradigms (Guba & Lincoln, 1994) so the Researcher sought further insights into the human in HCI.

Bevan et al., (2015) describe the fundamental principles of human-centred interactive systems as shown in Table 2.1.

**Table 2. 2: Human-Centred Interactive Systems**

| Human-Centred Interactive Systems: |
|---|
| The design pivots on the explicit understanding of users, tasks and environments |
| Users participate throughout design and development |
| Design is driven and refined by user-centred evaluation |
| The process is iterative |
| The design addresses the whole user experience |
| The design team includes multidisciplinary skills and perspectives |

Source: Adapted from Bevan, Carter, & Harker, (2015)

This research draws this literature that helped respect users as domain experts in their context and positioned them as essential knowledge research partners (Stephens et al., 2019). Mandel (1997; 2002) formulates the critical principle of user centred design as: "Let users do what they want to when they want to do it, and how they want to do it." The design, therefore, had to consider humans' psychological and physical properties and constraints: how humans perceive, how memories work, what task humans do, and where the machine provides support. Three design principles were therefore considered essential viz.:

**Table 2. 3: Design Principles**

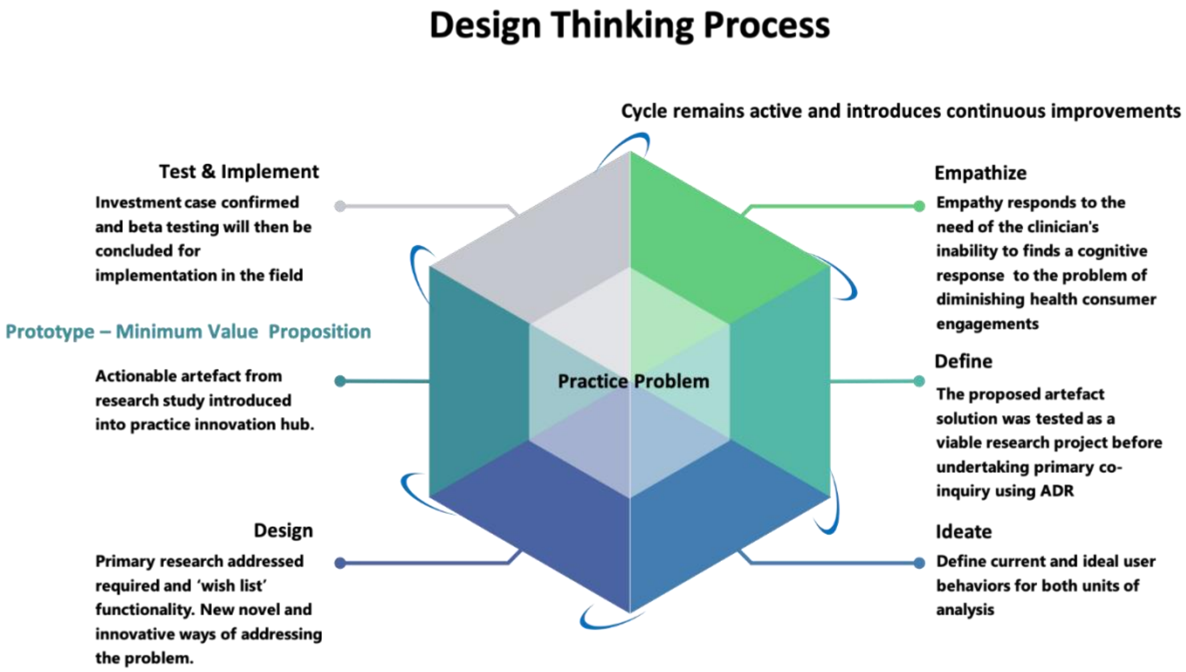
| Design Principles |
|---|
| Place users in control |
| Reduce user’s memory load |
| Make the interface consistent |

Source: Adapted from Mandel (2002)

As this became a design project the Researcher had to look at design principles comparing HCI and DT processes (Gregor et al., 2020). While the ADR relied on the HCI guidelines focusing 30% on the user's interaction with the system and 60% on the user's relationship and behaviour with the proposed solution (Mandel, 1997), most research involved clinicians in the system's consultancy but, very few consider the consumer as a valuable partner (Eikey, Reddy & Kuziemsky, 2015). The intrinsic focus on design prompted the Researcher to look at areas where ADR intersects with DT within HCI as reviewed in the following sections.

### 2.2.2 Design Thinking (DT)

This ADR is focused on a human-centred approach and process for creating new knowledge (Brown, 2008; Brown & Katz, 2019). Using DT helped achieve this by helping the Researcher hone the design by empathising with the end-users. DT is often used to address real-world problems, and as in HCI, invites collaboration between multidisciplinary teams (Lockwood, 2010). Furthermore, it specially engages participants in the design process to bridge the communication gap between different stakeholders and knowledge domains (Gatos et al., 2021). DT for this study can be defined as a discipline where sensibility and methods between the clinician and consumer designers can be matched with technological innovation. This ADR methodology leveraged HCI paradigms and DT processes ensuring that the Artefact design adhered to human values (Brown, 2008; Brown & Katz, 2019) as shown in Figure 2.3.



**Test & Implement**
Investment case confirmed and beta testing will then be concluded for implementation in the field

**Prototype – Minimum Value Proposition**
Actionable artefact from research study introduced into practice innovation hub.

**Design**
Primary research addressed required and 'wish list' functionality. New novel and innovative ways of addressing the problem.

**Empathize**
Empathy responds to the need of the clinician's inability to finds a cognitive response to the problem of diminishing health consumer engagements

**Define**
The proposed artefact solution was tested as a viable research project before undertaking primary co-inquiry using ADR

**Ideate**
Define current and ideal user behaviors for both units of analysis

**Figure 2. 3: Design Thinking Process adapted from (Plattner et al., 2009; Leifer, 2013)**

The Researcher used iterative design-cycles continuously building on previous participants HCI responses to refine the design before the next interview. Each cycle used: - Empathy-Step 1 helped the Researcher build an understanding of the participants motivations, emotions, and experiences (Plattner, et al., 2009). Needs-Step 2 informed and helped the Researcher understand contextual inquiries; he adjusted his interviewing activities to ensure a defined understanding of the problem to that participant. Ideate-Step 3 is the inventive step. Here the Researcher focused on design solutions and is where he became a participant using brainstorming and visualisation activities to craft the Artefact. Solution development– Steps 4 & 5 – was dedicated to transferring the Artefact for development in the practice. This is where participants become users of a prototype which may inform further actions (Park & McKilligan, 2018). This research took advantage of the attribute that design processes in DT are malleable to situational needs allowing each step to be executed differently according to user-specificity. DT is usually five steps however, the order may change, and steps may be grouped or individually iterative. This thinking allowed the Researcher to weigh the data points according to clinician's discipline-specificity and consumers socio-behavioural needs. The Researcher used the synthesis in Table 2.4 below to help structure his interview questions and, continuously referenced the depicted highlights within the Table as a field guide drawing on unique scholastic commentary during the interview processes.

Table 2. 4: Design Process

| **Model** | **Step 1** | **Step 2** | **Step 3** | **Step 4** | **Step 5** |
|---|---|---|---|---|---|
| (C. Adams & Nash, 2016) | Empathise & define<br>Understanding users | | Ideate<br>Brainstorming | Prototype<br>Building and testing | |
| (Brown, 2008; Brown & Katz, 2019) | Inspiration<br>Problem framing Contextual observations<br>Involves diverse disciplines | | Ideate<br>Sketches Scenarios<br>Involving customers<br>Prototype<br>Test | Implementation<br>Spread across the world | |
| (Culén & Følstad, 2014) | Empathy/<br>contemplate | Define | Ideate | Prototype | Evaluate |
| (Dam & Siang, 2018) | Empathise<br>Empathic<br>understanding of<br>the problem<br>Observing | Define<br>Defining the problem<br>Synthesising observations | Ideate<br>Brainstorming<br>Brainwriting | Prototype<br>Adopting a<br>hands on approach in prototyping | Test<br>Developing a prototype/<br>solution to the problem |
| (Gibbons, 2003) | Understand (empathise & define)<br>Developing knowledge<br>Talking with users<br>Observing users | | Explore (ideate & prototype)<br>Brainstorming<br>Creative ideas | Materialise (test & implement)<br>Transform an aspect of the end user's life | |

| | | | | | |
|---|---|---|---|---|---|
| (Johansson-Sköldberg, Woodilla, & Çetinkaya, 2013) | Gather inspiration<br>Discovering what people really need | | Generate ideas<br>Push past obvious solutions | Make ideas tangible<br>Build rough<br>prototype. | Share the story<br>Craft a human story<br>10 inspire others toward action |
| (Pandey, 2016) | Problem identification | Problem & continued discovery<br>Ecosystem mapping<br>Design ethnography | Synthesis<br>Affinity mapping (grouping data) | Ideation<br>Sketching | Prototype<br>Storyboarding<br>Rapid prototyping |

### 2.2.3 Why HCI and DT?

It is important to emphasise the need for empathy and draw on the human in HCI to see the need through the lens of a patient (Wright, & McCarthy, 2008). This element in this study is sensitive to patient vulnerability (Blandford, 2019) as it is threaded through the power of innovation design in DT resulting, in a highly innovative patient-centric solution (Chen et al., 2021).

Park & McKilligan's summation of 72 peer-reviewed research papers convinced the Researcher of the benefits of adopting the intersection of HCI and DT. At face value, both are problem-solving process. However, HCI focuses on analysing, evaluating, and testing; in contrast, Brown, 2008 & Brown & Katz (2019) argue that DT focuses on users' seeking innovation by observation and inquiry but focuses more on the design outcome. After careful consideration of Hobbs, & Fenn (2019) arguments that 'mature practice' can allow for assimilation of both modalities to extract a more robust outcome, the Researcher designed the ADR to leverage the best of the human approach in HCI and the design in DT as expressed, in an overlay of the co-created knowledge processes described by Langley et al (2018); & Park & McKilligan, (2018) (Figure 2.4).

Aligning the two methods the Researcher argues that HCI can learn from DT as it places both clinicians and consumers on par in the centre when designing a health solution. The Researcher used empathy to manage a concern he had around his personal view of the limited ability of ADR using HCI and DT to omit bias. This was crucial to not just limit bias but also stimulated creative ideas making the artefact more acceptable to both. Suppose we accept that HCI analysis interrelates with the DT define step (Figure 2.3), where data is gathered from user observations the Researcher concluded that his interviews and contextual data gathered can be used to determine and discover unique insights that differentiate the Artefact from other apps. Park and McKilligan, (2018) argued that HCI analysis can learn from DT to find context. The Researcher argues that the design step in HCI and ideate in DT is similar; however, Dix et al. (2004) reminded the Researcher that HCI uses standardised guidelines. Plattner, et al., (2009) and Henderson et al. (2013); & Langley et al. (2018), argued that DT does not follow guidelines but focuses on exploring the solution for alternative answers. The Researcher adopted this notion as a 'mature practice' (Hobbs, & Fenn, 2019) to form agility in exploring the design novelty of the Artefact drawing on multiple human settings.

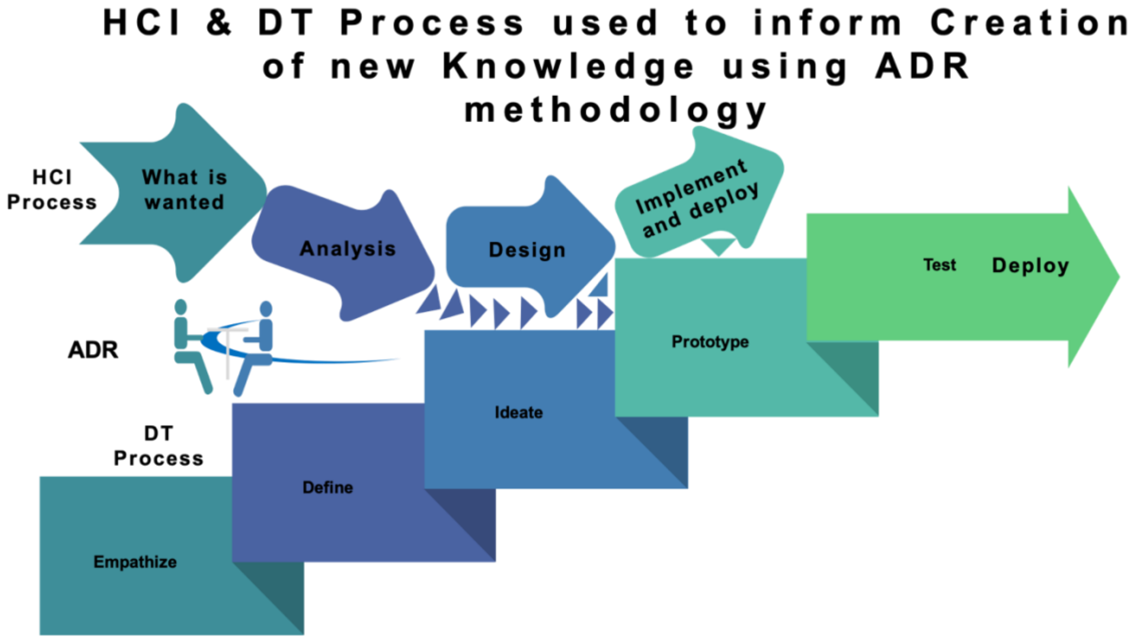


**Figure 2. 4: HCI & DT Process adapted from Park and McKilligan (2018)**

### 2.2.4 Participation - Consumers and Clinicians in Solution Design

There is a gap in the literature creating solutions that include both clinicians and health consumers. The Researchers axiology backed the values associated with collaborative design, emphasising ethics and multi-party empowerment (Rizzo, 2011), two critical attributes in this study. Halse et al., (2010) argues it facilitates collaboration between users and helps build stakeholder solidarity but, extends to other stakeholder's post research including investors, engineers, software designers and insider practitioners (Forlizzi, Zimmerman, & Evenson, 2008). However, this projects success as Mattelmäki and Visser, (2011) argues, lay in the user's creativity drawing on what Mattelmäki and Visser, (2011) show; that people are knowledgeable in their field of expertise. However, the Researcher realised that these are often erroneous assumptions as users are disparate in health systems (Holland, (2006). Therefore, this research had to continuously leverage disparate user thinking, creating mutually beneficial themes by merging knowledge of all participants needs (De Bono, 2017). This research also proves that a shared language across a field of knowledge and mutual learnings, enhanced by Researcher empathy as argued by Simonsen (2013); Teli, Di Fiore & D'Andrea, (2016) is crucial to dispel bias and enhance creativity.

However, the dynamism of shared conceptual understanding of each participants needs, required the Researcher to build deeper insights in participatory design processes as synthesised in Table 2.5 below.

**Table 2. 5: A Review of Participatory Design in Healthcare compiled by the Researcher**

| Principle | Literature Synthesis |
|---|---|
| Observe the relationship between designers and participants | Mantzana et al., (2007)state that Participants may be individuals or organisations. However, Hamzah & Wahid (2016) argue that a natural hierarchical relationship may form where likes and dislikes may over dominate due to social discourse. Thus, the Researcher manged the data so that heirachical clinicians should be prevented from becoming too dominant. . |
| Participating groups will have differing habits, preferences, and cultures | Hamzah & Wahid (2016) argue that all should respect varying perspectives; for example, consumers' viewpoints may differ from clinicians on system requirements. Clinicians may prefer to provide feedback on readymade systems rather than on the build and a ssociated prototypes. |
| The designed system may be perceived from conflicting perspectives within user groups. | Hamzah & Wahid (2016) add that not all Clinicians have the same role and may come from different disciplines. The Researcher noted that each may have different design requirements. Noticeably he had to manage apparent gaps when looking at the clinical needs through a consumer's lens. |
| All users should be involved from the start. | Reis et al., (2011) argue that this allows designers to gauge the urgency and complexity of the system requirements. |
| A designing participant should have some knowledge of the information technology practices that may be considered. | Hamzah & Wahid (2016) offer that domain knowledge allows for creative ways of designing a prototype. This enables participants including the Researcher to understand the system more and quickly provide more meaningful feedback. |
| Active participation should be encouraged and enabled | Lindström et al. (2003) remind us not to be limited to set techniques for soliciting participation. The Researcher therefore implemented elucidation, probing and free-thinking techniques to act as a bridge in overcoming communication gaps. |
| Participants should know the specific languages used by participating groups. | Baas et al. (2014) conclude that users from differing groups may not necessarily speak the same research language and may impact the user's participation levels. This advice helped the Researcher exclude jargon, technical terminology, and abbreviations. |

| | |
|---|---|
| First, consider the implementation context of the system before commencing design work. | Hamzah & Wahid (2016) argue that two relevant implementation contexts need considering: personal and institutional context. Personal needs are specific to individual users, while the Researcher needed to incorporate institutional requirements focused on adherence to stimulate reunification. |
| Observe the relationship between designers and participants | Mantzana et al. (2007)theorise those participants may be individuals or organisations. Hamzah & Wahid (2016) relate this to social discourse, and a natural hierarchical relationship may form where likes and dislikes may dominate. For example, clinicians should be prevented from becoming too dominant when participating and CDE corporate needs should not dominate the discourse. |

These insights helped the Researcher with dealing with participants from differing paradigms seeking a single view. When interviewing various clinical disciplines, he explored behaviours, problem identification and solution ideation that were unique to each. For example, impacts of consumer-behavioural psychology with the psychiatrist, a patient living with diabetes with the endocrinologists and education with the diabetes nurse educators. These came together as a confluence of ideas and created a more complete design.

The business had adopted this ADR project, seeking an artefact to solve a socio-behaviour problem (Denzin & Lincoln, 2018) to bring the human and the machine into formal clinical care. However, the relationship hinged on both parties' relationship with the machine (Chute & French, 2019; Khayamian Esfahani et al., 2019) and its attempt to treat disease outside of clinical practice (Kapoor et al., 2020; Keesara, Jonas & Schulman, 2020; Rubin, 2020; Wong et al., 2020).

De Souza (2006) helped the Researcher to consider the Artefact as a hybrid space where we can leverage ubiquitous PGHD behaviours showing mutually beneficial impact on the relationship between the participants. The solution's design malleability embraced the machine blurring traditional research borders. The Researcher used Creswell et al., (2011); Creswell & Poth, (2018); Yin, (2017) to help position the machine as a new theme, checked against contemporary literature, and incorporated in the study (Hagen et al., 2005).

Findings from the pre-thesis data collection were harmonised with literature on ubicomp that explores embedded digitisation into the fabric of everyday life (Weiser, 1991). Harmonising all elements of the review made sure that interviews were focused on themes supporting uniting the clinician and consumer incorporating the elements of PGHD (Burns et al., 2019; Lai et al., 2017; Shapiro et al. 2012)

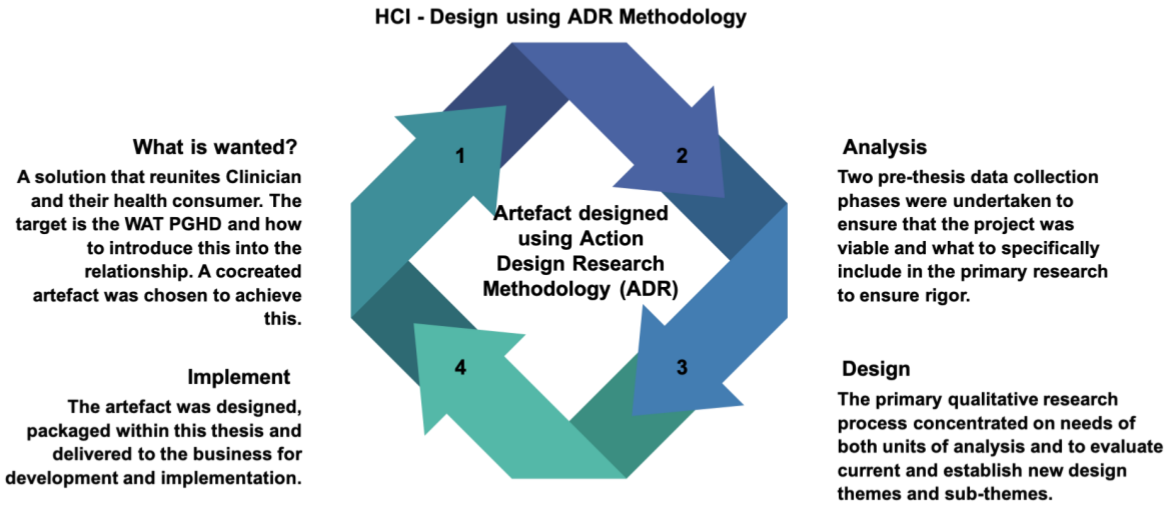
The literature review pivots on the impact of the health consumer's evolving digital habits (Schmidt et al., 2017) and the lack of a clinical response amongst a network of individuals (Wellman et al., 2002).

Literature was also specifically chosen to stimulate new ideas and innovative suggestions (Angrist & Pischke, 2010; Forlano, 2009; Gordon et al., 2015; Willis, Jost & Nilakanta, 2007). This paid particular attention to the discourse between (Mullarkey

& Hevner, 2019) and (Sein & Rossi, 2019), highlighting the dangers of an epistemology that may allow participants exploring unqualified assumptions and reasoning potentially restricting the emergence of an innovative design.

Reflecting on this discourse, the Researcher adapted Newman & Gough, (2020) version of the Tranfield, Denyer, & Smart (2003) Systematic Literature Review methodology by collating various perspectives on emerging themes to create an empirical position. The three-stage approach of first planning, conducting, and writing was adapted to a dynamic, ongoing four-stage process so that the Artefact design could be presented to the practice with supporting evidence from growing contemporary literature.

The Researcher studied several articles depicting approaches to DT models (Table 2.6) but settled on guidance from Dix et al. (2004) and crafted the design process to align with stronger human attributes of HCI (Figure 2.3) that dovetailed with the ADR methodology. He argued this would best suit creating an artefact that would address user's situational needs (Dix et al., 2004).



**What is wanted?**
A solution that reunites Clinician and their health consumer. The target is the WAT PGHD and how to introduce this into the relationship. A cocreated artefact was chosen to achieve this.

**Analysis**
Two pre-thesis data collection phases were undertaken to ensure that the project was viable and what to specifically include in the primary research to ensure rigor.

**Design**
The primary qualitative research process concentrated on needs of both units of analysis and to evaluate current and establish new design themes and sub-themes.

**Implement**
The artefact was designed, packaged within this thesis and delivered to the business for development and implementation.

**Figure 2. 5: HCI Design using ADR, Adapted from Dix 2009**

**Table 2. 6: HCI – A synthesis of DT Models**

| Models | Step I | Step 2 | Step 3 | Step 4 | Step 5 | Step 6 |
|---|---|---|---|---|---|---|
| (Cross, 1999, 2007) | Exploration | Generation | Evaluation | Communication | | |
| (A Dix, 2004;2009) | What is wanted requirement.<br>Find out what is currently happening<br>Interviewing<br>Videotaping<br>Looking at document<br>Object that they work with<br>Observing directly | Analysis The result of interview<br>Scenarios<br>Rich data | Design Runic.<br>Guidelines<br>Design principle.<br>Modelling and describing interaction | Prototype<br>Evaluate design | Implement & deploy<br>Writing code<br>Making hardware<br>Writing documents and manuals | |
| (Mirnig, Meschtscherjakov, Wurhofer, Meneweger, & Tscheligi, 2015) | Identifying the need System must encompass the specified: functional, organisational, and user requirement, | Observe & analysis<br>Understand specify the user context | Design Specify the user requirements | Prototype<br>Produce design solutions that meet user requirements | User feedback<br>Evaluate designs against requirement | |
| (Kollmann, Sharp, & Blandford, 2009) | Identifying needs & requirements for the UX | Developing alternative designs that meet those requirements | Building interactive versions of the designs so that they can be communicated and assessed | Evaluating what is being built throughout the process and the User Experience | | |
| (Tayal, 2013)] | Understand needs<br>Detecting problem<br>Understanding project<br>Detecting limitations<br>Understanding users<br>Establishing goal<br>Gathering information<br>Conducting research- people from different | Imagine<br>Brainstorm<br>Being creative<br>Investigating existing technologies and methods 10 use<br>Exploring, comparing, and analysing possible solutions | Select a design<br>Selecting the most promising idea | Plan<br>Planning for analysis, and review | Create<br>Building a prototype and ICSI<br>Analysing and finding what could be improved | Improve<br>Revisit |

The scope of the review was at risk of growing cumbersome as it starts to consider latent drivers of socio-economic, organisational change management amongst others. To ensure that the systematic process remained within the scope of the study but still expansive enough to include themes and subthemes that would impact the Artefacts design, the Researcher used his position as insider-practitioner and developed a "loops of learning" analytical process for the CALC team creating congruence between research and the practice to test the themes. This centred-on stakeholders needs within paradigm of HCI and further, leverage DT's depth using action learning outcomes as building blocks to the ADR process (Fischer et al., 2019). These are expressed in the adaptation of Sein et al. (2011) Figure 2.6 and discussed in more depth in Chapter 3.

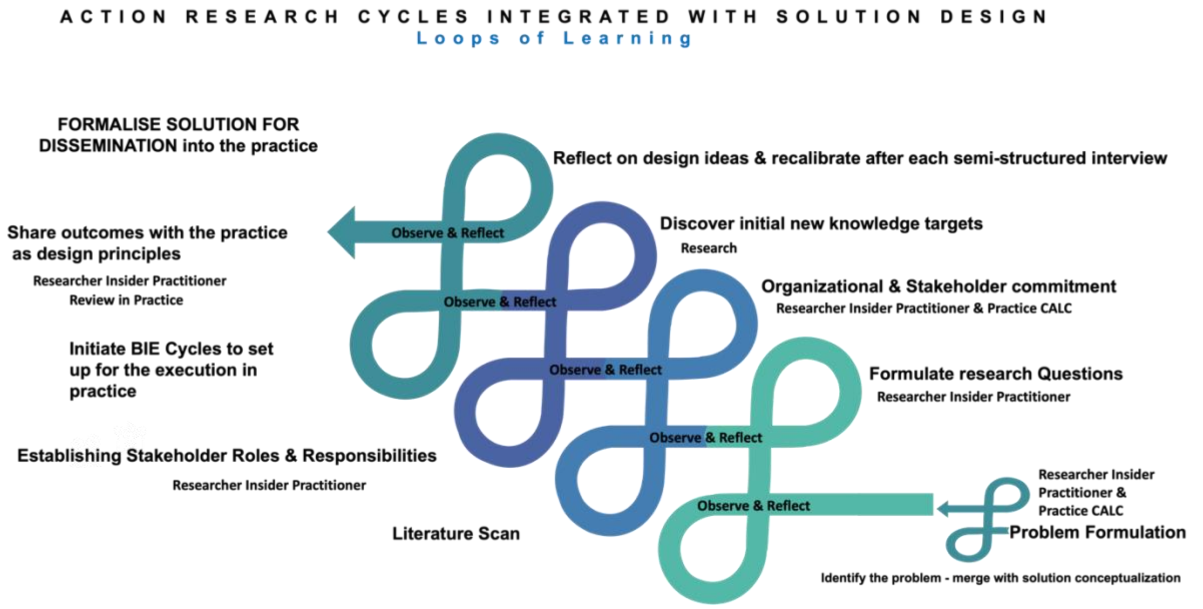


**Figure 2. 6: Action Research Cycles Integrated with Solution Design/ADR adapted from Sein et al. (2011)**

Dix (2009) guided that the planning stages (see 1 and 2 in Figure 2.5 above) established a contextual framework. Likewise, Bilandzic & Venable (2011) guided that ADR phase 1 evaluates the context of the insider-practitioner's and business stakeholders' assessment of the problem.

However, due to the novelty of the study design, the Researcher faced some challenges when seeking supporting literature. Literature stemmed either from business school academics theorising on the subject (Christensen et al., 2017; Leatt

& Porter, 2003; Porter & Kaplan, 2014; Porter & Lee, 2013), or clinician centric arguments (Watson, 2006; Watson, 2017), or tech and institutional analysis (Abdekhoda et al., 2015; Astrup, 2018). Some emerging authors began looking at clinician and health consumer needs, and a few considered the impact of COVID-19. Consequently, the Researcher had to consider a few second-tier journals and publications.

Themes and subthemes emerging from the analytics of the pre-thesis data sets (Appendix D & E) assisted in opening new literature. However, there are still gaps addressing the unique attributes of this topic using clinicians and consumers behaviours in co-inquiry.

The literature presented contextual insights but few practical solutions.

The lack of empirical findings from a hermeneutic literature review (Boell & Cecez-Kecmanovic, 2014; Hughes, Shaw & Greenhalgh, 2020) supports the chosen process of looking at new fields of study extrapolating meanings and texts of the seminal academic arguments (Hyland, 1999). Thus, the Researcher narrowed the review to embrace the solution growing from co-inquiry into participants socio-behaviours to craft a solution (Kriz et al., 2021; Ravitch & Riggan, 2016).

This part concludes that the literature review does not cover peripheral themes (Atkinson, Coffey & Delamont, 2003; Runco, 2014), like mainstream change management or the readiness to adopt innovations in the health system as these had previously been dealt with in the practice’s initial framing of the problem.

## 2.3 PART 2

The research is contexed within the 4th Industrial Revolution, focusing on Health 4.0 (Chute & French, 2019; Khayamian Esfahani et al., 2019) and its ongoing creation of consumer autonomy that is driving self-quantification. It explores the dynamics surrounding this phenomenon and the associated drivers so that the Researcher could better understand what impact these may have on the design of the Artefact.

### 2.3.1 Digital Behaviours - Context

Schwab (2017) talks about a revolution that will change how we work and live as nothing humankind has experienced before. The Researcher feels that we cannot segregate health solutions from the dynamics of people experiencing change across all facets of their lives. Health must leverage innovations in other fields to inform and build models that understand 4.0s impact on consumers' social and work environments. Scholars like Christensen et al. (2017) talk about the disruptive effects on care delivery systems. Schwab (2017) presents the unlimited possibility of billions of people using mobile devices and wearables "giving rise to unprecedented processing power, storage capabilities and access to knowledge." He raises the "staggering confluence" of breakthroughs in AI, the Internet of Things (IoT), robotics, 3d printing, nanotechnology, quantum computing, and biotechnology. The Researcher argues that we must take cognisance of these dynamics and, HCI studies looking at the clinician-patient relationships, must consider dynamic human-computer-behavioural-interaction to ensure consistent functional relevance (Benyon & Murray, 1993; Preece et al., 1994; & Rogers, 2012). As Razzaki et al., (2018) argued, the impact of the explosion and ubiquitous presence of personalised technologies like WAT's has seen the rise of connected health that has empowered the consumer into self-management changing behaviours that seemingly replace the clinician's judgement. To understand the impact on the research question, the Researcher had to understand the technology and consumer-behavioural drivers and barriers (Silverman, 1990) within the doctor-patient relationship so that the Artefact is designed to effect best possible user outcomes. This Part explores the literature to understand the who our consumer is today and, the participant's relationship with WAT and PGHD (Zhu et al., 2016).

### 2.3.2 Drivers

#### 2.3.2.1 Doctor-Patient Behaviours - Impacts on Design and Adoption

For decades, doctor-patient behaviour has been the subject of academic research (Beisecker, 1990; Beisecker & Beisecker,1993). Ha & Longnecker (2010); Stewart et al., (1999) & Teutsch (2003) show an historic communication gap between the two. Emanuel and Emanuel (1992) captured these types of relationships within counter-party decision-making interactions (Figure 2.7) and Smith (1997) predicted the patient shift to the deliberative model the primary, of the four models. The Researcher positions this study within the deliberative model where consumer-choice and access to digital care are the drivers (Emanuel, & Emanuel, 1992) encouraging self-quantification (Lupton, 2016; Lupton, 2013). Unfortunately, clinician paternalism has faced-off with consumerism (Beisecker & Beisecker, 1993), resulting in a disconnected response. Today, command over patient care has shifted away from the clinician (Demiris, 2016). The Researcher argues that these attributes need to be recalibrated to get parity, so both users' needs are incorporated within the solution (Starr, 2008).

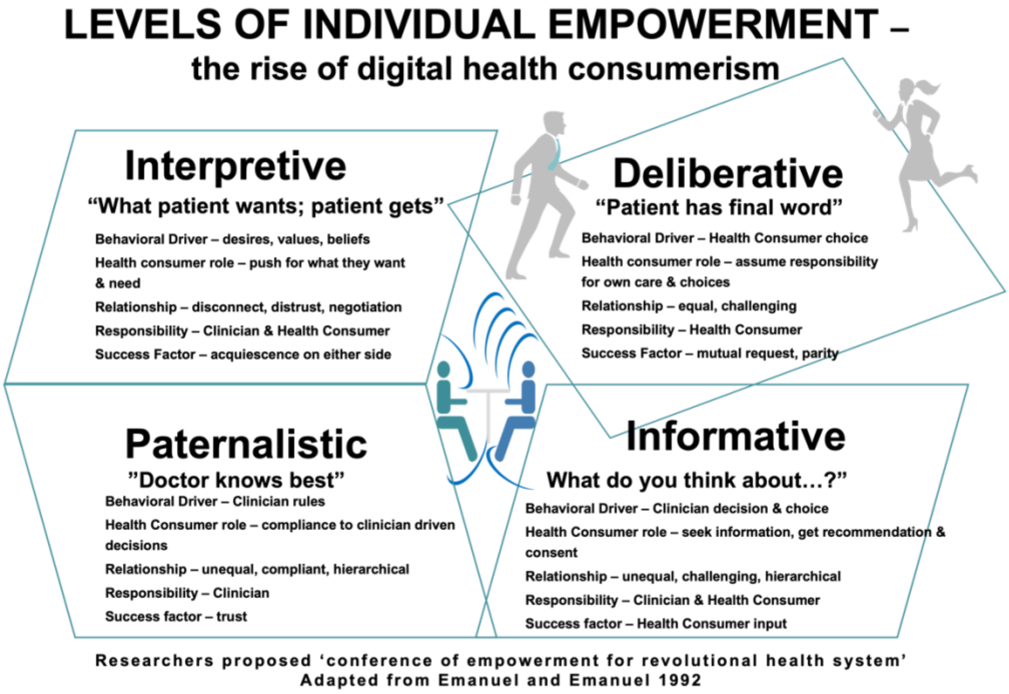


**Figure 2. 7: Levels of Individual Empowerment, adapted from Emanuel and Emanuel (1992)**

The Researcher appreciates his practice interactions still displays the legacy of paternalism. He however advocates that the confluence of new consumer paradigms driven by the rise in digital consumerism (Herzlinger, 2002; Taylor, 2019), patient self-empowerment (Segal, 1998) and increased cost (Kaplan & Porter, 2011) are key drivers to help change paradigms. Embracing collaborative-ideation neutralises the hierarchies' and creates parity around a mutually beneficial task of partnering on conceived solutions. Rodrigues et al. (2018) argue that AI, advanced analytics software, and the Internet of Health Things (IoHT) has challenged the clinical care status quo. Phillips, Street, and Haesler (2016) support the notion of deliberative consumers who want to actively participate in their health, opening opportunities to leverage remote sensors/devices cloud services (Machado et al., 2016), and electronic health records (Greenhalgh et al., 2014). The said paradigm change is also fuelled by the exponential increase in the "World of Wearables" Burmaoglu et al., (2018). Figure 2.8 presents technologies that present new ways of aiding better health care decision-making. Mandel et al., (2002) argue that this functionality can affect efficiencies and cost controls. Greenhalgh (2009) argue that consumers are electronically connected, empowered, engaged, self-appointed experts, enabled and equipped with self-awareness and consciousness of their disease. However, Distiller et al. (2010) caution that self-help decisions made without clinical oversight if left unchecked, could cause unintended health risk consequences.

**World of Wearables – interoperability - an extraction for relevance to this study**

**1 - Medical Applications**

- Vital signs monitoring & In Vivo/implants
- Chronic Disease management
- Brain & eye movements

FOR:

- Unobtrusive Patient Monitoring
- Body Augmentation
- Diabetes Care
- Remote EEG, ECG, EMG

PRESENTS AS:

- Wireless Headsets (e.g. wireless EEG) WAT's
- Vision enhancement instruments (glucose measuring contact lenses)
- Ingestible sensors
- Bio-feedback patches

**2- Lifestyle Wearables**

- Physiological Monitoring -Weight/Energy
- Gait/Posture

FOR:

- Sleep/Diet/Motion Trackers
- Obesity Control
- Interactive Instruction

PRESENTS AS:

- WAT's
- Sensor shoe insoles
- Weight monitoring bands
- Posture sensors
- Sun exposure & skin monitors

**3 – Sport/Fitness**

- Fitness & Performance biophysical measurements
- Virtual Coaching
- GPS Tracking

FOR:

- Biophysical performance/goals – activity & sleep
- Direction/Location data

PRESENTS AS:

- WAT's
- Smart glasses, bio harness, smart shoes, smart clothes

**4 – Lifestyle Computing**

- Responsive Learning
- Interactive gaming – data & media access
- Shared Experience

FOR:

- Compliance and schedule management, EEG Optimized Learning- Augmented Reality
- Realtime screening & interactivity

PRESENTS AS:

- WAT's, Head up Display glasses, VR, Gesture control bands

**Figure 2. 8: Adapted from - World of Wearable Technologies (Burmaoglu et al., 2018 p275)**

Linking this back to the research question, The Researcher is experiencing what Zhu et al. (2016) show as a behavioural shift in health consumers due to the explosion of wearable-sensing a shift Swan, (2012) suggests, is akin to "sensor-mania."

Now, consider what the practice is solving for, i.e., the decline in warm-body clinical visits and, one can link this through literature related to the rise in self-quantification. The Researcher notes international trends supporting this notion Ganguli et al. (2020) examined 142 million primary care visits by private health insured consumers over 94-million-member years. They concluded a startling 24.2% decline in visits to primary care providers between 2008 to 2016. Nearly half of the members did not even have one consult each year by 2016. They concluded that this phenomenon was related to several systemic causes – viz:

- decreased perceived need to visit a doctor,
- financial disincentives and,
- that health consumers were using *“alternative sources of care.”*

Ganguli et al. (2020) noted a marked increase in consumers engaging digital “alternative venues” of information and care, the crux of this research problem.

Bhavnani et al. (2017) show that digital care provides more accessible and affordable access. Consequently, traditional relationships between consumer and clinician have been challenged, and there is a departure from warm body to digital as explored in more detail below.

#### 2.3.2.2 Digital versus Warm-Body Advantages & Barriers

Conventional models of care where the clinicians physically see patients and digital health, currently vest on opposite sides of the health delivery spectrum. The Researcher reviews academic commentary on exploring the drivers of the advantages and barriers to contextualise and position the Artefact as a catalyst for reunification. These are explored in more detail in Table 2.7:

**Table 2. 7: Warm-Body versus Digital Health**

| **Traditional Care -**<br>**Barriers and Good care** | **Digital Care -Barriers and Good care** |
|---|---|
| **Governance:** Gask et-al (2003) argue that there are **emotional barriers** between consumer and clinician that **prohibit full symptom disclosure**. Pollock (2007) conclude that consumers struggle with **health literacy** restricting adequate explanation of their symptoms **resulting in inadequate evidence** for an accurate diagnosis. | **Governance:** Williams et-al (2015) argue that a downfall of the digital health systems is that they **inhibit control of consumer data and that consumers are unaware that they** generate health related information and are blissfully **unaware of the permissions they are giving unknown third parties.** |
| **Evaluation:** Rogers (2002) & Manyard & Heritage (2005) raise an interesting phenomenon; the Researcher argues as **clinician burnout** (Gardner et-al. (2019) & Norton (2018). Rogers (2002) raise the notions of **"tensions between medical and social explanatory"** – clinicians may find it **challenging to distinguish sad life stories from medically based treatment-based disorders**. **Stressful life** management is **moving to self-care** rather than having to deal with a clinical interaction. | **Evaluation:** Moore Graham et-al (2015) conclude that extensive care needs to be taken around the **susceptibility of data to breaches**. We need to concern ourselves with screening all other data inputs and integrations including but not limited to EHR's. |
| **Do no harm:** Cape (1996) remind us about the unknown assumptions about agency as **warm body consults often are mismatched** as **consumers are relegated from ownership of the interactions.** | **Do no harm:** Majeed (2015) argues that **connected health technologies could exacerbate** the **digital divide between clinician and patient self-management.** Majeed (2015) also argues that **older populations** can become **under serviced** when treatment depends on digital technologies. |
| **Nice-to-have:** De Rosis & Barsanti (2016) raise the critical matter of **under resource**d warm body health sectors causing **rationing of good care.** Stretched resources also **rush care interactions** which **limit full symptom** checking and appropriate **diagnosis**. | **Nice-to-have:** Majeed (2015) caution we must **not replace the clinical judgement with digital interactions**. Clinicians should be **empowered** with clinical systems. We must |

| | |
|---|---|
| Emanuel & Emanuel (1992) (per Figure 2.11) present a case that the **“deliberative” patient requires** the **intimacy of human explanation,** and this **leads to better outcomes** and decision making. | Ball & Lillis (2001) argue that digital make administration more effective. In 2001 this may have been the case, but the Researcher prescribes to the notion that **clinicians are overwhelmed with clinical systems** from multiple sources that now hinder the effectiveness thereof (Shanafelt et-al (2016) |
| Buszewicz et-al (2006) remind us of the advantages associated with the **healing elements** of **human connection**. Health consumers need a **softer and shared health approach.** | Ball & Lillis (2001) argue that consumers boast a higher degree of health literacy and expect a **degree of convenience**. Consumers do not want to wait for appointments. |
| Emanuel & Emanuel (1992) argue that if clinicians were to **empower the consumer with credible information** this would result in **improved adherence and better outcomes**. | Ball & Lillis (2001) argue that **digital** technologies can **provide remote self-diagnosis** and **self-imposed medical judgements** where there is a **shortage of available clinicians**. Ball & Lillis (2001) add that these **technologies increase compliance and adherence**. The Researcher argues that while this seems theoretically acceptable, the practicality when you live this problem manifests differently. |

Concluding, Silverman (1990) argued that clinicians face traditional care models' barriers letting digital systems power the relationship between health consumers and clinicians and cautioned, that health data structures do not cross the traditional health model's health and social divides.

Reuniting the consumer and clinician requires a new model that makes human centredness and digital behaviours fundamental.

Part 3 examines the literature to help understand elements that need considering if the ADR is going to capture and enhance this proposed harmonious intersection within an artefact.

## 2.4 PART 3

This project offers a solution to achieve harmony in an artefact using HCI co-creation (Forlizzi et al., 2008) subscribing to "research through design" (Frayling, 1993) or in modern terms ADR.

### 2.4.1 Human Centredness in Co-design

Forlizzi et al. (2008) argue that we can incorporate DT into HCI studies while offering a way to transfer research findings from the ADR process. Forlizzi et al. (2008) also presents an argument that allows incorporating "true" or experiential knowledge with the "how" knowledge and its relationship with a technical invention that has captured functionality through an evaluation of user needs (Carroll, 2003). HCI in health elucidated by Blandford (2019) guided the Researcher in deploying ideating, iterating, and critiquing elements which helped problematise and, iterative reframing, helped harmonise the "right" thing; a concrete framing and articulation of the Artefact's preferred design (Forlizzi et al., 2008).

Forlizzi et al. (2008) gave the Researcher confidence that one can bring human perspective to the technical development of an artefact.

#### 2.4.1.2 HCI Drivers for Users'

The complex interactions between technologies and ways of life led the Researcher to evaluate clinical and consumer user interfaces (Adams et al, 2008).

Gardner et al. (2019) raised an important consideration, that interaction with computer interfaces has historically left clinicians frustrated and burnt-out. In addition, clinicians find them time-consuming and unfulfilling due to system design inflexibility (Benyon, 2014; Benyon & Murray, 1993; Preece et al., 1994).

Benyon and Murray (1993) concluded that as health systems evolve in complexity to become "dialogue partners" we must include a high degree of flexibility and accommodation to incorporate changing consumer needs. Krueger et al (1985) stated that as people engage with interactive digital systems, we move closer to the process. However, the Researcher argues that this has not happened in clinical health care delivery due to traditional care legacies, clinical paternalism, and lack of digital skill.

So, as not to impose this philosophical bias on the study, he explored how usability issues are subjectively and collectively experienced and perceived by the participants. This meant using this research to identify the users' emotional and social drives and perceptions which might contradict his notion. The Researcher became confident in reading that HCI has evolved to investigate these elements crucial to the Artefact design (Adams et al., 2008; Seffah et al., 2006). However, he was vexed about how he was going to extract research data that could help create constructive dialogue between humans and computers also called Human-Machine Interaction (HMI) (Carroll, 2003) that could help balance out paternalism and embrace consumerism. To address this, the Researcher made sure that the probing in the primary data collection addressed fundamental HCI design goals "to develop or improve the safety, utility, effectiveness, efficiency, and usability" of the Artefact (Barlow, Rada, & Diaper, 1989; Preece et al., 1994). Scholars, such as Benyon and Murray (1993), Preece et al., (1994), and Rogers (2012), all note that HCI must be seen as broader than just the interface design and consider all aspects of clinical interactions. To effect change, the Artefact cannot be seen as only a digital solution; as Carroll (2003) describes, it must include the intersection of social sciences, behavioural sciences, and computer information technology. The Researcher concluded that he would have to probe participants to understand “context of use” (Despont-Gros, Mueller, & Lovis 2005) to help understand what elements beyond functionality would align with those of the clinicians and visa-versa.

Despont-Gros et al. (2005) noted that the number of studies focusing on user interactions had increased exponentially. These the Researcher addresses through an increase in the unstructured approach to the discovery stage (Adams et al. 2008). Beck et al, (2003) and Kjeldskov & Graham (2003) found that in HCI there are bodies of work on lab-based methods of research but, few examples of actual user studies in natural settings or, conceptual and theory-building research. This action-based study data collection relied on Mandel (2002), to centre on practical HCI phenomena.

### 2.4.1.3 HCI in Healthcare

HCI studies confirm that private care delivery is not focused on consumer-centricity (Blandford, 2019). The Researcher adopted the arguments of Mahmood et al., (2000), whose synthesis of 45 empirical studies supports health consumer-centricity in HCI research. Mahmood et al., (2000) found that "user involvement in information system development" was essential in determining satisfaction levels with the solution. The Researcher also reviewed Kaplan and Shaw (2002), taking cognisance of the view that barriers to the successful deployment of HCI projects in the medical field were broadly categorised as follows: insufficiency; factors inherent to a medical environment; project management; people; organisational and social issues. These became centre within the semi-structured interview scripts for the primary data collection. Consequently, the Researcher raised the importance within the data collection, of the human experience.

#### 2.4.1.4 User Interface (UI) and the Human User Experience (UX)

Studies show that an essential part of artefacts is the UI design that enhances the interactive use of artefacts (Dix, 2009). Benyon (2014), however, caution on the difficulties involved in designing an interface that will deal efficiently with individual preferences without creating other user frustrations. Dix (2009) offered the Researcher remedial options to these challenges arguing that the Artefact is the interface between machines and its users and must facilitate personal changes and real-time developments to encourage interactivity. However, Hassenzahl & Tractinsky (2006) warn that evaluating usability is not enough to improve an application's quality.

This moved the Researcher to explore the need to evaluate the users' senses while interacting with the Artefact defined as User Experience (UX). UX extends the concept of usability by emotional and aesthetical factors. Albert and Tullis (2013) made the Researcher appreciate this as a critical element within the very personal and sensitive clinician health consumer relationship.

He then looked at Vosinakis & Koutsabasis (2018) who argued that there are various means of exploring these factors with the participants, including (1) participants envisaged usability, (2) the performance of the tasks set up within the Artefact and (3) understand what experience the user would have wanted when engaging with the Artefact. Nascimento et al., (2016) also explore usability insights which helped the Researcher assess how the characteristics of a device or interaction technique affect the user's use of the Artefact, including ease of use, learnability, user task performance, user comfort, and system performance. Nielsen (1994) narrowed this to prioritising ease of use and user satisfaction needs assessments. Seffah et al., (2006) distilled this further arguing the definition of usability is an application affected by the user's characteristics (his/her cognitive perception, his/her ability to act upon the application and how (s)he perceives the reaction from the application).

The Researcher included interview questions prompted by arguments from Bachmann et al. (2018), exploring user task performance framing the quality of performance of specific tasks in the Artefact such as the time to navigate, accuracy of object placement, or the number of errors a user makes in selecting an object from a set. These are all critical if the users are expected to use the Artefact to manage the patient's treatment plan. Furthermore, Bachmann et al. (2018) explain that UX is "a person's perceptions and responses resulting from the use or anticipated use of a product, system or service." Therefore, the Artefact must be associated with aspects of everyday usability considering beauty, hedonic, affective, or experiential aspects (Hassenzah, 2008; Hassenzahl & Tractinsky, 2006). Hassenzah (2008) argue that Artefacts must promote the users' human needs to achieve this. Measuring whether the design will fulfil the users' expectations, the Researcher relied on Legris et al., (2003), explaining the attributes of Bailey and Pearson (1983), who argued that the researcher should understand satisfaction as an ensemble of feelings or attitudes towards various factors affecting specific situations.

### 2.4.2 Defining ‘The Artefact’ from the Data

The literature argues that the Artefact is a technological tool used for the mutual benefit of users (Orlikowski & Iacono, 2001) and can be presented as an intermediary between the users and the system. It is then the responsibility of the digital-interface to ambiently collect PGHD and other data points, placing them to close out communication gaps (Gatos et al., 2021) and develop recommendations to be carried out during and post consultations. The Artefact is presented to the participants as a translator of each user's input. The participants must opine on the correct display and management of these system commands (Dix, 2009; Dix et al., 2004; Dix et al., 2003). This ADR process centred around the Artefact's design but adheres to Dix et al. (2003), who caution on limitations on the design process by external factors. The

Researcher appreciated that there might be a need for trade-offs (Dix et al., 2003) to help prioritise bespoke participant needs if there is not 100% agreement between the participants on mutually beneficial functionality.

The Researcher contextualised the interview scripts by using Dix (2009); & Dix et al.'s (2004) arguments that: (1) requirements and features raised through observations and interviews are broadly mapped, (2) analysis in which the gathered requirements are ordered to explore critical issues (3) within the design (4) to be included in the blueprint. The final step is operationalised in practice (5) implementation and deployment after the research project, where the practice will release the full minimum viable product.

The Artefact must be usable by anyone. To achieve this, the Researcher had to ensure that any range of abilities adhered to seven general principles highlighted by Dix et al. (2004) and Dix et al. (2003). These included fair uses, user flexibility, sensitive information; low physical effort; size, and space for approach and use, which are crucial to getting parity between stakeholder needs. The exact form and definition of an IT artefact is a much-debated issue. However, the Researcher adopted the definition by Orlikowski and Iacono (2001) as being "the material and organisational features that are socially recognised" within Artefacts that reflect "technology as a structured view" of the organisational domain inscribed into the Artefact (Orlikowski & Iacono, 2001).

This positioned the Artefact as an intelligent application (App) interface that serves an intermediary role by encoding and translating information between participants who do not understand others' knowledge (Carroll, 2003; Chignell & Hancock, 1988).

### 2.4.3 Defining Health Consumer Data

Burns et al. (2019) argue two types of consumer-generated data (CGD) can inform clinicians and consumer at the point of care, viz., active and passive data. Dynamic data can be described as the health consumer consciously generating data. For example, interacting with a mobile health application (Baudendistel et al., 2015). Passive or ambient data is generated without the consumers' interaction, for example, sleep tracking or steps (De Zambotti et al., 2016). The Researcher studied Mandl and

Kohane (2016), who reviewed the Apple health kit, allowing the Apple consumer to view Apple Watch data and input physiological measurements of their activity device. These insights made it clear that the Artefact would engage with both active data from the consultation, e.g., medicine, pathology, clinical notes, clinical education on the data points, and passive PGHD from WAT.

### 2.4.4 Challenges in Leveraging PGHD

Literature exposes that clinicians could be disintermediated by consumers' exponential adoption of Ambient Intelligent wearable devices (Ahuja, 2019; Alkureishi et al., 2016). Therefore, looking at a potential key differentiator of the Artefact, specifically PGHD, the Researcher reviewed Lai et al. (2017). They considered a comprehensive compendium of articles featuring PGHD in consumer health informatics. They concluded that there is a gap in how clinicians and consumers could use the data to improve clinical outcomes. Demiris (2016) concludes from a study of twenty-five years of data that patients will soon be in command of their health. Dimitrov's (2016) arguments conclude that this phenomenon is disconnecting clinical first-line support, placing private practice and the health of consumers at risk. Suppose we include conclusions by Distiller et al. (2010), Cole, Watkins & Kleine (2016) and Ho & Quick (2018), we realise that the disconnected consumer using unqualified PGHD is unsafe and potentially manifests in increased costs and patient risk. Resultantly, the Researcher positioned these arguments in the data collection to see what is necessary to be incorporated to maximise the need to present the PGHD. Maher et al. (2017) show that consumers are engaging daily with the axiomatic prevalence of PGHD; the problem to solve is can clinicians leverage it to help them recalibrate the relationship and become mainstream in the consumer's lives again.

It is essential to note the disconnect in strategies between those enabling the data and those who need to use it. Wingfield et al, (2018) noted that global investors and tech giants had seen the spiralling cost and passive response to consumer-centric health needs as an opportunity to leverage their IoT infrastructure to disrupt the care model. Horgan et al. (2019) highlight that these players have eyes on the PGHD but there remain gaps identifying effective use.

Krittanawong (2018) adds that these advances on PGHD threaten private care sustainability. The Researcher believes that if this is left unchecked, it will position the iDoctor, a "machine theoretically capable of replacing the judgement of primary care clinicians" (Karches, 2018 p91), to collect health consumer data and present a competitive diagnosis disintermediating clinician (Zhang et al., 2017). Nagy and Sisk (2020) show that machines can already imitate intelligent human behaviour and extract and analyse clinical and scientific data in a fraction of the time it would take a clinician. Findings in recent reviews (Bhavnani et al., 2017; Esteva et al., 2017; Fogel & Kvedar, 2018; Wise, 2018) across several clinical disciplines, like radiology, pathology, ophthalmology, and dermatology, show the trend of clinician disintermediation. Bouchard (2019) observes that it is not just specialist clinical medicine that is being disintermediated but that family medicine, which is usually personal, and relationship based, is also being usurped by Dr Google's avaricious moves on PGHD. The Researcher found it interesting to position this phenomenon among the participants and test their view of the need for clinical humans when machines can successfully partner with the health consumer (Arnold & Wilson, 2017)?

The Researcher built this question in the context of the arguments of Greenhalgh et al. (2017), who deduce that the more complex the system (Holland, 2006), the more the relationship between human activities and their organisational, social, and political context, needs evaluation before implementation. This research leverages this empowerment of consumer's socio-economic and psycho-social behavioural needs arguing that they are safer in a clinically controlled environment, enhanced by digital-Artefacts (Van Velthoven & Cordon, 2019). These thoughts are echoed by Meskó et al., (2017) and Meskó, Radó, & Győrffy (2019), showing that historical relational structures are at risk of being replaced by "clinical factories" and must be met with a consumer-centric digital solutions that can leverage the PGHD and bring the clinicians left on the periphery until required, back into daily patient care (Caiata-Zufferey et al. 2010, Dedding et al. 2011 & Sommerhalder et al. 2009). Zhang et al. (2017) argued that despite the intrinsic value clinicians add, as agreed by Huang et al., 2019, they are not engaged in revolutionised thinking and do not embrace consumer needs, which the Researcher hoped to disprove through this study.

However, the Researcher had to consider Lopes et al. (2015), who argued that clinicians are only accustomed to managing care on retrospective and consultation data points. He, therefore, drew on the arguments of Langstrup (2019), who show the legitimacy of using patient-reported data to measure "active patient outcomes." This is supported in Demiris (2016) and Demiris et.al. (2019), which led the Researcher to create supporting interview questions encouraging clinicians to see the benefits of PGHD which he hoped would encourage that to support robust debate on whether the clinicians will see value in the data and will engage with the PGHD within the Artefact.

### 2.4.5 Understanding Consumer's Relationship with Their Data

The Researcher decided that if he were going to promote the PGHD arguments above, he would have to understand the consumer's growing relationship with their data deeply. There is increased academic attention addressing the rise of the "Quantified-self consumers" (QHC), which, Swan (2009; 2013) explains, are a "new class" of demographically nondescript healthcare consumers using WAT for diagnosing and managing their health. Taylor (2019) notes that patients utilise the digitalisation of care to mature from clinical paternalism and hierarchy into consumerism as they find it "burdensome" to share PGHD with clinicians. Consequently, consumers carry their "Quantified-self."[14] (Lupton, 2016; Lupton, 2013) data away from structured clinical delivery models into agile digital receptors resulting in fewer visits to their clinicians. Norman (2017) raises the risks of a growing health consumer narcissistic self-confidence to “self-manage.”

The Researcher explored the behaviour raised by Norman (2017) and looked at apps that link home lab test results[15] that then integrate with vital signs data. He researched some of the communities set up to enhance self-management without clinician oversight. Ajana (2017) presents the notion that newfound knowledge from these sources fuels the rise of the Quantified-self-movement. At face value, this sounds

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[14] http://quantifiedself.com/guide

[15] https://www.labcorp.com

progressive; however, the Sharon (2017) study cautions on the dangers associated with users' "blind belief", who cannot interrogate the clinical context of this data. As PGHD has become prolific, big business has responded with several consumer-centric support platforms[16][17][18] (Christie, 2013) to assist in interpreting the data. The Researcher thinks about these as digital communes of people with similar health interests that support each other but without skilled medical intervention.

The Researcher then considered peripheral drivers and found that global medical payors are using WATs to encourage self-monitoring. Discovery Health Medical Scheme tracks and rewards members using WAT. Patel et al. (2018) show that payors discount the acquisition of WATs to encourage daily measurement and offer daily milestone rewards for submitting PGHD. Mercer et al. (2016) and Ryan et al. (2019) evidence that these initiatives also change clinical behaviours. Wellness programmes like Vitality® reward consumers for measuring and managing themselves. As evidenced by Patel et al. (2018) and Raber et al. (2019), this is causing consumers to embed WATs, like Apple Watch®, Garmin® and Fitbit®, into their everyday lives (Bilandzic & Venable, 2011; Maher et al., 2017).

Added, Wong et al. (2020) argued that COVID-19 had ensconced this trend to self-monitor as consumers deal with fears that make clinicians' practices unsafe. WATs are already more pervasive than clinicians' availability, and as they become more intelligent, Briganti and Le Moine (2020) propose they may become the first line for diagnosis and patient support. In seeking innovative ways to differentiate this support, the Researcher investigated machine learning transformation supporting consumer shifts.

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[16] https://www.bigwhitewall.com/?lang=en-us

[17] https://www.meetup.com

[18] https://www.patientslikeme.com

### 2.4.6 Artificial Intelligence (AI)

The Researcher went through the literature to look at AI to see if there was merit instead of replacing the clinician rather replicating the clinician within the Artefact. Wang et al. (2019) comment that while machines used to rely on humans to input expert medical knowledge, today's medical AI mimics humans and trains themselves. Applied to medical imaging AI uses pixels to define pathological differences. In diagnosis, the machine draws on terabytes of raw data from health records and published Journal literature. Beam and Kohane (2018) show that consumers engage with AI daily, whether through Google searches or choosing a movie from Netflix. As agreed by Yu et al. (2018) and Beam & Kohane (2018), these daily consumer-centric behaviours have applications in healthcare.

While most medical schools do not yet include AI in the syllabus, clinical decision support tools were the first successful application of AI in HCI design (Rundo et al., 2020). More recent advances in machine learning and AI algorithms build predictive models allowing for real-time predictions (Grudin, 2009). IBM Watson is already assisting doctors with proposed decision-making support (Razzaki et al., 2018). Deep learning can predict future illness trajectories and predict readmission to accumulate substantial cost savings (Pham et al., 2017). Miller and Brown (2018) show that AI can analyse scientific medical literature and collate informative clinical outcomes. Angermueller et al., (2016) prospect that machine learning from medical data could predict and prevent human medical errors, thereby impacting patient care positively.

The Researcher realised that the threat of clinical disintermediation increases exponentially when you bring PGHD and AI together; he believes there is a compelling advantage if able to triangulate on multiple data points, including PGHD to present the clinician's prognosis, with significantly more analytical rigour. Additionally, Yu et al. (2018) argue that the proliferation of AI in healthcare can create access and efficiency. These present opportunities to expand the clinical service through the Artefact into consumers' homes and address the cost of care. The Researcher, however, was discouraged by the significance (Ahuja, 2019; Armstrong & Lorch, 2020; Horgan et al., 2019; Krittanawong, 2018; Nagy & Sisk, 2020; Panch et al., 2018; Shah, 2019; Topol, 2019) literature was weighted towards replacing the clinician with machines. However, Razzaki et al. (2018) raised a valid driver for this trend, arguing that this is due to a critical global shortage of health workers. This presents an argument that the Artefact can be positioned as an extension of specific clinicians creating digital multiplications of medically skilled humans.

Tran et al. (2019) argue that AI will become more critical than clinicians. They show how AI can draw on a confluence of data points, including but not limited to complex algorithms using a variety of markers, and aggregate published clinical research from PubMed and thousands of clinical notes from EMRs to ascertain patient conditions. In this intelligent new world where AI can already interpret electrocardiograms, read and diagnose cardiovascular disease and diabetic retinopathy from fundus photographs (Yu et al., 2018), Arnold & Wilson (2017) question the place in the future of the clinician? However, the Researcher argues the case for the face of clinical care and AI to come together as a more formidable value proposition.

Unfortunately, clinicians need to be more experienced around PGHD and AI. Oh, et al. (2019) surveyed 669 doctors in Korea's high-tech environment and showed that only 5.9% were aware of AI. However, juxtaposed, 83.4% of the respondents agreed that AI would help make a diagnosis.

The Researcher argues that the literature needs to be more comprehensive considering the power of the three agents, viz. the machine, the clinician and the health consumer acting harmoniously to deliver optimal cost-effective care and sees a novel opportunity for the Artefact to explore these possibilities.

### 2.4.7 AI for Wearables

The next era of wearables will be their link to AI. Shi et al. (2020) add that this advancement is well positioned as a rapid systems enabler for the use of data to create self-sustaining, intelligent systems that may allow for immediate triggers for clinical responses. El-Gayar et al., (2020) conclude that wearables and AI are causing a notifiable paradigm shift to self-care. The exponential increases in Big Data derived from wearables and quantified patients El-Gayar et al. (2020) argue will transform healthcare and add the notion that real-time data from wearables monitoring patients presents opportunities not just to intervene earlier but, with intelligent interactions making for better and more cost-effective outcomes. However, Luprano et al., (2006) caution that using unqualified raw data can lead to erroneous and sometimes dangerous clinical reactions. The Researcher argues that the use of AI leveraging wearables predicting potential fatal events like myocardial-infarct (Van Helleputte et al., 2014) will increase investment and development in the association between wearables and AI.

### 2.4.8 WATs Growth – Opportunity or Threat

Threats. The literature argues that clinicians still rely on their intuition, assuming machines to be inferior (Chaudoir et al., 2013; Longoni et al., 2019; Morris et al., 2011). Additionally, Goldsmith (2012) argues clinicians are commercially and technically under-resourced, undercapitalised, and challenging to embrace significant technological and data advances. Nevertheless, WAT consumer adoption shows no abating. Loomba and Khairnar (2017) show that WAT was already (pre-COVID-19) growing at a CAGR of 19.6%. Consumers are increasingly acquiring devices for immediate feedback to manage chronic disease and "individual well-being" (Bhavnani et al., 2017; Majmudar et al., 2015; Swan, 2013). WATs are becoming more “personable” to consumers as they measure their physiological metrics (Seshadri et al., 2020). As the likes of Google's AI form close bonds with Quantified-self-consumers, clinicians may be superseded by supercomputers as the machines forge stronger relationships with consumers (Powles & Hodson, 2017). The more WAT grows and empowers the Quantified-self, this may increase the threat and increasingly marginalise caregivers from their first-line care (Gabriels & Moerenhout, 2018; West et al., 2016). Opportunity. The Researcher believes differently and argues that the explosion of WAT must be seen as an opportunity to be grabbed by the clinician before Dr Google disintermediates them. The Researcher presented this for discussion to the participants with a view of building on this notion.

### 2.4.9 Patient-Centricity

The Researcher feels that the definition of patient-centricity, when discussed in the literature (Getz, 2015), represents a positivist view. The literature presents the consumer as the subject, often referring to them as a biparty to the system rather than the centre thereof. Yeoman et al. (2017) prove the point by referencing a need to "deeply understand *their* medical conditions" and engage *them* throughout the process. This study counters this theme and proposes the Artefact as a bridge from the clinician to the patient.

This requires creating a digital ecosystem that incorporates clinicians, IoT, and supporting technologies, and seeks to work with the health consumer. However, Adler-Milstein et al. (2017) highlight the challenge. There is an "IT chasm" between the health consumer and the clinicians, each working on separate platforms. Clinicians are overwhelmed with non-consumer-centric data systems imposed upon them. Friedberg et al. (2014) show how this counterintuitively defrays the quality of care and consumer experience. As a critical driver to using an artefact as a digital catalyst to reunite the clinician with the consumer, the Researcher spent time studying Zhang et al. (2015); Zhang et al. (2017); Zhang et al. (2018). He concluded; consumers are adopting lifestyle technologies that are growing into clinical tools. The Lee et al. (2014) and Lee et al. (2015) studies concur that Dr Google presents as an agent continuously ready to respond.

Unfortunately, small to medium enterprise “SME” (Auer & Jarmai, 2018) clinical practice is not focused on patient-centricity (Blandford, 2019; Yeoman et al., 2017). Clinicians are seldom involved in their consumers' everyday lives and have lost the caring character of the “house doctor” (Kravitz & Melnikow, 2001). Patel (2020) shows that until the disruption of COVID-19, clinicians have not had a compelling reason to remodel their businesses and are not positioned to meet patients' fast-paced existential needs. Paré et al. (2018) show that this private practice inertia has opened the playing fields for self-management to become entrenched. Findings from Fiske et al. (2020) support the view that it will be hard to realign consumers who are morphing into “iPatients,” with the previously familiar need for a “check-up” or the “pop-in” to your clinician for symptomatic acute care.

Quantified-self health consumers are on the rise. Lupton (2013) and Lupton (2016) show the growing and convenient proliferation of content and data machined health that will continuously increase the threat to warm-body clinical treatment. For effective care management, the literature maintains it is crucial to preserve clinician-supported treatment plans to deter downstream costs (Distiller et al., 2010). Hex et al., (2012) proved that 80% of these costs could be reduced if clinicians and consumers collaborate to manage their diseases. However, clinical response to the rise of the health consumer's digital care needs could have been better, where machine agility seems to have no bounds.

Additionally, when patients are not seeing their clinicians due to COVID-19, payors look at alternatives and encourage members to interact with their PHGD more often. Kapoor et al. (2020) argue that as consumers become more autonomous, the system will replace clinicians as the patient's first line of care.

Vendors have attempted to “digitise” the clinician; however, these have predominantly been in the form of asynchronous messaging (Bouchard, 2019), EMRs, telemedicine and specialised remote monitoring (Liddy et al., 2019). These existing platforms are usually isolated from the patients and are not consumer-centric. They are forced on clinical workflows by insurers, hospitals, or managed care organisations. Additionally, health information technology "burnout" among clinicians due to the belabouring EMR administration is well documented (Gardner et al., 2019; Norton, 2018). Shanafelt et al. (2016) showed that the clerical impedance from EMRs contributes to clinician burnout, detracting from seeking digital consumer-centric solutions. These scenarios needed probing with the participants to see what these extenuating forces may have on the usability of the Artefact

### 2.5.10 So, ‘WAT’ is the Position for Clinicians?

Feng and Liu (2016) concluded that clinicians' problem is complex at technological, economic, and behavioural level. Private practice high street models waiting for patients to arrive and be treated is breaking down (Fraser et al., 2020). Bolton et al. (2018) argue that it will require that clinicians engage in structured processes that bring the clinical expertise and the patient's daily management of their wellness into symbiosis.

The study by Loos and Davidson (2016) shows that most research has concentrated on the consumer adoption of WAT and PGHD. While the importance of integrating WAT-generated PGHD is again undisputed, getting clinician buy-in and how to use the data remains a gap. Loos and Davidson (2016) conclude that a driver of clinician inertia to adopt WAT PGHD is the need for more understanding of the data's usefulness, and there is a gap as to how to incorporate the information efficiently into the treatment plan. Shin et al. (2019) presents a synthesis of 463 studies that show that WAT overcomes conventional health measurement barriers. The Researcher argues these can be solved if we empower clinicians with education around new digital ways of diagnosing and managing disease, increasing their value to the Quantified-self.

### 2.5.11 ‘WAT’ PGHD will Affect Better Outcomes?

Only a few integrative studies on the convergent and divergent views of health consumers and doctors around digital transformation and the impact of growing PHGD exist. More studies need to address how to integrate PGHD elements into the workflow of clinical practice. The literature shows a direct benefit to outcomes if we can reunite the two disengaging agents (Caiata-Zufferey et al., 2010; Dedding et al., 2011; Seeman, 2013; Sommerhalder et al., 2009). Ford et al. (2017) argue that the challenge is that digital disruptors are currently pulling them apart, and there needs to be more evidence of proactive clinician responses. Patient data mostly comes from retrospective sources captured at the point of clinical care, pathology laboratories, hospitals, or insurers (Lopes et al., 2015) but little from the patient directly.

The literature demonstrates the benefits of PGHD and its value to clinicians (Cohen et al., 2016). However, what is also evident is the fight for the data. McEvoy (1999) and, more recently, Birtwhistle and Williamson (2015) show that health consumers remain commoditised post facto data sources. In understanding the data's equity, the Researcher found rich debates (Kish & Topol, 2015; Kostkova, 2015; Kostkova et al., 2016; Safran et al., 2007; Safran, Miller & Beckman, 2006; Shapiro et al., 2012). However, they rarely and conclusively recognise the health consumer as the data's owner, originator or even a stakeholder. The Researcher argues that clinicians need to take ownership of this space and add value to PGHD, endearing them as a value-add to consumers.

Klasnja et al. (2015) conclude, establishing like-minded collective groups of clinicians is crucial to sustaining care delivery. The literature encouraged the Researcher to use the interviews to elucidate consumer behaviours, to help build data patterns to leverage and build the PGHD as the patient triages through the clinician's processing systems seeking better outcomes (Benyon, 2014; Jacko, 2012; Nardi, 1996).

Dunn & Shapiro (2014); & Dunn et al. (2015) concluded that the clinician, as the author of care plans and the prescriber of medicine, has a competitive advantage over the iDoctor. The Researcher argues that merging PGHD with these superpowers within a single management platform (the Artefact) will show the consumer that clinicians support ongoing wellbeing and disease prevention outside their rooms. The Researcher drew on Murtagh (2009) and concluded that the data collection process should highlight these clinical attributes as ideas to test whether their participation in consumers holistic wellness management using PGHD can add value to their disease outcome. Hargraves & Montori (2014) inspire this and add; it is only through knowledge, communication, and empowerment that we will find ways for clinicians to remodel and embrace "digital patient-centric care." There is a narrowing gap to capitalise on the clinician-patient trust factor as this advantage is dissipating, according to Ward (2018) and Rozenblum et al. (2015), who argue that we must allow for more intensive patient self-management. The Researcher draws on the collective commentary and concludes that clinicians linked to PGHD could deliver better outcomes.

### 2.5.12 ‘WAT’ for COVID-19

The Researcher could only begin the study with considering the emerging influences of the pandemic. Continuous media commentary heightened the awareness of WAT as governments and institutions used WAT to manage people under lockdown (Brem, Viardot & Nylund, 2021; Chamola et al., 2020). Pépin et al. (2020) show prolific use to measure activity during "home confinement" but showed an alarming decrease of 25% to 54% of steps when measuring people's movement. Lin and Hou (2020) show how proximity management using WAT keeps people away from people living with COVID-19. Best (2021) shows that remote clinical monitoring was not just piloted; it was a critical tool in managing people with COVID-19 across the globe.

Kalhori et al. (2021) reviewed 32 papers that reported 37 digital health applications for controls while managing COVID-19. Telemedicine was prominent and represented a third of the reviewed literature. WAT-based real-time tracking and self-care management made up another third. Kalhori et al. (2021) conclude that COVID-19 is the beginning and that more intelligent digital devices should be used to manage health and populations.

However, while there are powerful advantages of using WAT to manage a population health crisis, clinicians were excluded as consumers turned to digital care (Wong et al., 2020). Kapoor et al. (2020) heightened the debate promoting digital as better healthcare during the pandemic while clinicians were left on the periphery debating their future in changing societal behaviours (Rubin, 2020).

While traditional businesses are accustomed to deploying change models (Hamilton, 2020), clinicians have yet to be exposed to change or crisis management thinking. Keesara et al. (2020), in the context of restrictive analogue healthcare, conclude that only an immediate health revolution can address the crisis we face with the advent of COVID-19.

If, as Sun et al. (2020) show, WAT is used to monitor behaviour change, eating disorders (Weissman, Bauer & Thomas, 2020) or elderly inactivity (Roschel et al., 2020) in a world living with COVID-19, the Researcher questions why did the clinicians not grab the opportunity and incorporate it into telemedicine consults? Natarajan et al. (2020), focusing on identifying COVID-19 patients, observe no question using WAT to measure biophysical and vital sign metrics to help diagnose and manage COVID-19 patients. The Researcher proposed that one of the drivers of frustrating processes is clinicians' inability to receive, interpret, and interact with the PGHD, which he addresses in the interviews.

### 2.6 CONCLUSION

This research project is focused on creating a disruptive technological artefact that will reunite CDE clinicians and their patients. The literature informs that if this is to be successful, the Artefact needs to address stakeholders’ personal health needs. The Researcher gained scholastic confidence from the review that overlapping design principles with participative action-based methodology should succeed in creating a tool that brings technology, business, and user needs into one universally acceptable solution (Behrendorff et al., 2011). This thesis focuses on designing the Artefact as a part of an integrated business solution that anticipates future user needs. The literature set the Researcher up to consider the associated main themes. These included but were not limited to capturing the scope of each user's needs, and the requirement to upskill clinicians and consumers using the artefacts functionality to educate around the disease specificity continually. It also highlighted sub and latent themes that would help address clinician technical shortcomings, the neutralisation of paternalistic care and the previous inability to embrace patient-centricity and their digital world effectively. Chapter 3 shows how the Researcher resultantly built the ADR using innovative thinking to match disruption with a more human approach leapfrogging, current commercially available tools that hinder the nurturing of warm-body clinicians back into the daily delivery of healthcare.

# 3 Research Methodology

## 3.1 INTRODUCTION

This chapter begins with the research purpose and empirical research objective, followed by a discussion of research paradigms and a justification of the chosen research paradigms for this study. Next, the methodology is discussed in detail, providing grounds for choosing sampling techniques and associated data collection and analysis. The intent is to show rigour, credibility, dependability, conformability, within the Interpretivist approach so that the references to pre-thesis data can be contextualised as support for the subsequent and primary data collection. The Researchers axiology is driven by his passion for the value of new knowledge that will help not just bring his stakeholders together to answer the research question but, to achieve his purpose of developing a health system that is sustainable, accessible, and affordable while not marginalising the humanity of care represented by clinicians. He knows that with Interpretivism he is bound as an insider-practitioner within the research (Tekin & Kotaman, 2013) and, accepts that this philosophy is the backbone of the research objective best suited to understanding the participants social realities (teleology), so the design of the artefact is encompassing.

## 3.2 RESEARCH OBJECTIVE

The research problem centres around finding a way to arrest the reduction of clinician-consumer visits through reunification by leveraging the pervasive use of WAT and PGHD. The objective is to design an artefact that can introduce PGHD into the clinician-consumer relationship to enhance the engagement's value, as depicted in Figure 3.1

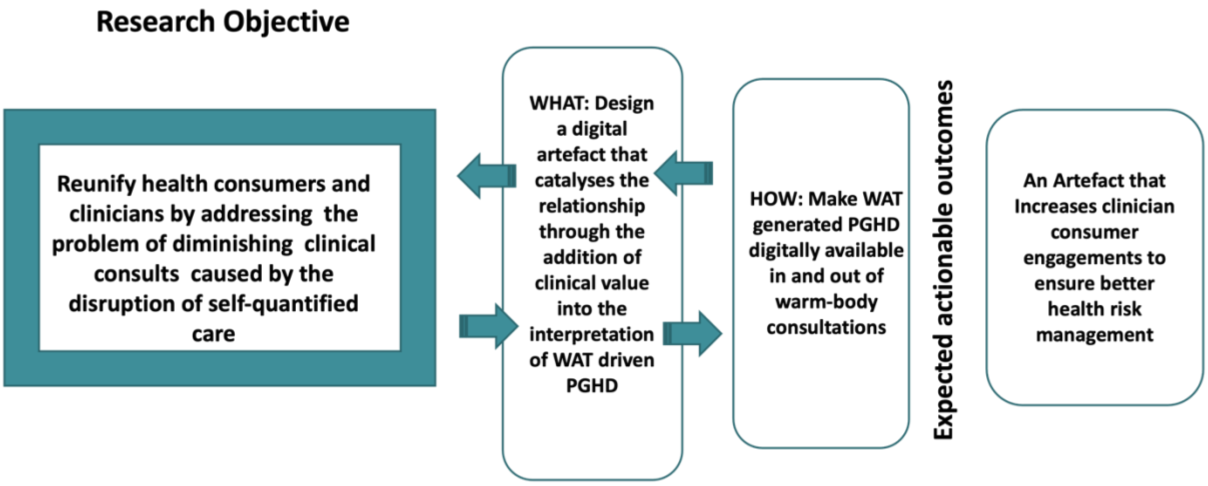

**Figure 3. 1: Research Objective developed by the Researcher**

Literature showed that health technologies and machine intelligence in our health consumers' hands threaten to replace our clinicians, who are the practice's revenue bloodline (Cohen, Winstanley & Greene, 2016; Karches, 2018). Literature evidenced that there are advantages in integrating PGHD from WAT and position these data points as enablers of care and not competitors to our clinicians.

The Researcher reflected on findings from the preliminary data (Appendix D & E) and the literature (Creswell & Poth, 2018). The need for a practical solution highlighted ADR as a methodology looking at participant co-design contributing to the practices knowledge management systems. ADR he felt addressed the research and practice requirement of designing an Artefact that can display the PGHD in a meaningful and mutually understandable linguistic during and outside face-to-face consumer-clinician interactions (Bass et al, 2014).

## 3.3 RESEARCH PARADIGMS

Literature informed that designs are "logical blueprints" with the logic evolving from the links between the research objective, the data to be collected, and the strategies for analysing the data (Collis & Hussey, 2014; Yin, 2015; 2017). The design (Haj-Bolouri et al., 2017) had to address multiple structures necessary to gather, analyse and use data not available to the practice (Bell et al., 2018; Bryman & Bell, 2014).

The following section will discuss options considered justifying the choice of the selected paradigm. Then, the Researcher discusses his Ethical Considerations, Ontology, Epistemology, Theoretical Perspectives, and Methodology.

The Researcher considered relevant paradigms suited to the four foundations: ethics, epistemology, ontology, and methodology that explored the needs and parameters of a study that identifies clinicians as positivist and consumers as deliberative (Denzin & Lincoln, 2018; Guba & Lincoln, 1994).

**Table 3. 1: Considered Research Paradigms  adapted from Denzin & Lincoln (2018); Creswell & Poth (2018).**

| **Research Paradigm** | **Ontology** | **Epistemology** | **Theoretical Perspective** | **Methodology** | **Data** |
|---|---|---|---|---|---|
| Positivist X | Encapsulates a single empirical reality | Emphasises the measurement of reality | Positivism<br>Post-Positivism | Experimental research<br>Surveys | Often Quantitative |
| **Interpretivist** | Involves multiple created realities | Emphasises the interpretation of reality | Critical Theory<br>Social Constructionism<br>Participatory Action | Narrative Research<br>Phenomenology<br>Grounded Theory<br>Ethnography<br>Case Study<br>Action Research | Often Qualitative |
| Pragmatist X | Speaks to single & multiple realities | Emphasises both the measurement and interpretation of reality | Post-positivism & Social Constructionism as approaches to research | Emphasis on experience | Often a Mixed-Method Approach |

The Researcher made a clear distinction considering the variances in the realities of both participants and, himself who was not a clinician, but as for clinicians who could be seen as participant consumers, researchers, architects, and designers of the Artefact (Hamzah, & Wahid, 2016); he therefore dispelled ethnography and phenomenology and concluded that Action Research within HCI positioned towards design, was best suited to capture the context of each participants reality. Linking this to his four foundations he was confident that the research question was most aptly addressed within the Interpretivist paradigm.

### 3.4 ETHICAL CONSIDERATIONS

This HCI study had to produce the design of an artefact involving human subjects' participation (Lazar, Feng & Hochheise, 2010; Lazar et al., 2017) and thus necessary to ensuring ethical best practices for the study.

Consequently, he grounded the study's research practice in moral principles of respect for persons, beneficence, and justice (Marshall 2006; Marshall et al., 2016). Approval for the study protocol was obtained from DBA Ethics Committee, University of Liverpool (Appendix A). No local approval was required but, the Researchers axiology required that his research ethics demanded that participants must be treated equitably and with respect. The Researcher sensitive to his positionality as CEO and insider (Herr & Anderson, 2005), positioned himself on parity amongst participants by empowering them with material covering the scope and objects to be used within the semi-structured interviews positioning participants to make objective judgements when consenting to participate (Lazar et al., 2017).

Informed consent had two parts. "Informed" means that the Researcher had to explain to participants the reason for conducting the study, the procedures involved, potential risks, including but not limited to the fact that COVID-19 prohibited face-to-face interaction. Pre-reading the questionnaire (Appendix B), provided the information necessary to ensure no chance of research harm allowing informed decisions as to whether they wish to participate (Lazar et al., 2017). Participation in this research was entirely voluntary and free from implied or implicit coercion. Sensitive to role duality and positionality as CEO (Herr & Anderson, 2005), participants were not given any reason to believe that a decision not to participate would lead to clinical prejudice, repercussions, including but not limited to reimbursement, contribution risk or service associated retaliation (Lazar et al. 2017: 392). Consent form is shown in Appendix C.

**Foremost no clinical, medical, personal, vital sign or real-world personal data was solicited or used in any part whatsoever.**

All interviews were done online except one – a clinician requested a face-to-face interview that coincided with a practice meeting. This interview was held, observing all social distancing and the strictest medical COVID-19 protocol.

## 3.5 ONTOLOGY

The Researcher explored all properties and relationships and concluded that there was no known fit-for-purpose current solution to his practice problem (Williams, 2016). His ontology centres around the need for humanity and the machine to live symbiotically rather than the machine potentially taking over the need for the human in healthcare. Key ontological questions addressed the assumptions around the nature of the consumer's reality, looking at how they were engaging with their emerging world of digital health and, more specifically, PGHD from WAT. The Researcher had also opened his academic pathway, publishing on the topic positioning himself publicly as an Interpretivist that stated that the problem is multi-layered, and the phenomenon has many dimensions. He positioned the study to emerge with an actionable solution to build on his and other academic commentary (Maykut & Morehouse, 1994; Saunders et al., 2012). There were two aspects of ontology that helped the Researcher deal with whether the participants should be considered objective entities. Do they have an objective reality outside of the social aspects connected to their parochial existence and, what are the related divergent and harmonious digital behaviours and practices (Bell et al., 2018; Bryman & Bell, 2014; Saunders et al., 2012)? It had to be considered that the Artefact needed to be built on the user's needs designed to incorporate social constructions. The Artefact can only address the social behavioural problem if created through social actors' perceptions and consequent actions referred to as constructionism (Bryman & Bell, 2014; Creswell & Poth, 2018; Saunders et al., 2012).

Constructionism, akin to Interpretivism, helped the Researcher assert that the participant's social phenomena and their meanings are constructed through the participant's perceptions and consequent actions (Saunders et al., 2012). This made the Researcher confident that the malleability of ADR would capture the participants' experiences, observations, and insights as social actors engaging with WAT PGHD.

He believes that the clinical engagements with PGHD are continuous social interactions, and as a result, the Artefact must be set up to solve a socio-behavioural problem (Denzin & Lincoln, 2018). However, the Artefact will have to have the agility to appreciate that these social phenomena are likely to be continuously revised (Saunders et al., 2012). The Researcher needed to get a deeper understanding of what is happening and the reality behind what is happening, such as behavioural habits of using WAT and the evolutionary impact on the clinician-consumer relationship. The Researcher deduced that the social world and its healthcare categories are not external to the participants but are built up and constituted through their interactions (Bryman & Bell, 2014).

This helped form the Researchers view that social constructivism intercedes with Interpretivism within this study, addressing the need for the Researcher to conduct research understanding of both clinicians and health consumers' perspectives, gleaning insights from both parties, creating expansive data. (Creswell & Poth, 2018).

### 3.6 EPISTEMOLOGY

Epistemology dealt with the question of what is or should be regarded as adequate and actionable knowledge (Bryman & Bell, 2014). Epistemology is the philosophical underpinnings of researchers' beliefs regarding the nature of knowledge and how it is derived or created. The Researcher's epistemological position (Yin, 2015) was developed in Interpretivism and considered the requirement for reunification of the participants through innovating around their social realities (Bryman & Bell, 2014). Collis & Hussey (2014) define an epistemological position as a philosophical strategy and structure that guides the research process. The following discussions are dealt with in sub-sections to show how the Researcher considered the methodological prescriptions that guided his choice of ADR (Chalmers, 1982). What mattered for this research was the agile ability to capture socially constructed meanings that the social actors (participants) expressed so the Artefacts scope and design would become an embedded part of their daily lives.

### 3.7 INTERPRETIVIST (QUALITATIVE)

Interpretivism advocates that any research needs to respect the differences between people (Bryman & Bell, 2014) and their role as social actors (Saunders et al., 2012). The Researcher’s aim was to understand the meaning of the social realities and events for both his cohorts of participants (Maykut & Morehouse, 1994). The Researcher’s aim was not to generalise like with a positivist inquiry, and this study sought to report contextual and restricted results to the time of inquiry (Tekin & Kotaman, 2013)

Therefore, this research focused on non-numerical data to highlight content and cultivate innovations that could be actioned as the functionality of the Artefact to help shift paradigms and stimulate increased clinical interactions (Bryman & Bell, 2014; Crotty, 1998; Quinlan et al., 2015). Given the exploratory nature of this research and the insufficient literature on the meaningful inclusion of PGHD into the consumer-clinician relationship, and the fact that incorporating ADR within the health space is not well documented, made Interpretivism appropriate as the core research paradigm.

As the research analysed health consumers' views about their use of WAT and clinicians' perspectives on the value that PGHD would add to consultations, targeting these key "social actors" through a qualitative Interpretivist approach was justified (Gephart, 2004). The Researcher included insights from the semi-structured industry interview and the surveys causal explanations which deployed a more critical realism paradigm, to inform the questions in the semi-structured interviews in primary data. Interpretivism allowed him to build on the multiple sets of data. The primary study developed on the causal explanations from pre-thesis data and, moved to adequately capturing user needs in the Artefact (Myers, 2009).

The Researcher appreciated that qualitative approaches are frequently criticised for being subjective. However, an essential guard against this criticism is that all methods, not just qualitative methods, are open to being done poorly and that all experimenters may bias the outcomes (Adams et al., 2008). Consequently, the Researcher reviewed all processes and recorded findings adding reflexive Journal notes that included nuances not captured in the raw data, ensuring rigour, credibility, dependability, conformability of this research. It has made the research methods defensible to ensure the quality of the Artefact design as a research outcome (Adams et al., 2008; Adams & Nash, 2016). Initially, the benchmark surveys and Innovation Health Summit were not intended to be part of the research. However, they unearthed a plethora of causal insights. The Interpretivist paradigm allows this peripheral data that informed and supported the study to reinforce the primary findings.

The epistemological assumptions of Interpretivism were suitable to deliver an actionable outcome as an insider-practitioner, as discussed below.

## 3.7 ACTION INSIDER RESEARCHER

As the Researcher, Insider, and business-leader (CEO) of the practice, judgements about values in the research process was always mindfully present (Saunders et al., 2012; Saunders, Lewis & Thornhill, 2009). The Researcher's background, having had experience in the healthcare industry, placed the Researcher in a position to actively participate and bring insights and inputs throughout the ADR design process. Within Interpretivism, the Researcher became part of answering the research question. Thus, he embraced the insider-action researcher position (Saunders et al., 2009; Tekin & Kotaman, 2013). Instead of separating the research, the Researcher embraced the facilitation role and included his insights within each interview as defined by De Bono (2017). He took the reflexivity from the insights from each phase and positioned them as an insider to inform the next data point in an evolutionary process of reflection as the Artefact's wireframe emerged.

## 3.8 ACTION INSIDER RESEARCHER AS AN INTERPRETIVIST

The Researcher, driven by ontological passion and purpose to find a disruptive solution was evolving and aligning with his pursuit of becoming a scholar-practitioner (Badaracco, 1998) to solve a problem and contribute new knowledge (Maykut & Morehouse, 1994). Emersion in the Interpretivist paradigm allowed for critical understanding and discovering the meaning of social realities for the stakeholders experiencing them (Maykut & Morehouse, 1994; Tekin & Kotaman, 2013). This meant creating a new environment conducive to patients’ needs (Visser, 2005) by placing deliberative-consumers on parity with clinicians to solve this problem (Tsasis et al., 2012).

This would be done using the Artefact design process to show stakeholders the benefits of balancing profit and commercial actions (Baskin, 2006) while incorporating the consumers social-health needs. Harmonising the needs of the participants had as much to do with exploring trust and values as it did with building a joint strategic solution. The Researcher appreciated that his responsibility as an insider-practitioner was to harness the collaborative thoughts and put them into a logical course of action within the Artefact.

## 3.9 ACTION DESIGN RESEARCH (ADR)

The Researcher feels ADR has not been fully explored in practice. Scholars such as Keijzer-Broers & de Reuver (2016) and more recently Mullarkey and Hevner (2019), have noted a limited number of completed health ADR cases. However, evident in Haj-Bolouri et al. (2017), ADR has been acknowledged as an essential variant of the Design Science Research approach, and scholars conclude that several researchers have adopted it as the methodological basis for action learning doctoral dissertations and multidisciplinary research projects as will be explored in more detail below.

### 3.9.1 Defining this ADR

ADR represents a variant of design research that privileges the actionable organisational requirements in the design and evolution of a deployable artefact as a repository of knowledge. Haj-Bolouri et al., (2017) arguments allowed the Researcher to shape the Artefact as part of the practice. Haj-Bolouri et al. (2017) argued that ADR as an approach to design IT artefacts is suitable as a problem-inspired and action-oriented methodology that presents an actionable solution.

Given the research objectives, ADR: 1) combines Action Research (AR) and design research (Design Thinking) (DR/DT) to generate prescriptive knowledge, 2) it is problem-driven, and 3) it aims to build design principles based on iterative action-based reflexive cycles (Keijzer-Broers & de Reuver, 2016).

ADR was helpful to move seamlessly from the thesis design stage to organisational research and development, allowing efficient adoption and execution in practice. ADR tracked progress addressing the problem and enabled rapid iterations based on flexibility, adaptability and productivity combined with User Experience (UX) design (Sein et al., 2011). ADR is a cyclic design process and inspires participants to combine the thinking of other participants with what they were doing. The Researcher considered the ADR method agile for solving real-world problems and generating knowledgeable learning outcomes (Haj-Bolouri et al., 2017). It is usually an iterative process based on working hypotheses refined over recurring cycles of inquiry. This was helpful as the data from each data point was absorbed, reflected upon, and then positioned in the next data cycle. However, while it allowed for efficient transition into final development and execution (Sein et al., 2011) a shortcoming in the Researcher’s view, is that he found himself having to defend the expansive design to the budget constrained investment committee. This was mitigated by phasing development into importance’s-VH (very high) H (High) and M (medium).

This addresses Keijzer-Broers and de Reuver (2016) concerns who found that ADR researchers often face budget constraints and time within the practice setting. Furthermore, the Researcher agrees with Haj-Bolouri et al. (2017) who found that ADR researchers often find it challenging to balance industry partners' (sometimes conflicting) demands versus those of the research community. The Researcher, honestly unwittingly, believes this research mitigated this issue by initially inviting key opinion leaders in the industry to publicly debate the topic in the Health Innovation Summit.

### 3.9.2 ADR - Combination of Design Thinking and Action

DT is human-centred research equipped for innovation breakthroughs (Brown, 2008; Brown & Katz, 2019) and new knowledge. This research involved the users as research designers (Hamzah & Wahid, 2016), preparing the Artefact for rapid prototyping (Lockwood, 2010). Using ADR and DT engaged multidisciplinary participants in the design process to bridge the communication gap and knowledge domains (Simonsen, 2013). DT reduced participant disparities (Henderson et al, 2013), infusing sensibility and process, but ADR made the users' designers matching technological innovation with needs.

DT positioned the Artefact at the core of the information systems discipline. DT methods focused on designing the Artefact but relegated construction to a subsequent and separate phase (Sein et al., 2011). In DT, stages of development and evaluation are kept separate. However, this sequencing, which separates the building from evaluating, is insufficient as the Researcher requires an immediate post-thesis need for building a minimum value proposition (MVP) (Sein et al., 2011). As a result of these shortfalls, the need emerged for a research method that explicitly recognises IT artefacts as "shaped by the interests, values, and assumptions of a wide variety of communities of developers, investors, users" (Orlikowski & Iacono, 2001). As the overarching methodology, ADR incorporated DT and HCI to ensure and effect an actionable outcome.

### 3.9.3 ADR Stages

To comply with the research, need for continuous iteration, the Researcher introduced 'loops of learning' to compound the design rigour of the Artefact. These were assimilated with the Sein et al., (2011) critical stages of ADR, however, the Researcher implemented stage 3 reflection at all loops of learning opportunities as summarised below (see Figure 3.2):

- Stage One: The Researcher extracted practice data showing the decline in clinical visits and anecdotal reasoning from the clinicians manifesting in a view that health consumer behaviour has changed. This triggered the problemitisation process that in turn began the Artefacts conceptualisation.
- Stage Two: looked at the literature and presented a robust case to the practice for action-based research to find a comparable solution.
- Stage Three: the research process embedded with continuous Reflection and Learnings from initial data and the subsequently the findings.
- Stage Four: Formalisation of Learning, write up the research, present the design and move to the development of MVP in practice.

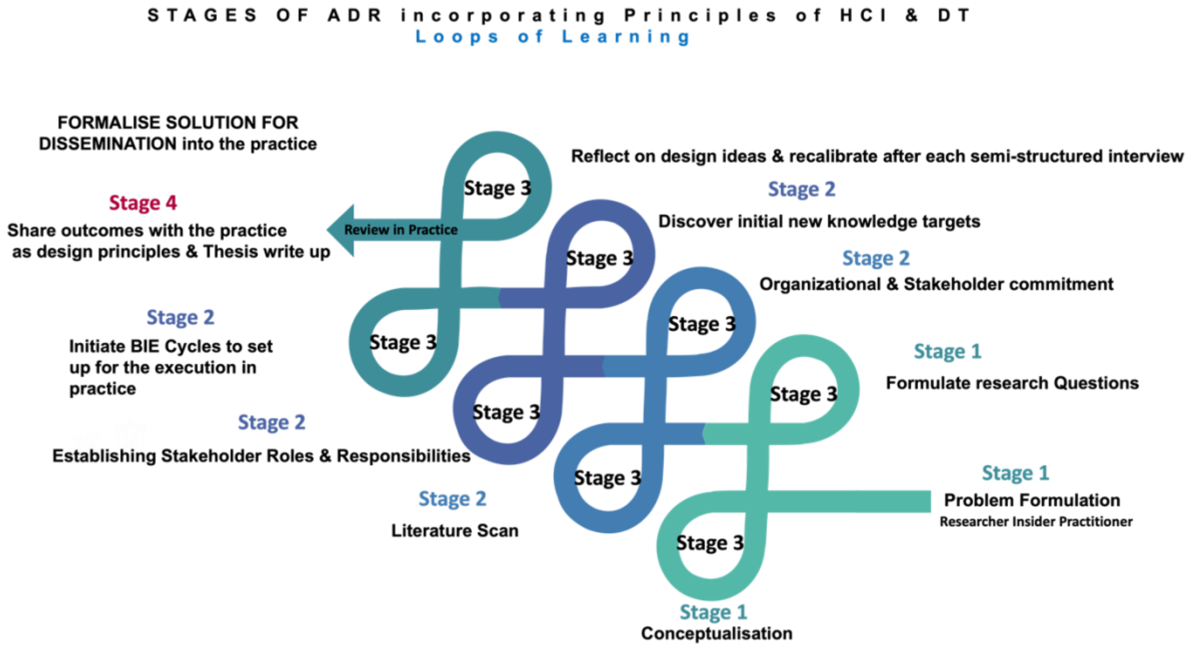

**Figure 3. 2: Reflexive Stages of ADR adapted from (Sein et al., 2011)**

The Researcher adapted the incorporation of DT and ADR principles (Sein et al., 2011) and aligned them with HCI paradigms (Adams et al., 2008; Adams & Nash, 2016; Bachmann et al., 2018).

## 3.10 PROBLEM FORMULATION

The first stage of ADR identified the problematic clinician-consumer disconnect resulting in losing clinical engagement, increasing health and financial risk. CALC adopted this as a strategic imperative for the business providing the impetus for formulating the research effort (Sein et al., 2011). The Researcher received a brief centred around the changing consumer value and the study crafted it into a practical digital solution (Brown, 2008 and Brown & Katz, 2019). The practice problem statement considered all market options and the potential implementation of a vendor-based solution. However, CALC agreed that no viable solution existed and looked to this research to present a solution. The Researcher went to the literature to explore novel solutions but realised that while the problem was being debated, most innovation hubs were building solutions still crafted for clinicians, hospital groups, and payors at the exclusion of the consumer. The Researcher looked internally to conceptualise and develop a solution that allowed users to do what they wanted to do (Mandel, 1997). Scholars debate that design can never be de-contextualised (Haj-Bolouri et al., 2017).

This researched solution came from stakeholders relevant to the "context of use" (Sein et al., 2011).

The Researcher focused on conceptualising the solution and the proposal of an artefact designed by the clinicians and consumers in co-inquiry (Keijzer-Broers & de Reuver, 2016). Haj-Bolouri et al. (2017) helped the Researcher to use this stage to shape the initial scope, determining the roles and scope and begin framing the initial research questions. The Researcher decided to explore context and initiated the two pre-thesis data collection phases. This assisted in meeting the requirements of Sein et al. (2011), who argue that a critical element is securing a long-term commitment from the participants.

### 3.11 THE BUILDING, INTERVENTION, AND EVALUATION (BIE)

This stage presented support from the literature because the problem was not unique (Sein et al., 2011). While the initial Problem Formulation explored the need and generic scope, looped learning allowed more insider discussions. This focused the solution on a digital-design to address users' needs (Keijzer-Broers & de Reuver, 2016). This research concentrated on the organisation-dominant requirements suited for ADR. Figure 3.3 builds on Figure 3.2 and distils the scope into thesis and post-thesis stages, ensuring a clear delineation between the Researchers responsibilities to present the Artefact design and what was then necessary for the business to project for completion and deployment of the solution.

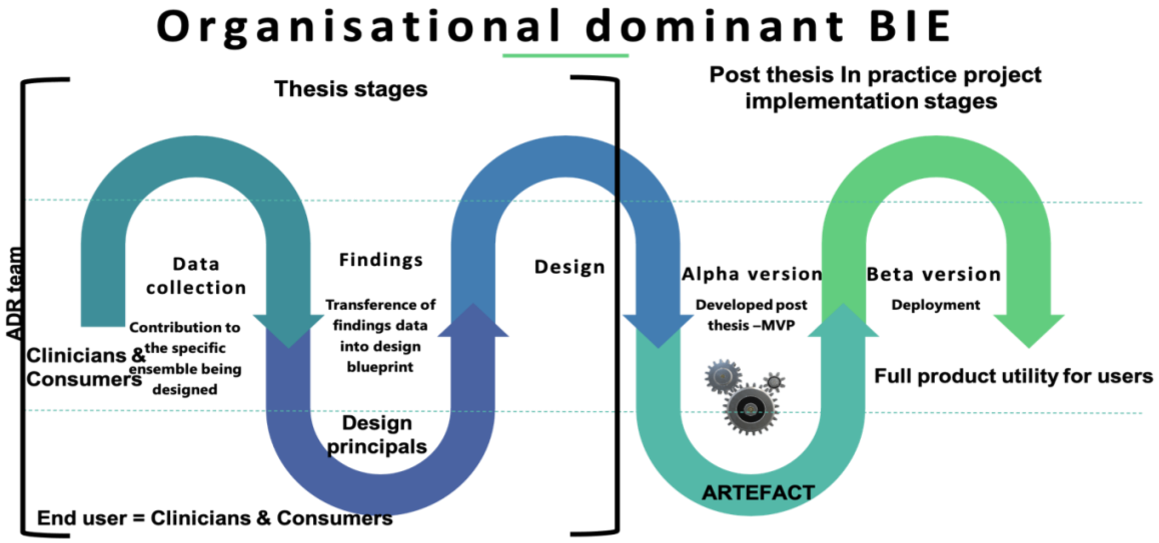

**Figure 3. 3: Organisational Dominant BIE Adapted from Sein et al. (2011)**

At this point, the Researcher realised one of the most powerful latent benefits of ADR - the process of challenging organisational pre-existing ideas and assumptions in the data collection, which is centred-on inanimate design (Sein et al., 2011). This opened opportunities for safe discussion on sensitive issues, e.g., the paradigms of hierarchies and paternalism. Added, practice participants involved in the process of design automatically transferred and created a readiness for the development of the Alpha version.

The flexibility of ADR helped create a human and digital interpretation of the complex data that informed the design and, it’s continual cross-referencing allowed for uncovering previously unknown issues through each iterative cycle (Adams et al., 2008; Adams & Nash, 2016).

Bias was minimised using ADR principles, including reciprocal shaping, mutually influential roles, authentic and concurrent evaluation (Sein et al., 2011). Reciprocal shaping emphasised the inseparable influences mutually exerted by the independence of the clinical and consumer domains that would shape the Artefact from the organisational context. This research used chosen design constructs to shape its interpretation of the organisational environment incorporating the two primary users' needs.

The Researcher adopted the principle of mutually influential roles that highlight the importance of inscribing into the Artefact organisational domains reflecting both user's needs (Orlikowski & Iacono, 2001). The Researcher realised that both clinicians and consumers are health consumers. However, the study's health consumer-participants were not all clinicians. Consequently, an exact assignment of these responsibilities was essential to enable objective reflection on each participant's experience (Blandford, 2019).

The evaluation points added rigour to designing, shaping, and reshaping the co-created Artefact. This was done in unearthing the Artefacts' disruptive conceptual elements not previously recognised in literature or practice (e.g., see clinician Avatars in Chapters 4 and 5).

The question then became one of when to stop. When the design-concepts reached saturation, each new data item could be fitted into the existing theory without requiring the approach to be modified (Sein et al., 2011). At the end of the primary data collection phase, the design was considered ready to present to the practice. The design was now grounded in the existing data, and the users' philosophies were fully accounted for (Adams et al., 2008). The iterations post-thesis would stop either when the organisation adopted or rejected the Artefact or when the contributions of additional cycles were marginal (Sein et al., 2011).

### 3.12 REFLECTION AND LEARNING WHILE UNDERTAKING ADR

The reflection and learning within ADR stages depicted in Figure 3.4 moved from building a solution for the instance to applying an actionable outcome derived from new knowledge to a broader class of problems. This stage recognised that the research process involved more than simply solving a problem. It was essential to adjust the research process based on results from the probes to reflect the increasing understanding of the Artefact as a solution (Sein et al., 2011).

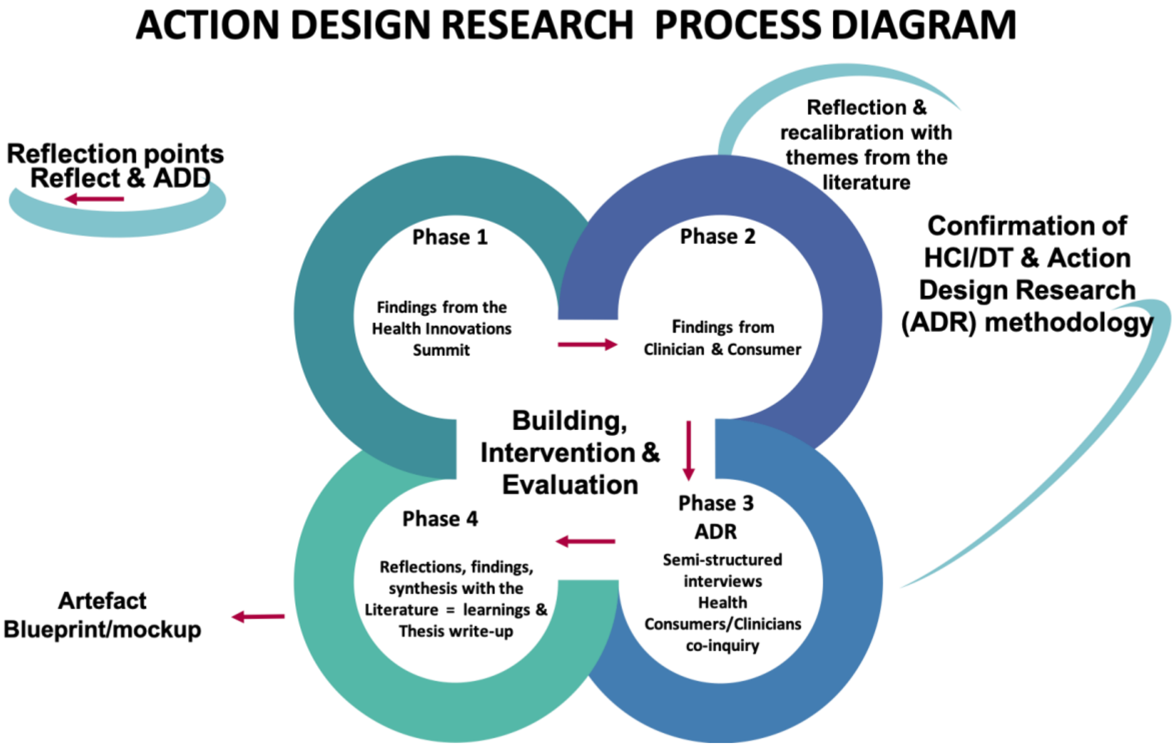

**Figure 3. 4: Action Design Research Process Diagram - Constructed by the Researcher**

Adams et al. (2008) argue that semi-structured interviews only evolve into tentative theory and not a practice solution. However, the Researcher argues that rigorous reflexive analysis and theorising, while the data was growing in real-time, made it agile enough to incorporate new elements. For instance, conducting an interview and analysing it before the following interview supported a richer, malleable, and more explorative understanding of the data, forming a solid foundation for robust findings (Adams et al., 2008). Furthermore, this process was validated using frequent comparisons with the raw data to confirm or refute conclusions (Adams et al., 2008).

Stage three, therefore, included: (1) Reflecting on the emerging design-concepts that were not initially apparent; (2) Evaluated adherence to health consumer-centric principles; (3) Analysed intervention results in line with business case requirements.

### 3.13 FORMALISATION

The fourth stage of ADR formalised the learning and looped it back into the business strategy. The outcomes were characterised as design principles and refinements to behavioural theories that contributed to the initial design (Sein et al., 2011). This research project is an example of formalisation as it documents the ADR real-world outcomes. The Artefact to be developed after completing the research project is also an example of this. The tasks, therefore, included: (1) Abstract the learning into concepts for a class of field problems directly related to the practice business process redesign; (2) Share outcomes and assessment with other organisational practitioners; (3) Articulate outcomes as design principles; (4) Articulate learning considering theories selected; (5) Formalise results for dissemination.

While ADR provides positioning of situated design projects, the approach still leaves much freedom for the Researcher in incorporating other research facets to strengthen the outcome.

### 3.14 DATA COLLECTION PROCESS

CALC agreed that the two pre-thesis sets of data would essentially set up the semi-structured interview process. Continuous reflexivity on each data set through semi-structured interviews unearthed new considerations that were tested in CALC as practical or impractical and then retested in the remaining interviews and collectively either included, excluded, or phased in the final output (Sein et al., 2011; Sein & Rossi, 2019). Bearing in mind the need for rigour when dealing with new knowledge and an unchartered associated course of action, pre-thesis initial data collection cycles (see

Figure 3.5) were used to explore gaps and add a robust framework for the design process

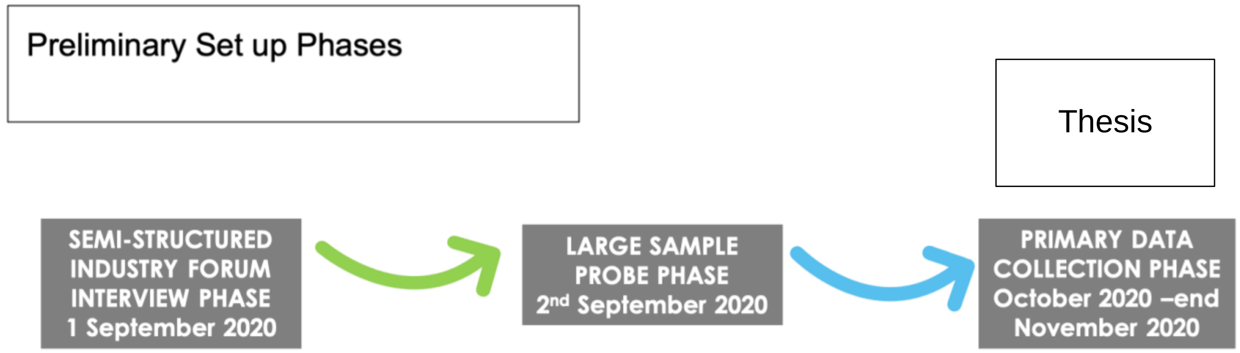

**Figure 3. 5: Data Collection Cycles - Compiled by the Researcher**

Data from the forum between health industry leaders representing clinicians and payors, discussing research themes, chaired, and facilitated by the Researcher using questions designed by the Researcher (Innovation Health Summit 2020), were analysed to explore macro themes of interest. Data were pooled and cross-referenced with the more granular large sample survey findings (Appendix D & E) sent to a broad group of consumers and clinicians, setting up the primary data collection (Cooper & Schindler 2008).

The disruptive potential of the outcomes required an agile and engaging qualitative research approach (Struwig & Stead, 2013). The richness of the data from the first two phases added value in confirming the broader themes to be tested in the primary phase, including consumer-centricity; the challenges associated with accessing PGHD; engagements between consumers and clinicians during and outside consultations; the current and future PGHD outputs regarded as valuable to health and financial risk indicators; the shift in health consumer-clinician dynamics and the resultant impact on declining patient visits.

The probe was set up to create the study's baselining, select third phase participants, and form content for the questions during the semi-structured interviews.

Systematic sampling was used to ensure a spread of demographics, variable use of PGHD and knowledge of its applications, a ranging of clinical disciplines representing more than majority of the CDE practice clinicians and, narrow eligible primary research partners (Stephens, et al.,, 2019) to a group of 24 cross-sectional respondents (eight health consumers, of which two fortuitously do not currently use WAT and 16 clinicians as a fair representation of the disciplinary vertical, of which two fortuitously do not use

WAT). Semi-structured interview questions were created based on themes discovered in the preliminary setup phases and, discussion around these with CALC (Lazar et al., 2017).

Firstly, the Researcher delimited generalisability by probing the data collected during the pre-thesis survey findings while also testing opinions around the key themes in CALC and the survey as identified by the industry experts. The second scoping was specific to deliver participants behavioural insights on the acceptance and adoption of UX/UI principles that respondents would find helpful in creating the solution. the respondents were encouraged to share experiences that were either already embedded in their behavioural patterns or, that they might consider crucial to helping in the care journey To ensure validity questions were guided by the attributes of HCI: the User Characteristics, the information System Characteristics, the Context of Use, the Development Process, and the Impactor Outcome of Computerisation (Despont-Gros, Mueller & Lovis, 2005; Lazar et al., 2017).

As the sessional chair of the Innovation Health Summit[19], the Researcher became an early participant in the research and received valuable input from an interview script designed by the Researcher.

While the initial phases assisted in understanding industry and consumer context, using ADR prioritised organisational and industry relevance (Sein et al., 2011). The Researcher created an environment for objective facilitation and active probing, which remains true to ADR methods (Bilandzic & Venable, 2011; Sein et al., 2011).

### 3.15 SAMPLING

Having chosen the research methodology, this section deals with how it was applied within a research approach that included: identifying the study population, deciding

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[19] https://healthsummit.africa/

what sampling methods would be most appropriate, and how the data collection process and analysis would be conducted.

### 3.15.1 Sampling Approach

The population of this research was defined as stakeholder participants relevant to the study viz. A wide cross-section of clinicians and health consumers (Quinlan et al., 2015). Creswell & Poth (2018) informed the meaning and helped define the population as a comprehensive set of individuals with certain mutual observable features. Struwig and Stead (2013) outline the procedure for drawing a good sample as depicted in Figure 3.6.

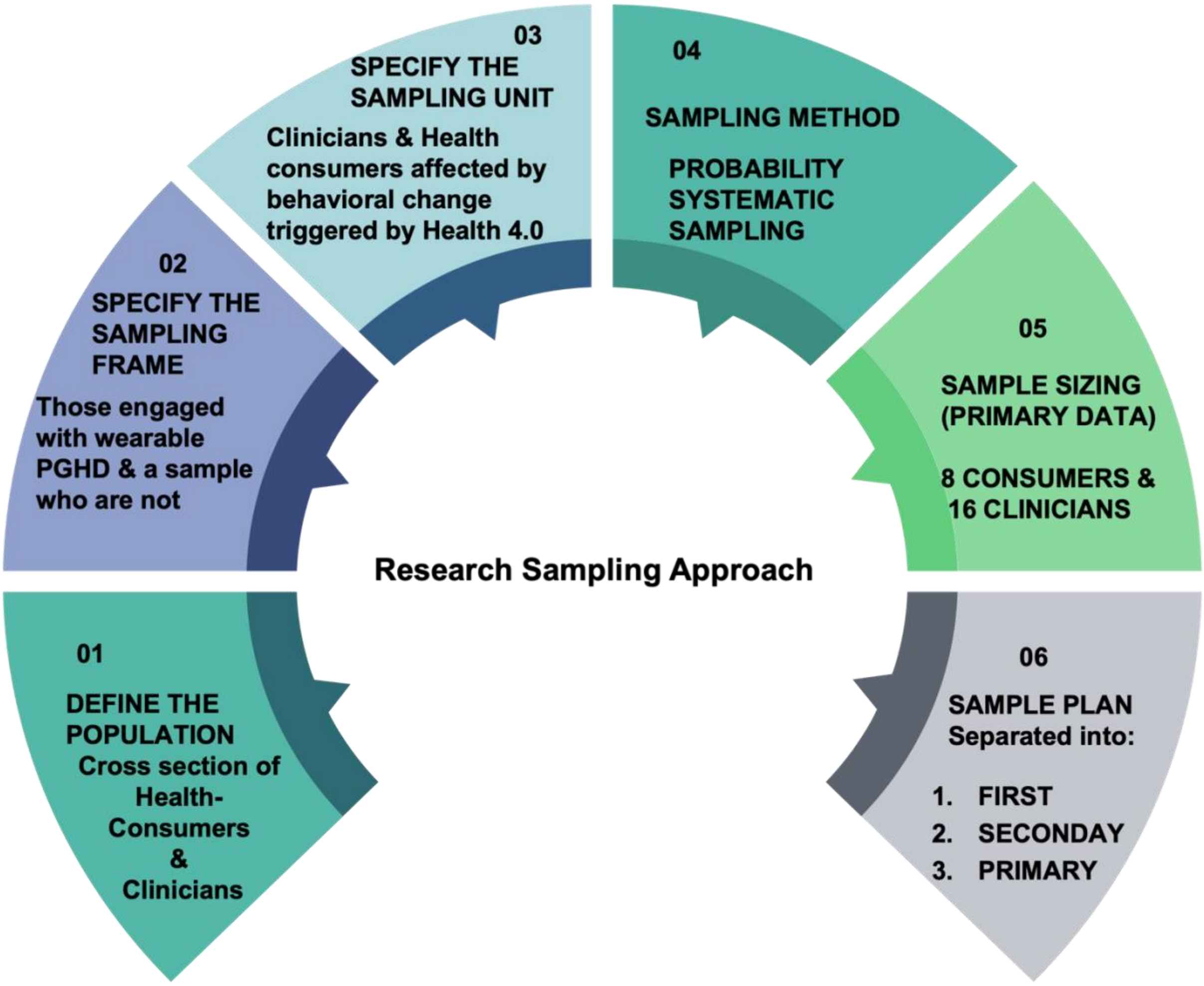


**Figure 3. 6: Steps in the Sampling Procedure - Adapted from Struwig and Stead (2013)**

## 3.16 SAMPLING CONTEXT

This study had two pre-thesis data collection phases and one primary data collection phase – the population for each of the stages are as follows:

Pre-thesis 1 - Innovation Health Summit - The Researcher invited two key opinion leaders in the field to get a macro perspective.

Pre-thesis 2 - Survey (Appendix D & E) – To recruit participants and get contextual intelligence. Insights from these phases presented new thematic insights previously unrecognised by the CALC but, as they are welcomed in the Interpretivist paradigm, they were included as new knowledge informing the primary data collection questionnaires (Braun, & Clarke 2006).

Primary data collection – qualitative research phase – 24 respondents were selected, consisting of 8 health consumers and 16 clinicians. Respondents were pulled from a broader CDE database of 2 310 clinicians and 19 291 explained in more detail below.

### 3.16.1 Qualitative Sample Selection

It was impractical to include everyone in the sample population (Struwig & Stead, 2013). A sampling strategy was implemented because the number of people who could contribute to the study was too large to be pragmatic. The Researcher used the survey to identify participants willing to participate in the in-depth semi-structured interviews. Further dilution was needed to narrow the respondents, thus bringing the group down to two primary groups who use WAT and consumers and clinicians who do not use WAT's thus delivering data from an uninformed view of WAT and PGHD.

### 3.16.2 Sample Size

The sample size was as significant as the choice of the sampling method because it informed how much the Researcher could form thematic notions and suggestions. This study sample was homogeneous (Struwig & Stead, 2013) but required reasonable cross-sectional representation (Bryman & Bell, 2014) and, was moulded by the research objective ensuring, accurate quality and quantity of data needed. The sample size of 24 participants were gleaned acceptable (Lazar et al., 2017). The clinicians' sample was intentionally larger to incorporate the cross-section of clinical disciplines.

### 3.16.3 Sample Frame

The sampling frame was built and defined as the specific CDE stakeholder group from which the sample was selected (Collis & Hussey, 2014; Mouton, 2009).

It is important to sequentially highlight the pre-thesis data collection phases as these assisted in building the primary data sample participant cohort.

- **first** phase (forum discussion) – three (including the Researcher) key opinion leaders who participated in the Researchers publicly chaired forum.
- **second** phase - an information survey with data that informed the primary data collection semi-structured interviews in phase three and, served as the base for participant selection using systematic sampling to distil the respondents to 8

health consumers and 16 clinicians (considering that clinicians are also consumers of health services).

Table 3.2 below summarises the sample in each phase.

**Table 3. 2: Participants for the Three Data Collection Phases**

| Iteration | Type | Thought Leaders | Consumer Participants | Clinician Participants |
|---|---|---|---|---|
| First | Industry Forum | 3 | - | Both participants are both clinicians and executives |
| Second | Probe | n/a | 253 | 72 |
| Primary | Semi-structured interviews | n/a | 8 | 16 |

## 3.17 Sampling Techniques

The Researcher considered two sampling techniques: probability and non-probability sampling (Bell et al., 2018; Bryman & Bell, 2014; Struwig & Stead, 2013).

### 3.17.1 Probability Sampling Process

According to Struwig and Stead (2013), probability sampling is established because every member of the population has a recognised non-zero probability of occurring in the sample and is chosen on a purely random basis. Therefore, a representative sample is more probable when this method of choice is used (Bryman & Bell, 2014) and includes methods, such as simple random, systematic, cluster and stratified sampling as synthesised in Table 3.3 below.

**Table 3. 3: Probability Sampling Techniques adapted from Sekaran & Bougie (2016); Quinlan et al. (2015); Struwig & Stead (2013); Bryman & Bell (2014)**

| Sampling method | Description | Authors |
|---|---|---|
| Convenience | Selecting members by virtue of their accessibility | Bryman & Bell (2014:178) |
| Purposive/ Judgmental | Selecting members for their unique characteristics and experiences | Marshall (2006:522); Babbie & Mouton (2012:167); Richards & Morse (2013:231) |
| Snowball | Initial contact is made with a small group of people who are relevant to the research topic and then these people are used to establish contact with others | Zikmund (2004:58); Babbie & Mouton (2012:167); Bryman & Bell (2014:178) |
| Quota | The population is classified per group/ quota based on some set criteria, and the sample is selected in a non-random manner | Mugenda & Mugenda (2003:50); Babbie & Mouton (2012:167); Struwig & Stead (2013:117); Bryman & Bell (2014:180) |

Having considered all the above options, the Researcher reduced the respondents to 24 participants using probability systematic sampling.

## 3.18 SAMPLE SIZE AND SAMPLING METHODS EMPLOYED – THE PRIMARY STUDY

Systematic sampling was used for clinicians and health consumers as detailed below.

### a) Clinicians

The respondents' clinician-focused group consisted of a mixed discipline group of 2 310 respondents from the CDE database who were sent the initial survey. The survey was set up to gather crucial exclusionary data about respondents. For example, only respondents who had answered yes or no to having a WAT and answered yes to being contacted for further research purposes were initially progressed through to the next phase. However, the exclusion criteria were adjusted, and all clinicians were included in the data set to exclude potential bias. Of the initial broader group of 2 310 clinicians, 121 (±5.0%) email addresses bounced; the Researcher was somewhat disappointed that 1 508 (±65.0%) emails remained unopened; however, 552 (±24.0%) emails were opened; 206 (37.0% of opened) emails were clicked and started and one (0.04%) unsubscribed.

Of those that did complete the survey, the Researcher was encouraged that there was a total of 72 respondents with a good disciplinary mix who had answered "yes" to willing to participate in further research phases (see Table 3.4). The Researcher needed to bring the relevant group down to 16, which was achieved through systematic sampling.

**Table 3. 4: Clinician Respondent Overview - Source: Researchers own**

| Clinicians | Number of Respondents | Percent |
|---|---|---|
| Total sent | 2 310 | |
| Bounced | 121 | ±5.0 |
| Not Opened | 1 508 | ±65.0 |
| Opened | 552 | ±24.0 |
| Clicked | 206 | 37.0% of opened |
| Unsubscribed | 1 | 0.04% |
| Spam | 0 | 0% |
| Relevant responses indicate "yes" to WAT and "yes" to being contacted for further research | 72 relevant | |

### b) Health Consumers

Health consumers consisted of a group of 19 291 patients from the CDE database. The surveys' purpose was to gather conversational data on health consumers' WAT usage habits and their willingness to allow their PGHD to be used in consultations. The survey was also a means of gathering crucial exclusionary data about respondents identifying those who answered "yes" to having a WAT compared to those who did not. The sample selection process was adjusted to include two health consumers who did not use WAT.

Of the initial broader group of 19 291 health consumers: 2 673 (±14.0%) email addresses bounced; 12 406 (±64.0%) emails remained unopened; 2 930 (±15.0%) emails were opened; 1 312 (45.0% of opened) emails were clicked and started and 45 (0.2%) unsubscribed.

Of those that did complete the survey, there were a total of 253 respondents who had answered "yes" to having a WAT and were willing to participate in further research phases (see Table 3.5).

**Table 3. 5: Health Consumer Respondent Overview - Source: Researchers own**

| Health Consumers | Number of Respondents | Percent |
|---|---|---|
| Total sent | 19 291 | |
| Bounced | 2 673 | ±14.0 |
| Not Opened | 12 406 | ±64.0 |
| Opened | 2 930 | ±15.0 |
| Clicked | 1 312 | 45.0 of opened |
| Unsubscribed | 45 | 0.2 |
| Spam | 6 | <0.03 |
| Relevant responses indicate "yes" to WAT and "yes" to being contacted for further research | 253 relevant | |

The Researcher needed to bring the relevant group of 253 down to eight, which he did through systematic sampling filtering every 21st respondent. Like the clinician's selection, the data set included non-users of WAT.

### 3.19 THE DATA COLLECTION

The Researcher reverted to themes identified in the literature review highlighting knowledge gaps crucial to be explored for the successful design and implementation of a solution that would address the research question. Added, the gaps were explored in more depth in the two pre-thesis phases and then analysed (Appendix D & E) and re-referenced against the literature. Resultantly further salient probing was included in the questions for the interviews.

### 3.19.1. Secondary Research

Cooper and Schindler (2008) define secondary data as interpretations of pre-existing data. Secondary research aims to gather relevant and up to date secondary data to be utilised in a study and contextualises the study within the general body of the developing knowledge (Mouton, 2009). Due to the gap in the relevant literature, the Researcher proceeded with a pre-thesis exploratory process allowing knowledge to accrue, which was then periodically tested against literature. This informed the primary data collection process as discussed in the section to follow. Data from each interview in the primary phase was used in subsequent interviews building data set upon data set.

### 3.19.2 Primary Research

Primary research data was gathered through the Researcher's efforts and fitting with Interpretivism including poignant themes and insights from pre-thesis phases (Struwig & Stead, 2013). According to Collis and Hussey (2014), all data created from a key central source can be considered primary data. While the Researcher acknowledges that there are various means available for gathering primary qualitative data, namely interviews, focus groups, observations, experiments, AR, and case studies (Collis & Hussey, 2014; Quinlan et al., 2015; Struwig & Stead, 2013) COVID-19 restricted him to online interviews. The data collection methods relevant to this study are discussed in the following sections, after which their respective measuring instruments will be addressed.

The research subscribed to all ethics and COVID-19 protocols. While focus groups may have been a viable option, they were disallowed due to COVID-19 and thus the Researcher chose individual semi-structured interviews which involved recording and transcribing discussions using ZOOM and OtterAI. Pre-reading was sent to participants for preparedness and context checking was done at the beginning and continually through each interview. Information regarding the role of transcription and field notes during the semi-structured interview phase are discussed below.

Interviews were digitally recorded and transcribed (Tessier, 2012). The OtterAI transcription software allowed the Researcher to create new forms of transcripts

(Mondada, 2007), and NVIVO was used to organise and code the data into sentiments and themes. Interviews were held using the questionnaires (Appendix B) allowing for agility to probe and explore new and latent emergent themes within the interviews.

There are various reasons (outside COVID-19 protocols) why the Researcher used digital files. Button and Lee, (1987, cited in Tessier, 2012, p.447) explain, "The data is naturally occurring conversation as a feature of social life, and the use of tape recordings and transcripts is a practical strategy for apprehending it and making it available for extended analysis." Digital files are stored to ensure the integrity of the files (Tessier, 2012). The recorded data will be reused and reanalysed in follow up studies because "the original data are neither idealised nor constrained by a specific research design or by reference to some particular theory or hypothesis" (Heritage, 1984: p 238).

### a) Transcripts

Producing transcripts was essential in translating recordings into searchable and analysable documents (Tessier, 2012). The Researcher accepted the notion that no specific version is correct (Bucholtz, 2000). He was also aware that data is sometimes lost when translating an event into text (Davidson, 2009). So, scrutiny and rigour were deployed to ensure that no relevant themes were excluded. In this research instance, the solution's novelty introduced some spurious understanding of WAT technology and the associated PGHD that could be excluded from the final data set. The Researcher also made field notes from the interviews that captured nuanced themes and insights challenging to convey through transcripts (Poland, 1995).

### b) Field Notes

Field notes were important because ideas and memories from interviews may have been lost in the research process (Tessier, 2012). Therefore, the Researcher spent time analysing and reflecting on each interview to add exponential value to the following interview. The Researcher also played back some of the themes unearthed in the process to ensure stakeholder connections with the content within the interviews (Wengraf, 2001). Recording new themes and ideas from interviews was essential for building on previous themes and subsequent analysis (Wengraf, 2001).

Hamo, Blum-Kulka, and Hacohen (2004) argue that combining field notes and transcripts provides a more robust analysis than only one of the two methods. They also add that a combination provides specific details (transcripts) and contextual elements (field notes), resulting in a complete understanding of the event.

### 3.19.3 The Semi-Structured Interviews

#### a) Insights from the surveys helped calibrate and prepare the study

A broad database of respondents, including clinicians and health consumers, were sent a survey to gather insights and identify the initial respondents to be interviewed. The ten-question, Likert-style questionnaire (adjusted to clinicians and consumers respectively) was initially intended to identify which respondents would be eligible to participate in the primary data collection phase (namely those that responded "yes" to having and using a WAT and "yes" to being contacted for further research phases). In addition, this survey was also intended to help form questions in the semi-structured interview script (see Appendix B).

The survey unearthed mixed results about health consumers' and clinicians' behaviours. The Researcher specifically wanted to understand why the willingness to change habits is higher in clinicians than in health consumers.

The survey shown that consumers and clinicians presented mixed and conflicting responses to the themes raised from the literature. Understanding these inconsistencies would be invaluable so, they were addressed in the primary data collection.

The semi-structured interview phase was agile and interrogated these different user behaviours and discovered new knowledge filling gaps in the literature.

#### b) the semi-structured questionnaire construction and execution

The Researcher also used survey data to expand a social science approach in primary data collection to understand what the participants found confusing or limiting when PGHD is presented, what were the drivers that deviated behaviour patterns from those found in the literature and, how this would impact the design in the Artefact's first development cycle (Creswell & Poth, 2018).

Survey insights informed the choice of questions for the semi-structured interviews. According to several authors (Bryman & Bell, 2014; Struwig & Stead, 2013), interviews can be semi-structured or unstructured. In the semi-structured interviews, the Researcher had a list of themes and questions to be covered. The Researcher created and utilised an interview questionnaire. A list of questions and topics were covered during the conversation – which were in a specific order (Crotty, 1998). The semi-structured interview was easily adjusted to allow the interviewee to raise issues and explain points of relevance (Bryman & Bell, 2014). More meaning was attached to the interviewees' viewpoint, allowing deviation from the questions asked in the interview schedule (Robinson, 2014; Rowley, 2012). The interviewee was encouraged to reflect on their answers more than once. This technique permitted the Researcher to achieve robust responses to defined questions and provide thorough responses (Crotty, 1998).

Unfortunately, end-users often hedged between different levels of generalisation when they were talking. This means that data could frequently be presented at a dimensional and selective level with elements of action/interaction strategies thrown in (Adams et al., 2008). The semi-structured interview questionnaire was thus crucial in bringing the respondent's thoughts back to the topic at hand. Crotty (1998) advised the Researcher to record the interviews and transcript the recordings for analysis because due to the novel topic, discussions went in unexpected directions. Digital interviews were conducted using video and audio elements in this research (Quinlan et al., 2015).

The interview questions were the same or similar for all participants. However, questions were adapted as the situation demanded extracting knowledge on elements not previously considered. The role of the Researcher was important as knowledge of the field was necessary to guide the research. In this research, where the objective is understanding rather than measuring and manipulating, the Researcher's subjectivity was an essential part of producing an interpretation (Adams et al., 2008; Adams & Nash, 2016).

Goulding (2002) guided that the following were considered when conducting interviews:

- Accessing the setting. Was the clinician participant in their work setting which may have been pressured due to waiting patient and had we provided for enough time. Appointments were made for hour slots for both participant cohorts.

- Understanding the comfort with language used and respecting culture of the participants was tested with respectful questions of understanding.
- Deciding on how to present oneself was important, so the Researcher presented himself as a party participant seeking insights and new knowledge with the participants.
- Gaining trust was achieved through a personal approach and the Researcher encouraged video to be always on so that facial expressions were apparent for both parties.

#### c) Conforming with HCI study methods

The limitation of physical contact due to the pandemic meant that the observational style of HCI alone would not always be possible. Instead, there was more focus on asking users to reflect on their use, thoughts, and feelings. This is considered a reputable alternative method within HCI research (Hagan et al., 2005). The structure incorporated the five fundamental HCI principles: User Characteristics, Information System Characteristics; Context of Use; Development Process, and Impactor Outcome of Computerisation into the questions.

### 3.20 TRUSTWORTHINESS OF THE RESEARCH FINDINGS

Due to the novel nature of the study the Researcher wanted to ensure readers would not question the trustworthiness of the data and findings (Quinlan et al., 2015). Trustworthiness relied somewhat on the extent to which the Researcher could be depended upon and believed (Struwig & Stead, 2013) but also on the quality and representativeness of the participants. Quality was established by ensuring the impartiality of the Researchers personal views based on his experience (Mouton, 2009) and trustworthiness, is presented by the fact that the clinicians and consumers were direct stakeholders in the outcome of the study initiating a high degree of credibility.

### 3.21 CREDIBILITY

As CEO, the Researcher had a good reputation among both cohorts of participants. Participants felt comfortable, safe, and open because the research was conducted to initiate organisational change that would mutually benefit all participants and, they had personal vested interests in finding a sustainable solution (Struwig & Stead, 2013). There is also a specific nexus between clinicians and patients that entrenched further credibility.

### 3.22 DEPENDABILITY

According to Babbie and Mouton (2001), dependability equals reliability. This research procedure was systematic, rigorous, and well documented (Quinlan et al., 2015). Struwig and Stead (2013) mention that the findings of qualitative research should be constant and reliable. The chapter on findings illustrates a balance of data and interpretation on each theme taking the disciplines of the clinicians and the patients views into account Quinlan et al. (2015). Guidelines of documenting, explaining, and justifying every choice made in the research project, were followed.

The ADR process diagram, Figure 3.6, displays the reflection and rigour testing points that justified each decision and data point.

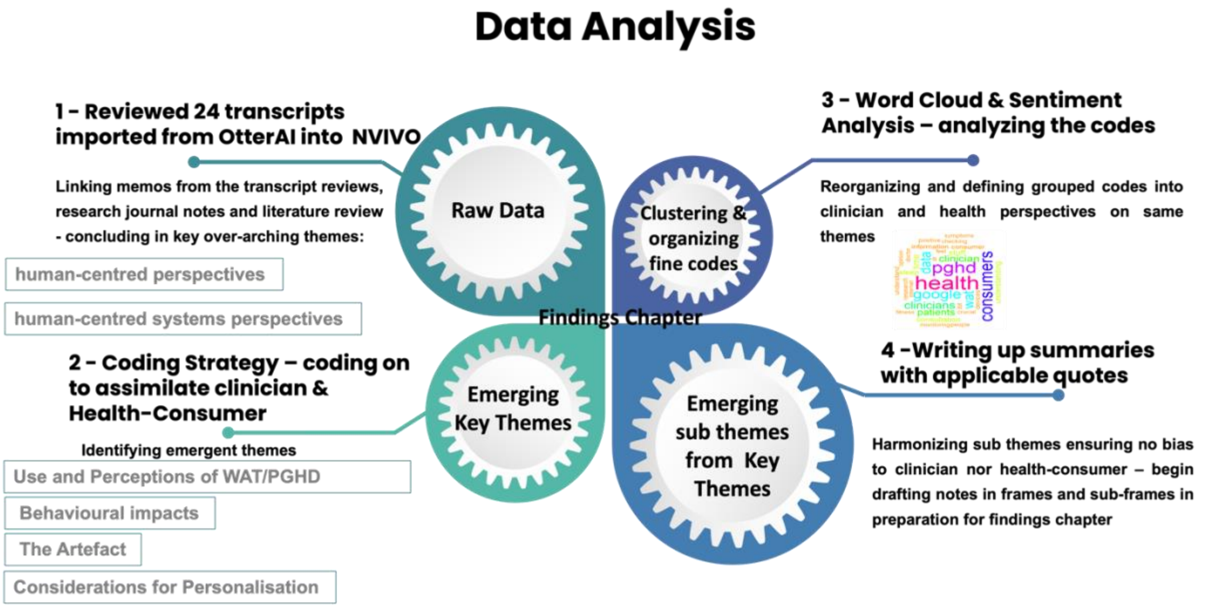
### 3.23 CONFIRMABILITY

The Researcher intentionally includes numerous participants quotes in each theme to illustrate that findings are a direct interpretation (Struwig & Stead, 2013). Second, the data used was comprehensive and the interpretations made are conceptually broad but clear enough to not be challenged by the practice and more specifically the CALC. Third, the theory developed was abstract enough to include sufficient variation to apply it to various phenomena related to contexts across multiple socio-economic consumers and multidisciplinary clinicians (Adams et al., 2008).

### 3.24 DATA ANALYSIS AND INTERPRETATION

Raw data from the probe was analysed, combined with the themes emerging from the forum transcripts, aggregated into text fields, into themes and then subthemes, automatically coded and labelled (Creswell & Poth, 2018). Before all the data was transferred to NVIVO for analysis, each recording (averaging 1.06 hours) was edited. The raw data was then themed and coded in NVIVO, presenting a well-structured Big Data set for findings, sentiment analysis and interpretation. Thematic analysis is used (Braun, & Clarke, 2006) to break down and identify the themes from the data findings from the primary and secondary data sources. As the Researcher wanted to find salience on specific points from each perspective one set of codes was created but separated into clinician and health-comer clustering to avoid bias. The Researcher uses Figure 3.7 below to show how he followed the Braun, and Clarke (2006) framework, which helped become familiar with the data, generate initial codes, extract, define the themes, review these, and summarise recommendations, feelings, and insights. These were then itemised, drawing the emerging new knowledge, and reported within the sentiment analysis and theme headings in Chapter 5 (Rogers, 2008; Rogers 2012 & Holzinger, 2013).

Findings were captured verbatim and then structured to explore semantic and latent themes. As a result, the analysis identifies, interprets, and makes sense of four specific themes from the body of data.



Linking memos from the transcript reviews, research journal notes and literature review - concluding in key over-arching themes:

Reorganizing and defining grouped codes into clinician and health perspectives on same themes

Harmonizing sub themes ensuring no bias to clinician nor health-consumer – begin drafting notes in frames and sub-frames in preparation for findings chapter

**Figure 3.7 Data Analysis process as compiled by the Researcher**

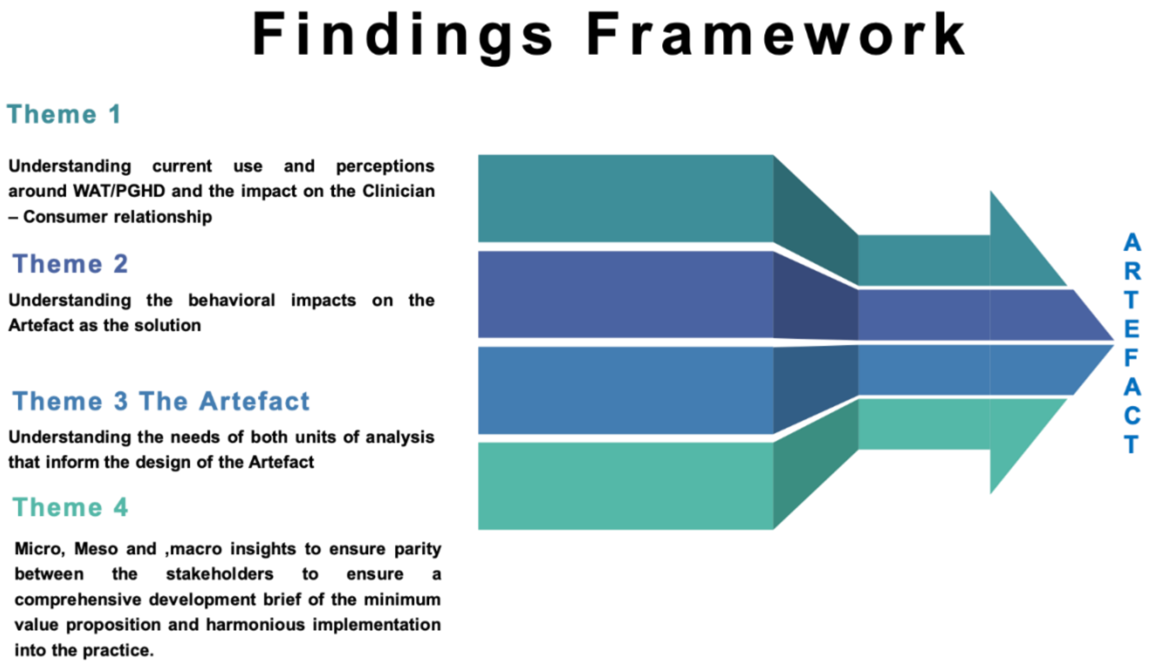
### 3.25 RESEARCH METHODOLOGY REFLECTIONS AND CONCLUSION

The chosen methodology using the mature practice approach of integrating the attributes of DT and HCI made this a feasible AR project. Challenges with the leaning of ADR towards design while this study is leant towards behavioural-science was dealt with by introducing reflexive thinking among participants, this HCI study using ADR as the methodology fusing DT into the method, allowed engagement harmonisation on a common problem with two completely disparate cohorts of participants. However future researchers using this methodology it is advised should ensure that the rigour in the drawing up of the questions is sound to ensure transference from behavioural data to computer design. The design of an artefact as part of the practice knowledge systems (Hwang et al., 2018) illustrated that it is feasible to plot a digital path to the reunification of the stakeholders using an/the Artefact. The Researcher was confident that questions were carefully constructed in each phase to ensure no bias, allow fluidity, and produce innovations, thinking, and paradigms that the Researcher would not have otherwise realised. The findings opened latent themes that consequently open new areas of further researcher identified below. The experience proved beyond the literature that clinicians and consumers can collaborate to help solve problems that have an impact on both social circumstances. Chapter 4 illustrates the value of both participants contributions to creating a design of an artefact that will benefit all stakeholders and, chapters 5 and 6 highlight results and contributions to new knowledge.

# 4. Research Findings

## 4.1 INTRODUCTION

The Findings Framework (Figure 4.1) has been structured so that Theme 1 discovers views and feelings of the relationships and systemic human and environmental factors (Harrison et al., 2007) that may impact the design or impede the use of the Artefact. Theme 2 captures views and feelings that address socio-behavioural impacts on the problem, guided by Denzin and Lincoln (2018). Theme 3 focuses on what, why, and how the Artefact will need to incorporate the practical needs, exploring different HCI paradigms identified by Guba and Lincoln (1994). The momentum experienced during the data collection seldom deviated from the research question (Rogers, 2012) but discovered essential latent elements (Braun, & Clarke, 2006). Theme 4 takes a deeper look at the shared knowledge produced by two different participant cohorts (Blandford, 2019) and frames the personalisation requirements for anticipated maximising use of the Artefact (Orlikowski & Iacono, 2001)



Findings Framework

Theme 1

Understanding current use and perceptions around WAT/PGHD and the impact on the Clinician – Consumer relationship

Theme 2

Understanding the behavioral impacts on the Artefact as the solution

Theme 3 The Artefact

Understanding the needs of both units of analysis that inform the design of the Artefact

Theme 4

Micro, Meso and ,macro insights to ensure parity between the stakeholders to ensure a comprehensive development brief of the minimum value proposition and harmonious implementation into the practice.

Figure 4. 1:Findings Framework  Compiled by the Researcher

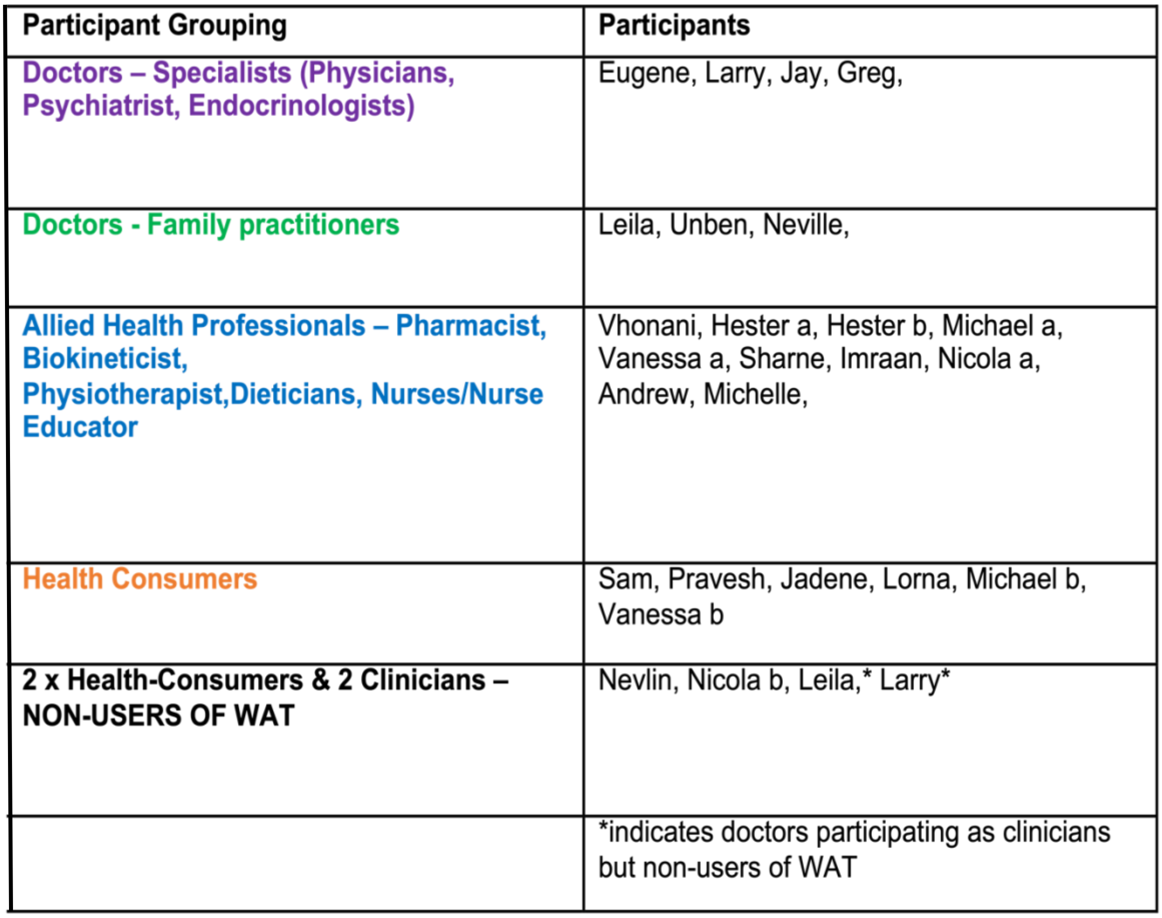
Word clouds and sentiment analysis at the beginning of each theme are used to aggregate and visualise the evidence of themes as coded from the text (Creswell &

Creswell, 2017). Italicised quotes are extracted in vivo as key phrases from raw data to present literal views and feelings labelled together in themes from (a) the clinicians' perspectives and (b) the Health Consumers' perspectives. Discourse coding was used extracting from INVIVO in building the word clouds. The most frequently used words are written in larger font sizes. Font colours are allocated randomly for easier reading. In the sentiment analysis, the font size is in proportion to the frequency of the word within its sentiment. Words with negative sentiment are written in red, while positive ones are written in green. Due to the novel subject, prefigured codes were used to help manage what the Researcher calls code creep as there were emergent themes that would influence the design but were not covered in the literature. An example of this is the hesitancy of the clinicians willing to share clinical notes with their patients. Those themes represented in the literature were aligned and then synthesised with pre-existing knowledge on the emergent themes (Creswell & Creswell, 2017). Each theme is discussed using best code labelling linking with subcategories. Interpretation is dealt with here but abstracting and interpreting out beyond the codes and themes and highlighting conclusions and new knowledge is dealt with in chapters 5 and 6, respectively.

## 4.2 CODED ELEMENTS

Lazar et al. (2017) caution that the source of data must be cross-sectional and without bias for clinicians (FitzGerald & Hurst, 2017) and patients (Green & Thorogood, 2018; Yeoman et al., 2017). The Researcher used thematic coding analysis using a taxonomy of data from participants insights and filing them as essential elements within each theme (Stephens, et al., 2019). Codes are structured under each theme (Miles & Huberman, 1994), working from human-centred perspectives (Rogers, 2012) in Theme 1 and 2 through to human-centred systems perspectives (Bevan et al., 2015) in Theme 3 and 4, using Mandel, (1997) and Mandel, (2002) to inform the Artefact design principles. Participants have been grouped to define the specific origin of the sentiment and resultant elements within themes (Figure 4.2), but data from participants is compared harmoniously within each element. This thematic analysis has scanned the data from all the interviews clustering the patterns to ensure the best possible design of the Artefact as the solution (Braun, & Clarke, 2006). Only first names are used for anonymity.

**Table 4. 1:Participant Grouping**



| Participant Grouping | Participants |
|---|---|
| Doctors – Specialists (Physicians, Psychiatrist, Endocrinologists) | Eugene, Larry, Jay, Greg, |
| Doctors - Family practitioners | Leila, Unben, Neville, |
| Allied Health Professionals – Pharmacist, Biokineticist, Physiotherapist,Dieticians, Nurses/Nurse Educator | Vhonani, Hester a, Hester b, Michael a, Vanessa a, Sharne, Imraan, Nicola a, Andrew, Michelle, |
| Health Consumers | Sam, Pravesh, Jadene, Lorna, Michael b, Vanessa b |
| 2 x Health-Consumers & 2 Clinicians – NON-USERS OF WAT | Nevlin, Nicola b, Leila,* Larry* |
|  | *indicates doctors participating as clinicians but non-users of WAT |

***indicates doctors participating as clinicians but non-users of WAT**

**For ease of reference: Doctor Specialist, Doctor, Allied Professional, Health Consumer**

User characteristics, the information System Characteristics and the Context of Use are crafted to inform the post-thesis development process (Despont-Gros, Mueller & Lovis, 2005; Lazar et al., 2017).

## THEME 1

### 4.3 USE AND PERCEPTIONS OF WAT/PGHD

This theme relies on the Mandel (1997; 2002) argument that the system relies 60% on the user's relationship with the Artefact. Thus, the Researcher assessed views and feelings related to the use of WAT and PGHD.

Demiris et al. (2019) informed the probing to capture use and sentiment around PGHD and its use in and out of clinical practice. Figure 4.2 summarises the emerging words that informed the categorised elements dealt with below.

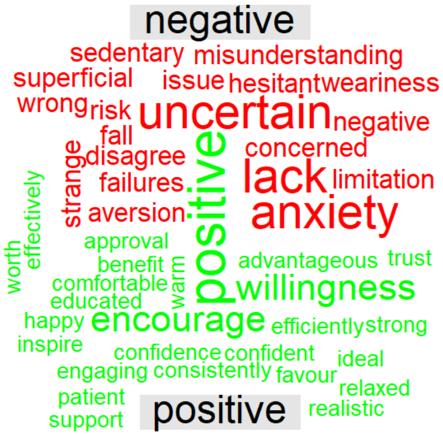
<table>
<tr><th colspan="3">(a) Clinician’s perspective</th></tr>
<tr><th>Theme</th><th>Word cloud</th><th>Sentiment analysis</th></tr>
<tr><td><b>Current perceptions</b></td><td> </td><td> </td></tr>
<tr><th colspan="3">(b) Health Consumers’ perspective</th></tr>
<tr><th>Theme</th><th>Word cloud</th><th>Sentiment analysis</th></tr>
<tr><td><b>Current perceptions</b></td><td> </td><td> </td></tr>
</table>

Figure 4. 2:Current Perception of WAT/PGHD - Compiled by the Researcher

### 4.3.1 WAT/PGHD?

> Greg *observed that some health-consumers would volunteer PGHD but, others may forget that they are wearing [a WAT], and when he sees the WAT and asks them about it, they are "quite happy to give information."*

Findings do not fully concur with Loos and Davidson (2016). While clumsy, clinicians are enquiring about PGHD. There is comfort but restrained ability to incorporate data. It is noted that clinicians who had not explored PGHD do not open consultation conversations around PGHD.

### 4.3.2 Health Consumer Volunteering PGHD

Probing the "hybrid space" between the warm-body consultation and consumer's interaction with their digital world (De Souza, 2006), the Researcher observed a trend that health consumers show data from their WAT because the data concerns them.

PGHD is seen as a critical point of discussion not only in warm-body consultations but also in telemedicine. However, concerning is that clinicians presented with PGHD seem to use it superficially. Clinicians argued that PGHD applications are used *“more from a recording point-of-view, as opposed to a diagnostic, clinical management.”* Encouragingly, consumer-behavioural trends show the use of WAT to help take medicine.

> *Eugene was specific that "If not volunteered, I now am beginning to ask patients for info from WAT because it is important to understand the effect of medication."*

However, interviews with clinicians highlighted the digital divide problem evident in the review of the literature in Table 2.4. In addition, elements of anxiety and concerns noted in the sentiment analysis are evident when clinicians express negative feelings when presented with PGHD in consultations.

> *Jay admits that if presented with PGHD, she feels "forced to interpret it", and it becomes "more admin."*

### 4.3.3 Perceived Value of PGHD in Informing a Consultation

As Zhu et al. (2016) concluded, although some clinicians had never incorporated PGHD into a consultation, most realise the value. Clinicians agreed that asking for PGHD would be beneficial.

> *Neville sees "the value of PGHD to pick up anomalies and tends to be very careful about writing WAT off." However, Neville admits that clinicians should ask for "average pulse rate for the last ten days."*

Some clinicians state that asking questions about any newly introduced device is crucial. They could incorporate questions in the consultation around PGHD if there is an adequate mutually adopted clinician-patient linguistic to interpret the data.

### 4.3.4 Barriers to Incorporating PGHD into Consultations

Findings align with Gask et al. (2003), as most clinicians concur that health consumers are embarrassed by the psycho-social issues like when they have not exercised, so they do not want to be exposed.

> *Hester says, "we must understand - health-consumers as they can be funny and sometimes feel angry or exposed when looking at uninterpreted data.*

It was conclusive that active people rather than those who are sedentary will more likely volunteer PGHD.

> *Michelle also highlights restrictive interpretation issues - "they only understand one aspect of it or do not see how the data is relevant to the consultation."*

Health consumers, however, suggest they have not had opportunities to present PGHD in consultations accordant with the literature (Rogers, 2012; Maynard & Heritage 2005). Likewise, clinicians find it challenging to distinguish the medical use against proving that they *are "psychologically doing something."*

Again, the data is clear that clinicians do not think about the PGHD because they do not have a tracker. However, it is observed that clinicians who are caught up in the "wave of wearables" (Tully et al., 2020) present an understanding of and willingness to engage PGHD.

> *Leila admits that she "does not encourage" questions around PGHD "simply because I am not that experienced at it."*

A worrying theme despite being dispelled by Strain et al. (2020), is that the clinicians see the age and infirm as barriers to the use of WAT. However, participants argued that reasons are likely related to a general aversion to exercise and not an anathema to WAT.

Norton (2018) and Shanafelt et al., (2016) highlighted that clinician digital fatigue, acceptance and knowledge of the use and functionality of the devices and PGHD were also evident. It was clear that ease of use to prevent digital fatigue is critical to both participants.

### 4.3.5 Stamp of Approval from Clinician

Some participants presented PGHD to their clinicians after the clinician *“asked me if I could share my activity heart rate from my device,”* which they saw as *"great because, as a layman, you do not know these kinds of things"* are essential.

There is strong support for working with clinicians to create awareness and potentially rollout a platform to present WAT PGHD. Consumers tend to present PGHD if they see their clinician has a relationship with WAT/PGHD. Clinicians who had integrated PGHD into consultations were clinically more confident in front of patients, and clinicians who use WAT themselves actually *“go through it with them and, gets them to sign up.”* They even adjust the calories and *“ideal body weights”* to mutually agreed *“more realistic levels.”*

> Greg *observed that some health-consumers who wear WAT are "uncertain as to what I am going to think about it, so they are almost a little bit embarrassed that they are wearing it and have been using it" and once "I am very positive about it" they "open up more."*

Shin et al. (2019) conclusions were confirmed when data showed how *“important clinician-driven behaviour modification counselling is”*. Participants held the opinion, *“the clinician can counsel to get people into the action phase.”* These findings also concur with the notion of agency (Nardi,1996) when the participants on both sides are looking for an accountability partner. Clinicians who begin checking PGHD and provide feedback become responsible partners. This is evidence of the patients emerging, as argued by Emanuel and Emanuel (1992), as deliberative agents seeking the intimacy of a relationship with their clinician to produce better outcomes.

*Vhonani notes; engagement with PGHD remains low because: “we may not know what to look for.”*

Clinicians offer that they do not know what they are looking for and do not identify information worth pointing out in a consultation unless explicitly asked. Even then, they are hesitant. The findings are clear that if clinicians see value in PGHD, consumers will present it. Participants agreed, as argued by Razzaki et al., (2018), that clinicians need to initiate conversations around PGHD. Health consumers show that they forget they are wearing a WAT when they go and see the clinician. If both stakeholders had the PGHD at their fingertips, they would use the PGHD source in the consultation.

Razzaki et al., (2018) arguments were also confirmed when stating that we need to empower the clinicians to be receptors and interpreters of patient-reported data. This research argues that the integration of PGHD starts with the clinician being empowered with the knowledge to engage and interpret the PGHD efficiently.

An added positive developed as a latent theme of this research is that if we create the Artefact as a tool of digital empowerment, we could address the concerns of clinician burnout from engaging with systems and its resultant admin as highlighted by Shanafelt et al., (2016).

It is safe to say that the barriers identified from the literature (Table 2.7) can be addressed by making sure the Artefact delivers a UX that has a mutually understandable clinical language; dual accountability and, traverses the inhibiting psycho-social issues through destigmatising the condition or unhealthy behaviours people are living with. In addition, there is evidence that the participants want to bridge the divide caused by the social and digital rifts identified by Silverman (1990) as prohibitive barriers, to reuniting the parties. These are explored further in Theme 2.

## THEME 2

### 4.4 BEHAVIOURAL IMPACTS

Theme 2 builds on the findings in Theme 1 but specifically explores user behaviours around data and the impact on trust identified by Cilliers (2020), Shih et al. (2015) and Finkelstein et al. (2016), those affecting use and consumption (Shin et al., 2019, Maher et al., 2017, Lee et al., 2020), and the use of features (Gupta et al., 2020, Tully et al., 2020).

While Alpert et al. (2020) conclude that bringing WAT data using an interface is practicable, there is little guidance on what is necessary to consider ensuring the Artefact is fit-for-purpose.

Shin et al. (2019) and the sentiment analysis, helped the Researcher realise that this study requires finding a balance between human behaviour and technology. As the data was coded, it became clear that Forlizzi et al., (2008) was correct that continuous reframing will assist in helping design "the right thing." Here the Researcher saw the benefits of HCI's attribute of benefit through design (Frayling 1993) emerge as each iteration presented authentic and experiential knowledge adapted to the Artefact to address the problem.

| **(a) Clinician’s perspective** | | |
|---|---|---|
| **Theme** | **Word cloud** | **Sentiment analysis** |
| **Current perceptions** |  |  |
| **(b) Health Consumers’ perspective** | | |
| **Theme** | **Word cloud** | **Sentiment analysis** |
| **Current perceptions** |  |  |

**Figure 4. 3:Behavioural Impacts - Compiled by the Researcher**

The Researcher used the next iteration of the associate word cloud and sentiment analysis to critique the semantic elements associated with WAT PGHD and compare the latent elements relating to trust in the solution associated before continuing with building artefacts design personas. The Orlikowski and Iacono, (2001) definition of the Artefact as "the material and organisational features that are socially recognised as bundles of hardware or software" were starting to form in the data. Nevertheless, the Researcher stayed true to the need to reflect the Artefact as a "technology as structured" for mutual benefit, where structures of the organisational domain and the participants' use are inscribed into the Artefact (Orlikowski & Iacono, 2001). As Benyon and Murray (1993), Preece et al., (1994), and Rogers (2012) all show in HCI, the interface (Artefact) design must consider all aspects of interactions with the broader system. The Researcher, therefore, extended the scope to understand the current dialogues between humans and computers (Carroll, 2003).

### 4.4.1 Dr Google

Lee et al. (2014); and Lee et al. (2015) encouraged the Researcher to explore the relationship the consumer has with Dr Google as an "agent ready to respond" - the participants offered varied perspectives. In terms of integrating technology into the consultation, all participants agreed, PGHD is best interpreted by clinicians to maximise the value of the responses from the Artefact. Consumers were clear and confirmed the arguments of Ip (2019) that they were indeed using Dr Google as a first-line intervention and then only began the current detached process of pursuing a warm-body consultation.

*Andrew believes that "at least 60%" of his health consumers, if not more, use Dr Google."*

> Jadene *describes her health journey as the "first thing you do is Google your symptoms, then you go to the doctor" for a "second opinion."*

### 4.4.2 Dr Google as Opinion 1 and Clinician as Opinion 2

Ward (2018) was corroborated when exploring the balance between trust on the Internet versus the clinician. It was clear that the health consumers start with Dr Google and use it as a reference point in a consultation. Conversely, clinicians believe that consumers use Dr Google to develop a putative diagnosis that disrupts the clinician-consumer relationship.

However, consumers argued that clinicians offer *"peace of mind and also comfort that you have been to a professional."* If a clinician *"had sight of Google's response,"* consumers indicated that they would *"feel more comfortable as Dr Google doesn't know me."* A common argument amongst the consumers was *that "Google is a referencing point, and the clinician's input is the confirmation point."* Consumers want more specific attention to their concerns than what Google offers.

Clinicians explain that health consumers *"come to consultations with printouts from Google about their WAT indicated symptoms."* Clinicians concur that those consumers *"have already done their own research"* and use the consultation *"to confirm that the doctor is going to say the same."*

> Andrew *found that some of his health consumers use Google as "fundamental" to test the WAT data, and then they compare their doctor's opinion to Google's opinion."*

These findings show that the clinician and Dr Google are seen as equally valid interpreters of PGHD.

> Vanessa *believes that "consumer habits have now evolved to a point where they no longer approach clinicians for their second opinion but diagnose themselves from Google."*

Rozenblum et al. (2015) was confirmed, and this research question was vindicated, as consumers were clear that their behaviour was creating a trend of diminishing need for clinical consultations. Consumers stated that they try to diagnose and manage their health using Google before interacting with the clinician. Often, this results in them not seeing the clinician.

> Lorna *notes: "if you do not understand what the wearable device is telling you, you can find that information quite freely on the Internet. So, for example, Dr Google has helped me understand my PGHD."*

### 4.4.3 'WAT' Health Consumers Search

The Researcher then sought detail on what the consumers were searching for. This element was also crucial in probing the theme raised by West et al. (2020) of *working with Dr Google* instead of trying to *compete with the giant*.

> Larry *observes that his heath-consumers; "are not researching diseases but rather therapeutics in terms of their symptomatic responses reported by their WAT."*

Consumers admitted that they search *"symptoms and descriptions of what it looks and feels like."* Most clinicians agreed with Wyatt et al. (2020) arguments that show online searches seem to be more *"diagnostic."* However, some clinicians disagreed, raising concerns with the trend that Distiller et al., (2010) warned against in consumers looking for detailed information to treat themselves.

Some clinicians saw Google interpreting PGHD as a source of empowering health consumers pre-consultation as positive awareness.

However, the biggest concern was that the consumers offered data that coincided with Dimitrov (2016), admitting that they are visiting their clinicians less using Google to determine whether the condition I am searching for warrants a visit to the clinician. Therefore, clinicians presented the notion that the Artefact should be the online reunification of the two parties by matching a health consumer with a clinician practising in their field geographically close to them.

Participants also offered debate that Google was not used to replace the clinician but rather to empower the patients to find a second opinion with the caveat that if the clinician did not help them, they would default to Dr Google for help. This is when the Researcher saw an unsolicited traversal of the participants thinking towards using the Artefact as a repository and interface for interpreting the data.

Clinicians, however, continued to default to the notion that consumer searches, should only be *“health maintenance.”* for *“long-term health benefits.”*

Lupton (2016) arguments are supported as the consumers indicated that they sought clinical and disease-peer support. In addition, there is evidence of vibrant activity with generous sharing of life-condition tips with other consumers living with the same condition.

This study proves, as Lupton, (2016) argued, consumers are looking for responsive spaces to share their information.

### 4.4.4 Why Dr Google Opposed to Warm-Body Care

Besides the issue that clinicians are *“not always available”* when needed the matter of cost, travel and other elements of *“the mission of going there*.” Nielsen (1994) was unambiguous that accessibility and ease of use for consumers were critical. This supported Zhang et al., (2017) who explicitly raised a consumer issue found in these findings when the WAT presented anomalies for the PGHD, and the consumers felt there was *“nowhere to go.”* A consumer participant used an extreme comment that she would have to be *“on her death bed before she would go-to the clinician.”* Interestingly she displayed a notion that clinicians default to overprescribing medication and, in any event, only treat the symptoms. Participants concluded that immediate gratification along with free access to information is what draws consumers to Google.

### 4.4.5 Positives of Dr Google

Instead of seeing Google as the antithesis of solving the research problem, the Researcher encouraged probing into the attributes that might add value to the Artefact. Consumers indicated that the use of Google was not always a distrust in clinicians; it is a response to the richness of the information age, and as Zhang et al, (2017) and Zhang et al., (2018) argued, increasing adoption of its connectivity to lifestyle technologies. Powles and Hodson (2017) argue that Google is forming stronger information relationship bonds than clinicians, from information that could assist in understanding the disease. This data suggests that if the Artefact could channel and filter through machine learning, the controlled use of Google could be beneficial. Participants believed that the search engines information should be added to the information from a clinical consultation. As Rozenblum et al., (2015) argued, and our clinicians agreed, we must find ways of using all resources to help self-management outside of warm-body consultations. However, participants debated the issue, agreeing with Rubin (2020) who, cautioned, we must connect digitally with the patients, or power will swing in favour of Google leaving clinicians on the periphery. The Researcher reflected on Chaudoir et al., (2013); Longoni et al (2019), and Morris et al., (2011), whom all show that clinicians naively rely on their hierarchy and paternal intuitive approach to positioning themselves in the care continuum, ignoring the risks of what Topol (2019) argues is a replacement of clinicians with the likes of Google.

Clinicians *“feel comfortable working with patients who they can empower rather than tell what to do.”* They offer that if they could control what their patients were searching for, this would fuse the knowledge with their treatment plans and help a shift to new clinical behaviours as identified in Ryan (2019).

### 4.4.6 Negatives of Dr Google Deciphering PGHD

Clinicians concurred with Norman (2017), who argued a narcissistic approach to self-management using the Internet. Clinicians offered that some patients *see “information on the Internet as from God and clinicians are mere human beings.”* Clinicians also showed frustration with Google stating that consumers using Google *"become quite frustrating for clinicians because there is a lot of non-researched and non-evidence-based stuff out there, so we have to spend much time correcting."* They add, they *“spend extensive consultation time, with these patients explaining, taking time away from more important things in the consultation.”* Another latent theme is that the clinicians argued that Google increases costs as consumers come into consultations demanding erroneous tests, they gleaned necessary, as raised by Sharon (2017) informed through *“blind belief”* of *“factual”* Google content. Clinicians argued that *“patients are not sure how to navigate PGHD.”* Consumers agreed, adding that they cannot discern between *"vast and unspecific information from Google.”* Clinicians do corrections in consultation, but the correction never occurs if there is no consultation. This, clinicians believe, *“have negative clinical consequences.”* They add that *"misinformation and misinterpretation of PGHD assimilated with Google content cause clinical anxiety and panic over "meaningless symptoms."* Consumers, when probed, agreed that they see things on Google and take the information as *“much more severe.”* Added, there was an acknowledgement that Google encourages medicine non-compliance as it argues the treatment's downside rather than the necessary often lifesaving qualities.

Clinicians raised similar conclusions to Sharon (2017). They warn that the use of Google as a source to interpret PGHD can be highly dangerous as it is merely a response to a list of symptoms without an understanding of the biophysical psycho-social make-up of the patient.

Clinicians highlighted cases such *as "pancreatic cancer being missed because the patient went to Google with their PGHD symptoms instead of seeking clinical advice."* This risk did not go unnoticed by health consumers – they noted that *"many use Google to save time and effort, but allow serious symptoms to go unchecked and untreated, leaving attending the clinician too late."* Thus, there was a definitive position that Google can be *"scary"* and *"dangerous."* However, adding filters to the data and steering consumers to appropriate sites that credibly support the treatment plan was considered valuable.

### 4.4.7 Increase or Decrease of Consultations

Some clinicians differ with the literature (Bouchard; 2019) that is observing a wholesale decline in visits that it can be argued is the reason for the current dismantling of the system (Holland, 2006). These clinicians argued that Google increases patients' desire for a discussion. When patients look up PGHD symptoms, they *"freak out"* and are *"prompted to seek further advice."* However, these clinicians were surprised when probing the consumers who aligned with the literature stating that they are *"less likely to go-to the doctor if you can solve the issue yourself."* Findings of this research show evidence of consumers using PGHD and Google to diagnose and treat a condition without any clinician intervention:

> *Imraan: "I had a discomfort on my tongue, I looked on WebMD, and it gave me some ideas on a diagnosis, and I started treating myself and using some vitamin B12, and in about four or five days, it was gone so, I did not see a doctor, but I still managed to handle the condition."*

Clinicians offered that *“the Artefact is crucial because it can provide context with AI guided, clinician approved advice”* But that *"nothing replaces the clinician's hands on the patient."* Where Google is sometimes seen as a risk to compliance, WAT is often used to assist with compliance. The benefit of Google to decipher PGHD is that it can be used to empower health consumers.

### 4.4.8 WAT User Behaviour

Clinicians argued that most health consumers see WAT as more *“fitness-related”* than *“health-related.”* Consumers also admitted specific use, as shown by Pal et al. (2020), that the *“purpose for [her] wearable device was initially purely for exercise.”* Clinicians proved the concerns that Strain et al. (2020) dispelled that some clinicians perceived WAT as accurate for activity but inaccurate for "health data." The danger is that it is *“just a matter of reaching targets without really interpreting the data.”*

> Leila *adds: “The role of the clinician in helping health consumers see the value in PGHD for health and not just fitness."*

The Researcher journaled all mentions of specific use of WAT-based and online resources to study the data and functionality clinicians and consumers were reverting to currently as itemised below.

**Table 4. 2:Downloads used for general support**

| WAT/Smartwatch App | Description: |
|---|---|
| My Fitness Pal[20] | Calorie tracking/overweight |
| Samsung Health[21] | All health-related |
| Discovery App[22] (Vitality)[23] | Payor rewards |
| My Fat Secret[24] | Weight management |

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[20] https://www.myfitnesspal.com/

[21] https://www.samsung.com/us/support/owners/app/samsung-health

[22] https://www.discovery.co.za

[23] http://www.vitality.co.za/

[24] https://www.fatsecret.co.za/

**Table 4. 3:Platforms for Online Health Advice**

| WAT/Smartwatch App | Description: |
|---|---|
| My Medicine[25] | Medicine compliance and education |
| WebMD[26] | Medical diagnostic and symptomatic information |
| Medisafe[27] | Medication management |
| Dischem[28] | Pharmacy Retail Chain |
| Doctor Connect[29] | Payor telemedicine |
| Hospital at home[30] | |
| Map my Run [31] | Activity tracking |
| B-Fit[32] | Activity and health tracker |

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[25] https://www.webmd.com/my-medicine/default.htm

[26] https://www.webmd.com/

[27] https://www.medisafe.com/

[28] https://www.dischem.co.za/

[29] https://www.discovery.co.za/corporate/drconnect-get-trusted-doctor-advice

[30] https://sa-homecare.co.za/hospital-at-home-care/

[31] https://www.mapmyrun.com/

[32] https://bfit.co.za/

| | |
|---|---|
| 30-day challenge[33] | Activity and health challenge tracker |
| Strava[34] | Activity tracker |

My Fitness Pal, described as a *“calorie tracker,”* was mentioned by several clinicians and My Fat Secret, a food logging platform reliant on WAT to measure biophysical metrics was common. Other recommended supporting apps were:

*"condition-specific", such as menstrual cycles monitoring.*

It was worth noting that if clinicians use a specific WAT, they are likely to recommend it to health consumers. The Researcher, however, noted some bias in clinicians recognising and recommending WAT's and App's they were comfortable with.

### 4.4.9 Consumer Purchasing Habits

User Behaviour influenced purchasing habits. Participants argued that the essential feature influencing their purchase was "functionality." However, probing highlighted that consumers' decisions were sensitive to price over functionality. Consumers also raised *“trust in brand”*, and as Nielsen (1994) and more recently Patel et al. (2018), marked as a behaviour now seen consistent to the acquisition of WAT being *“ease of use”* and *“product satisfaction.”* Reasons for not having WAT ranged from not seeing the value to finding the purchasing experience intimidating. Some clinicians argued a laziness researching which device to buy.

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[33] https://play.google.com/store/apps/details?id=com.popularapp.thirtydayfitnesschallenge&hl=en_ZA&gl=US

[34] https://www.strava.com/

> *"I never bought one, it is just it was not important, yet" I will "if I pick up weight", says Hester (b). This speaks to the use of WAT as a corrective health measure as opposed to a maintenance measure.*

### 4.4.10 Style

The Researcher picked up style as a latent element. Many clinicians highlighted that they wished there were WATs:

> that were not watches or could be worn in a "different location" where "the tracker could sit somewhere else." - Greg

Pal et al., (2020) was confirmed as participants raised the matter of fashionista driven purchasing patterns however, it was decided that the Artefact must remain agnostic and focus on functionality to enhance the motivations to use the device.

### 4.4.11 Understanding of PGHD

However, the concern dispelled by Strain et al. (2020) and Turakhia et al. (2019), is *that "younger ones"* have a better understanding but older health consumers *"just put it on and hopefully achieve their targets by the end of the day"* was still prevalent. Added, clinicians perceive that *"about 20% of the patients get the full use out of the device.*" They add*, "they do not look into the true capabilities."* Consumer data corroborated this position as they admitted that *"they never looked at WAT for disease or condition related management."* Probing discovered that this happens because they do not know how to connect the disease symptoms to the PGHD. When asked if consumers would use WAT and incorporate it into consultations if they understood it better, they said:

> *"yes, it would be fun to track yourself, health-wise, if you knew what to do with it."*

This lack of education highlighted by Lai et al., (2017) filtered through in general remarks: *"did I experiment with it? Yes. Could I interpret it? No. So I stopped using it."*

Clinicians admitted that they *“do not understand much of the functionality.”*

> Unben *says his health consumers "have a better understanding of what the WAT can do."*

Clinicians argued that *"many clinicians do not understand sleep. They have a general understanding of what REM is and what non-REM is, but they do not understand the different phases."* Clinician’s advocate that *"you need to educate people because the manuals provided with the devices are not read or understood."* Consumers offer that understanding PGHD in context is essential to them.

Clinicians believe that when health consumers *“feel the need,”* they will invest more time understanding the data and *“use it more effectively.”* On the other hand, the Researcher argues that there seems to be a hindrance to adoption and, akin with arguments raised by Taylor (2019) because participants see PGHD as burdensome. However, the data offers a solution of distilling the PGHD with the introduction of education addressing data specificity, accuracy, and credibility through embedding education in the Artefact to make the information more accessible, listening to the perception of it being burdensome.

### 4.4.12 Accuracy of PGHD

The challenge of accuracy around use in health conditions was dispelled by Strain et al. (2020) and Turakhia et al. (2019). However, the accuracy of the PGHD from these WATs remains a key source of criticism. Clinicians are concerned over the accuracy of the data.

> Greg *notes: "with these kinds of devices, and the circumstances in which they are worn, such as how tight this is against the skin, whether you are sweating, not sweating, the temperature outside etc., there is going to be a little bit of variability."*

Shin et al. (2019) similarly to these findings that health consumers still have a distrust, especially around *“sleep,” “calories burnt,”* and *“pulse rates.”*

> Jadene *admits she needs to; "build trust", especially when it comes to "chronic illnesses", where "if it is not managed properly", the consequences are "severe", and "it is just scary to trust something."*

Accuracy also had implications on health consumers’ willingness to follow prompts and clinicians concern that inaccurate data is the creation of false alarms.

> Andrew *notes, "he picked up on patients where they have had extremely high readings and a low intensity, and we have sent them to the cardiologist because of it."*

Although this demonstrates the value in clinicians monitoring abnormal data behaviour and making recommendations, it also highlights the danger if faulty readings cause anomalies with participants expressing concerns over a *“misdiagnosis.”*

> Imraan *says: “discussing with the clinician when to set alarms as the clinician would know best.”*

Clinicians added that consumers monitor superficial features such as *“heart rates and steps,”* but many should use the *“blood-pressure recording.”*

Concerns from Turakhia et al. (2019) were confirmed that despite the proven PGHD validity, clinicians rerun diagnostics. This phenomenon is highlighted when:

> *Leila notes that "over time, the checking of the PGHD from a WAT during a consultation can imbue the PGHD with added credibility and transfer some of the clinician credibility into the validity of the WAT PGHD to "decrease the white-collar effect over time."*

When probed on whether they ever tested the accuracy of the PGHD, consumers admitted that they had not and *“just generally went with what the common Internet results.”* Further, consumers acknowledged that they *“never checked and calibrated it [PGHD from WAT] against a standard”* but *“takes it at face value.”*

However, data argue against this notion as some consumers found WAT PGHD accurate.

> *Pravesh stated he: "tested the older heart rate monitor strap to see the accuracy of the heart rate", which he thought "more accurate", but when comparing the PGHD from the WAT, he found that the readings were "almost the same."*

Consumers who were sceptical and *“did question the accuracy”* but stated that *“with the help of [her] GP, [they] checked and tested”*, creating confidence in WAT PGHD. Some clinicians have an equally positive view of accuracy.

> *Neville and Unben see their WAT as “incredibly accurate.”*

Some clinicians expressed that the data's accuracy does not matter as much as the consistency of using the same device.

> *"As long as you stick to the same device, then you have got a trend as you are going to get discrepancies between devices because they might use slightly different ways of monitoring heart rate and accelerometery."*

> *Greg believes; "the big advantage behind PGHD is the volume of data, which I think overcomes the slight insensitivity about it."*

These, he explains, emphasises "trends rather than points of data." For example:

> *"If someone has a fever, we will not focus on the difference between 38 or 39 degrees, but we want to know the temperature over ten days and what the variability there is."*

User behaviours impact data accuracy as participants observed*: "some wear them intermittently, or not at all."* This was especially true for sleep.

> *Larry and Greg see; "the monitoring of sleep as crucial as "sleep is vital for managing chronic conditions."*

On balance, the participants concluded that WAT does not need to be "one hundred per cent accurate" if the other applications that feed into the WAT are themselves accurate, for example, *"Dexcom readings[35]"* used with WAT was *"trusted fully."*

### 4.4.13 WAT User Routine

For the Artefact to become a part of the consumer's lives, the Researcher needed to understand current user routines so that the design attributes could be scoped to fit into multiple behaviour patterns. Table 4.2 captures a comparison of usage patterns highlighted from the data.

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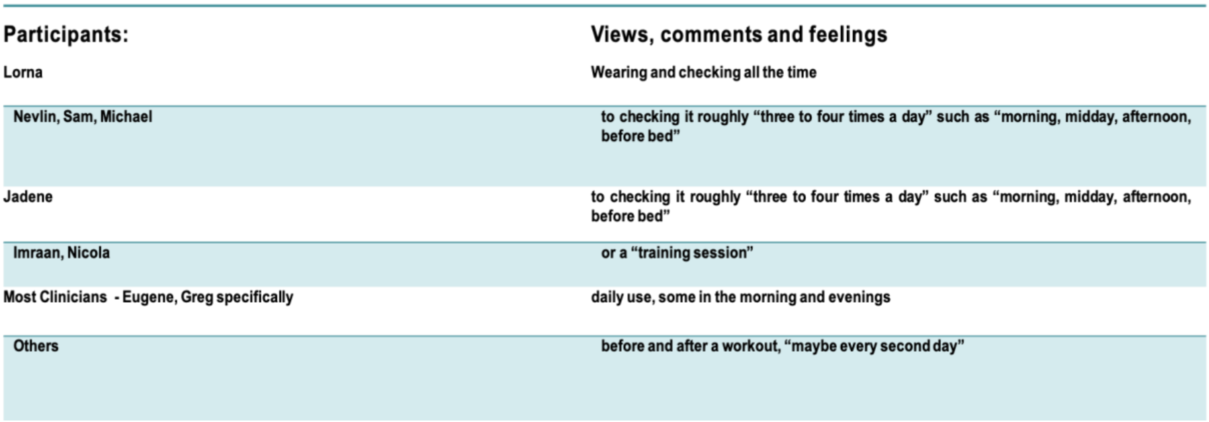
[35] https://www.dexcom.com/g6-cgm-system

**Table 4. 4:User Routines**



| Participants: | Views, comments and feelings |
|---|---|
| Lorna | Wearing and checking all the time |
| Nevlin, Sam, Michael | to checking it roughly "three to four times a day" such as "morning, midday, afternoon, before bed" |
| Jadene | to checking it roughly "three to four times a day" such as "morning, midday, afternoon, before bed" |
| Imraan, Nicola | or a "training session" |
| Most Clinicians - Eugene, Greg specifically | daily use, some in the morning and evenings |
| Others | before and after a workout, "maybe every second day" |

The actionable outcome of this research is the design of a novel artefact that leverages PGHD into our clinical value proposition. The design of the Artefact composed of technological and social elements is now dealt with in Theme 3.

## THEME 3

### 4.5 THE ARTEFACT

Fundamental principles considered within Theme 3 included reiterative shaping of the functional design, mutually influential roles within the design, and authentic and concurrent evaluation of PGHD within the Artefact (Sein et al., 2011). Furthermore, the inseparable influences mutually exerted by the two domains: the Artefact and the organisational context, centre around reuniting the need of the consumer (Zhang et al., 2017) with services of the clinician to halt the current marginalisation of the clinicians identified by Caiata-Zufferey et al, (2010) and Sommerhalder et al, (2009).

Notably, the element of patient-centricity was drawn from the sentiment analysis, placing it in context for the need for personability. Seshadri (2020) argued the functional design and associated adaptability of Artefact must address the risk of the relationship with Google hindering potential reunification, as reinforced by Powles and Hodson (2017). Findings are structured so that they reflect "technology as a structured" view of the mutually valuable Artefact, where structures of the organisational domain and the participants' use will be inscribed into the Artefact (Orlikowski & Iacono, 2001).

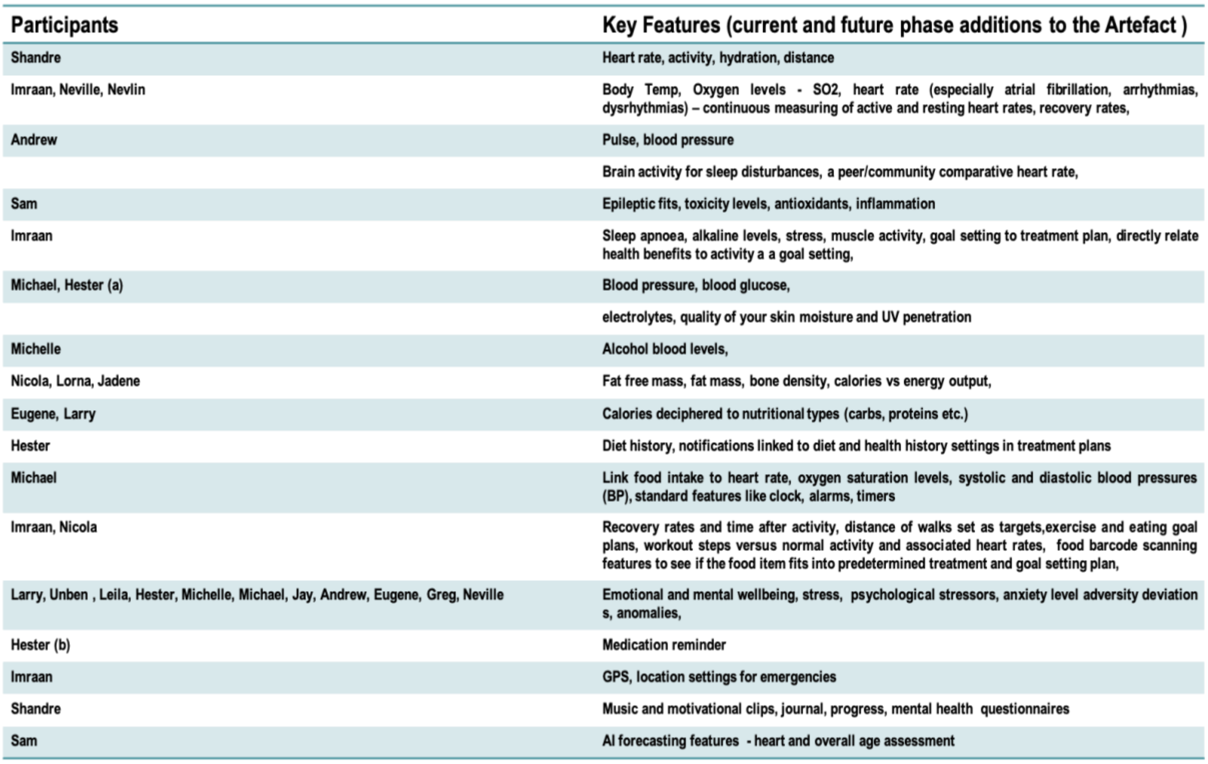
<table>
<tr><th colspan="3">(a) Clinicians' perspectives</th></tr>
<tr><th>Theme</th><th>Word cloud</th><th>Sentiment analysis</th></tr>
<tr><td><strong>Artefact Design needs</strong></td><td> </td><td> </td></tr>
<tr><th colspan="3">(b) Health Consumers' perspective</th></tr>
<tr><th>Theme</th><th>Word cloud</th><th>Sentiment analysis</th></tr>
<tr><td><strong>Behavioural impacts</strong></td><td> </td><td> </td></tr>
</table>

**Figure 4. 4:Artefact Design Needs - Compiled by the Researcher**

### 4.5.1 Features

Shin et al. (2019) argued that various features are important to different users: *"my chronic clients monitor their heart rate, teenagers monitor steps for fun while athletes monitor hydration and distance."* Dix et al., (2003) also cautioned that there would be limitations on the design dictated by external forces. These areas Dix et al., (2009) and Dix et al., (2004) advised, are most easily dealt with by ensuring that any range of functionalities should adhere to seven general principles. These included fair uses, flexibility in use, sensitive information; low physical effort; size, and space for approach and use (Dix et al., 2004), crucial to getting parity between stakeholder needs. Table 4.5 is a precis of arguments from participants on what user needs to require to be designed into the Artefact as core receptors of data and core functionality.

**Table 4. 5: Functional Artefact Features – details extracted from the narratives**



| Participants | Key Features (current and future phase additions to the Artefact ) |
|---|---|
| Shandre | Heart rate, activity, hydration, distance |
| Imraan, Neville, Nevlin | Body Temp, Oxygen levels - SO2, heart rate (especially atrial fibrillation, arrhythmias, dysrhythmias) – continuous measuring of active and resting heart rates, recovery rates, |
| Andrew | Pulse, blood pressure |
|  | Brain activity for sleep disturbances, a peer/community comparative heart rate, |
| Sam | Epileptic fits, toxicity levels, antioxidants, inflammation |
| Imraan | Sleep apnoea, alkaline levels, stress, muscle activity, goal setting to treatment plan, directly relate health benefits to activity a a goal setting, |
| Michael, Hester (a) | Blood pressure, blood glucose, |
|  | electrolytes, quality of your skin moisture and UV penetration |
| Michelle | Alcohol blood levels, |
| Nicola, Lorna, Jadene | Fat free mass, fat mass, bone density, calories vs energy output, |
| Eugene, Larry | Calories deciphered to nutritional types (carbs, proteins etc.) |
| Hester | Diet history, notifications linked to diet and health history settings in treatment plans |
| Michael | Link food intake to heart rate, oxygen saturation levels, systolic and diastolic blood pressures (BP), standard features like clock, alarms, timers |
| Imraan, Nicola | Recovery rates and time after activity, distance of walks set as targets,exercise and eating goal plans, workout steps versus normal activity and associated heart rates, food barcode scanning features to see if the food item fits into predetermined treatment and goal setting plan, |
| Larry, Unben , Leila, Hester, Michelle, Michael, Jay, Andrew, Eugene, Greg, Neville | Emotional and mental wellbeing, stress, psychological stressors, anxiety level adversity deviation s, anomalies, |
| Hester (b) | Medication reminder |
| Imraan | GPS, location settings for emergencies |
| Shandre | Music and motivational clips, journal, progress, mental health questionnaires |
| Sam | AI forecasting features - heart and overall age assessment |

Clinicians mentioned that they monitored *“psychological stressors.”* The clinicians proposed that the Artefact should have the optionality to include family participation so that notifications *"can go-to my close family members"* This concept of using the Artefact to assist with the healthcare of oneself and their family was novel.

> Nevlin *notes that he would “find it extremely helpful” as it could be “a lifesaver” for his “mom and dad.”*

Different age groups are looking for specified features from the Artefact.

> *In her 20s,* Sam *focuses on "disease preventative action, and not disease management action", such as "taking certain steps now to prevent getting a condition later in life."*

Clinicians introduced a Journal feedback option or questionnaire where *“if they tried something new like a new treatment, they could write down notes on how they felt”*, and the clinicians could *“tailor those programmes.”* The Researcher realised that the Artefact must follow a platform thinking approach to incorporate a multiplicity of functionalities that can draw on current best of breed IoT and associated Apps.

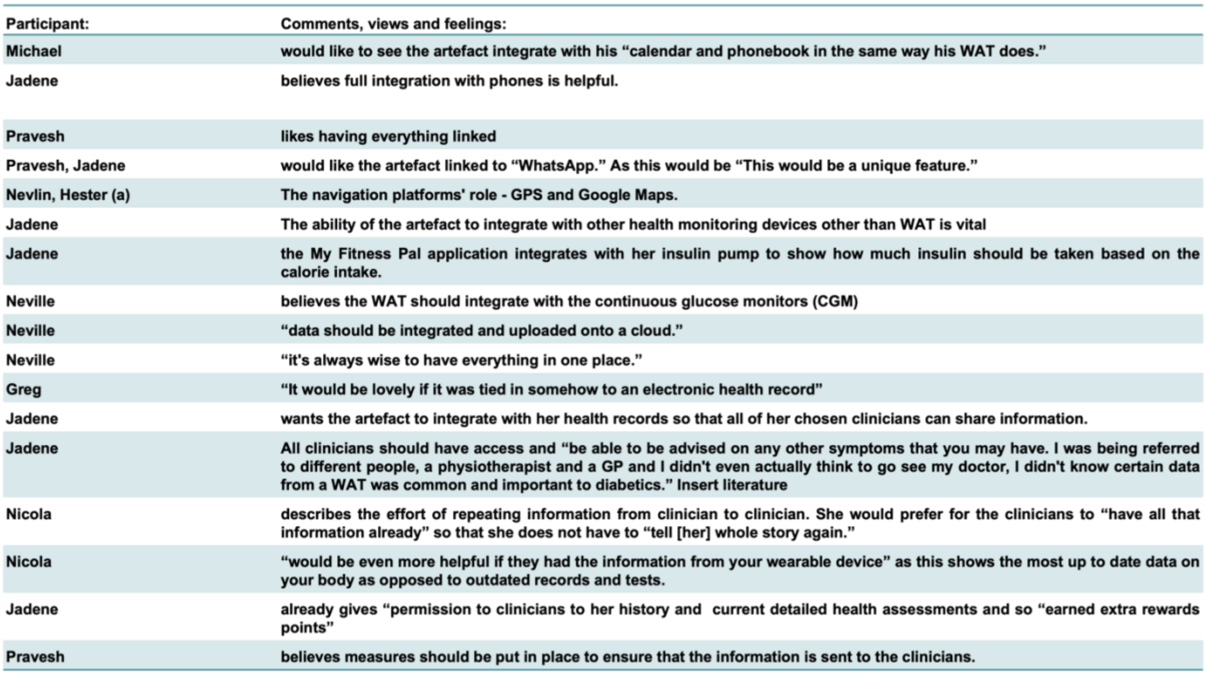
### 4.5.2 Integration

Patel et al. (2018) prompted the importance of probing the Artefact's integration into existing systems that form part of daily lifestyle. Findings show that users want the Artefact to pull from all data points effortlessly and seamlessly, including but not limited to the PGHD from their WAT's. Participants make purchasing decisions based on the devices ability to integrate with their other IoT's, including their tablets and associated health Apps. As Demiris (2016) argued, we can empower consumers on the Artefact to be in constant control of their health. Ease of use in real-time associated with the functionality supports the arguments of Lopes et al., (2015), advocating a move away from retrospective clinical reviews.

> Neville*’s desire is for “automatic integration” between devices; “Everything and everyone just talks to each other a little easier.”*

Lupton (2016) and (Lupton 3013) argued that consumers will continue to carry their data away from clinician structures if the platform is not agile to their current digital lifestyle. Therefore, the Researcher probed what crucial integrations would be necessary to achieve a consumer-centric platform that creates continued interactions to prevent this.

**Table 4. 6:Highlights Crucial Integrations required by the Participants - a Summary**



| Participant: | Comments, views and feelings: |
|---|---|
| Michael | would like to see the artefact integrate with his “calendar and phonebook in the same way his WAT does.” |
| Jadene | believes full integration with phones is helpful. |
| Pravesh | likes having everything linked |
| Pravesh, Jadene | would like the artefact linked to “WhatsApp.” As this would be “This would be a unique feature.” |
| Nevlin, Hester (a) | The navigation platforms' role - GPS and Google Maps. |
| Jadene | The ability of the artefact to integrate with other health monitoring devices other than WAT is vital |
| Jadene | the My Fitness Pal application integrates with her insulin pump to show how much insulin should be taken based on the calorie intake. |
| Neville | believes the WAT should integrate with the continuous glucose monitors (CGM) |
| Neville | “data should be integrated and uploaded onto a cloud.” |
| Neville | “it's always wise to have everything in one place.” |
| Greg | “It would be lovely if it was tied in somehow to an electronic health record” |
| Jadene | wants the artefact to integrate with her health records so that all of her chosen clinicians can share information. |
| Jadene | All clinicians should have access and “be able to be advised on any other symptoms that you may have. I was being referred to different people, a physiotherapist and a GP and I didn't even actually think to go see my doctor, I didn't know certain data from a WAT was common and important to diabetics.” Insert literature |
| Nicola | describes the effort of repeating information from clinician to clinician. She would prefer for the clinicians to “have all that information already” so that she does not have to “tell [her] whole story again.” |
| Nicola | “would be even more helpful if they had the information from your wearable device” as this shows the most up to date data on your body as opposed to outdated records and tests. |
| Jadene | already gives “permission to clinicians to her history and current detailed health assessments and so “earned extra rewards points” |
| Pravesh | believes measures should be put in place to ensure that the information is sent to the clinicians. |

Participants also stressed the importance of the Artefact being both mobile and web-friendly so that accessibility was never an issue.

### 4.5.3 Display

Studies show that an essential part of HCI is UI design for interactive computing systems (Dix, 2009). Benyon (2014) argued the difficulties involved in designing an interface that efficiently deals with individual preferences without creating user frustration. Dix (2009) offers remedial solutions to these challenges, arguing that the UI is the interface between the computer system and users, facilitating changes and developments necessitating a new, expanded way of looking at usability. Participants who want information should be displayed in a *“trend form”* for *“long-term data”*. Wong et al. (2020) is validated in that clinicians require the Artefact to *“look at history and point out to the patients what the signs mean.”* Clinicians indicate a necessity to see

PGHD variability as *“nothing in nature is a straight line.”* These elements of the display should be in a dashboard incorporating all data points to predict the impact of the disease.

#### 4.5.3.1 Comparison and Timelines

Participants indicated that displaying different time frames of *"a week, two weeks a month, and then sometimes three months"* is essential.

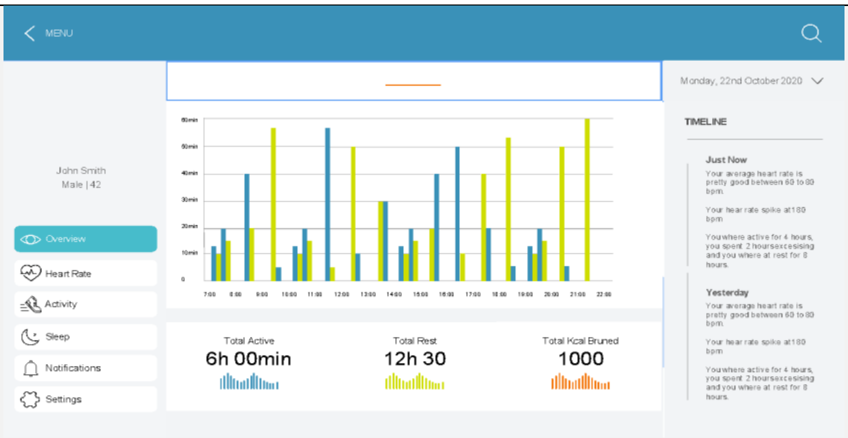
> Greg *says, “If it [the artefact] could indicate a clear change over a week or month period, for example, a one-page report on a dashboard to indicate this is what it is today” –“that would be wow,” says* Michael

#### 4.5.3.2 Preferences

The Researcher presented some popular mock displays of data to start moulding the UI and UX of the Artefact (Benyon, 2014). Essential in the probing was to elucidate the elements Bachmann et al., (2018) argued are necessary to measure and frame task performance. The mock-ups, see Figure 4.5, were presented to stimulate the discussions.

Precis of the discussions are constructed in the tables below.

A



**Just Now**

Your average heart rate is pretty good between 60 to 80 bpm.

Your hear rate spike at180 bpm

You where active for 4 hours, you spent 2 hoursexcesising and you where at rest for 8 hours.

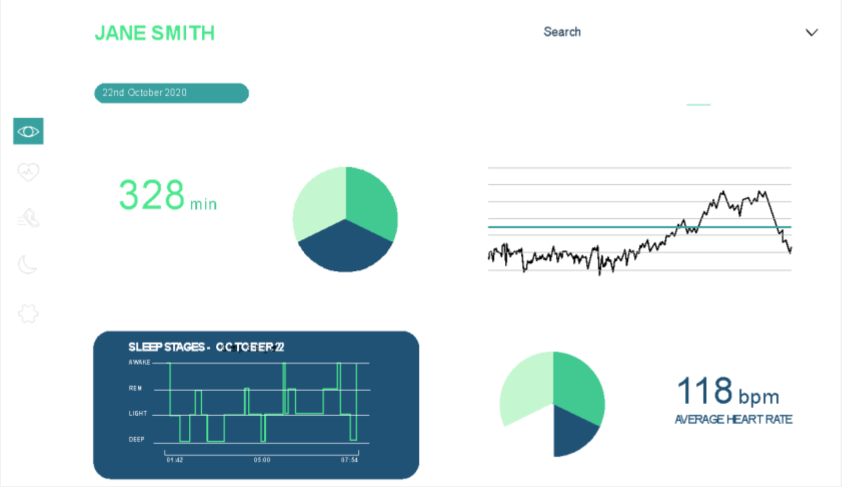
**Yesterday**

Your average heart rate is pretty good between 60 to 80 bpm.

Your hear rate spike at180 bpm

You where active for 4 hours, you spent 2 hoursexcesising and you where at rest for 8 hours.

B



C

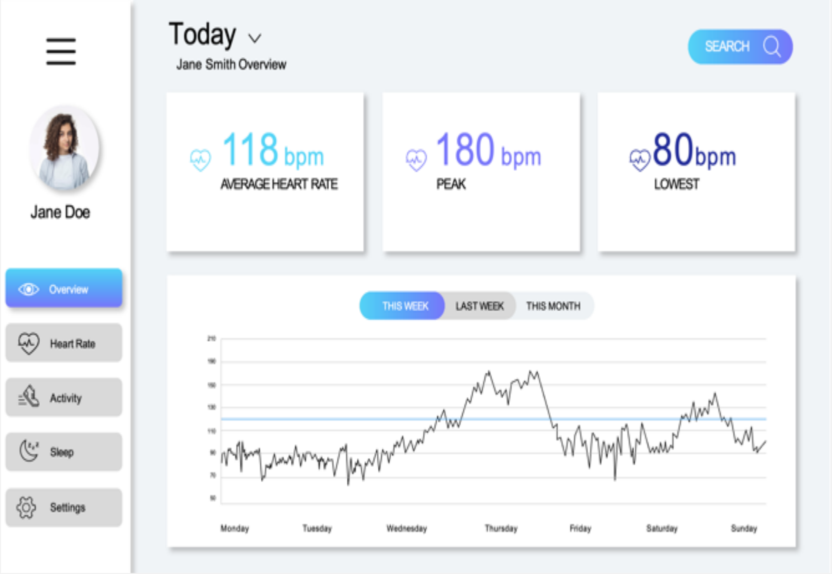
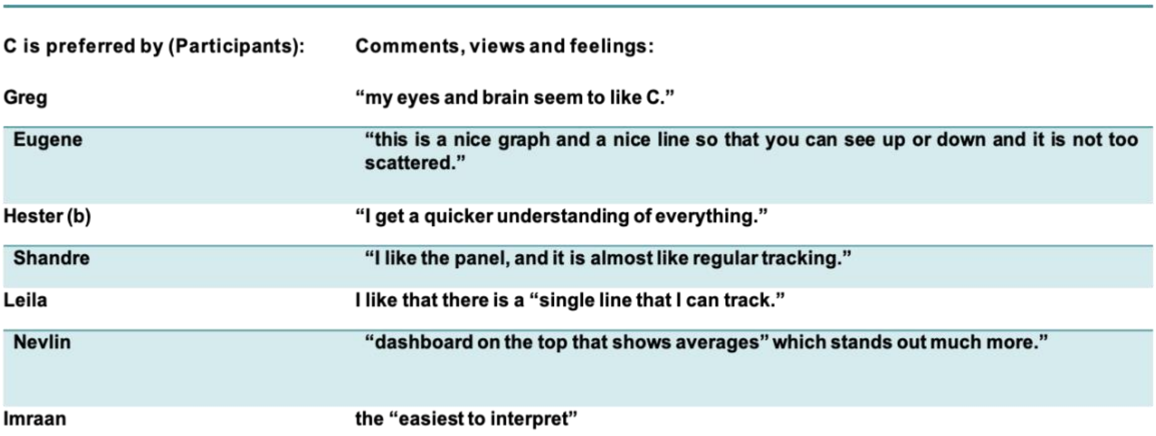


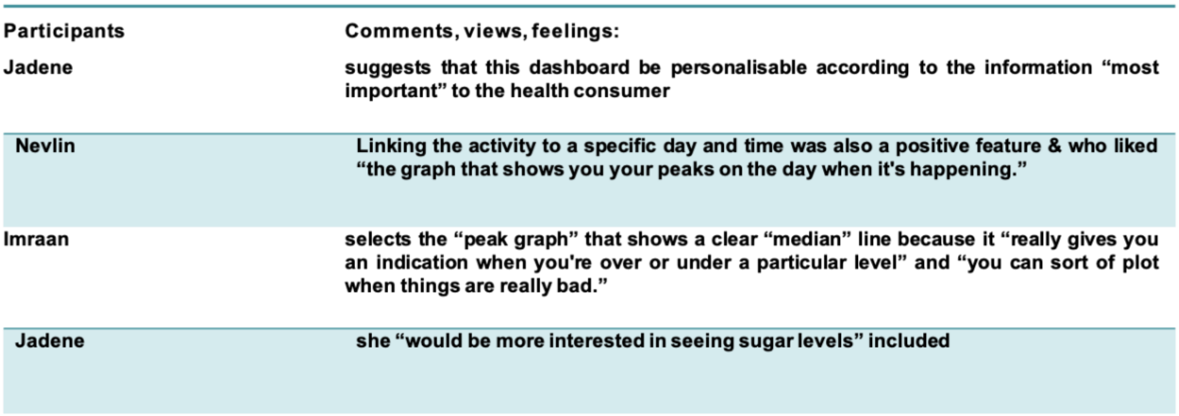
**Figure 4. 5:Mock-up Dashboards, Version A; Version B and Version C**

**Table 4. 7: The most popular display option among clinicians**



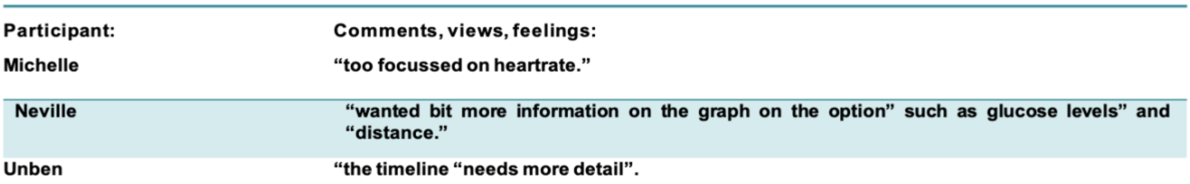
| C is preferred by (Participants): | Comments, views and feelings: |
|---|---|
| Greg | "my eyes and brain seem to like C." |
| Eugene | "this is a nice graph and a nice line so that you can see up or down and it is not too scattered." |
| Hester (b) | "I get a quicker understanding of everything." |
| Shandre | "I like the panel, and it is almost like regular tracking." |
| Leila | I like that there is a "single line that I can track." |
| Nevlin | "dashboard on the top that shows averages" which stands out much more." |
| Imraan | the "easiest to interpret" |

**Table 4. 8:Consumer Views on C**



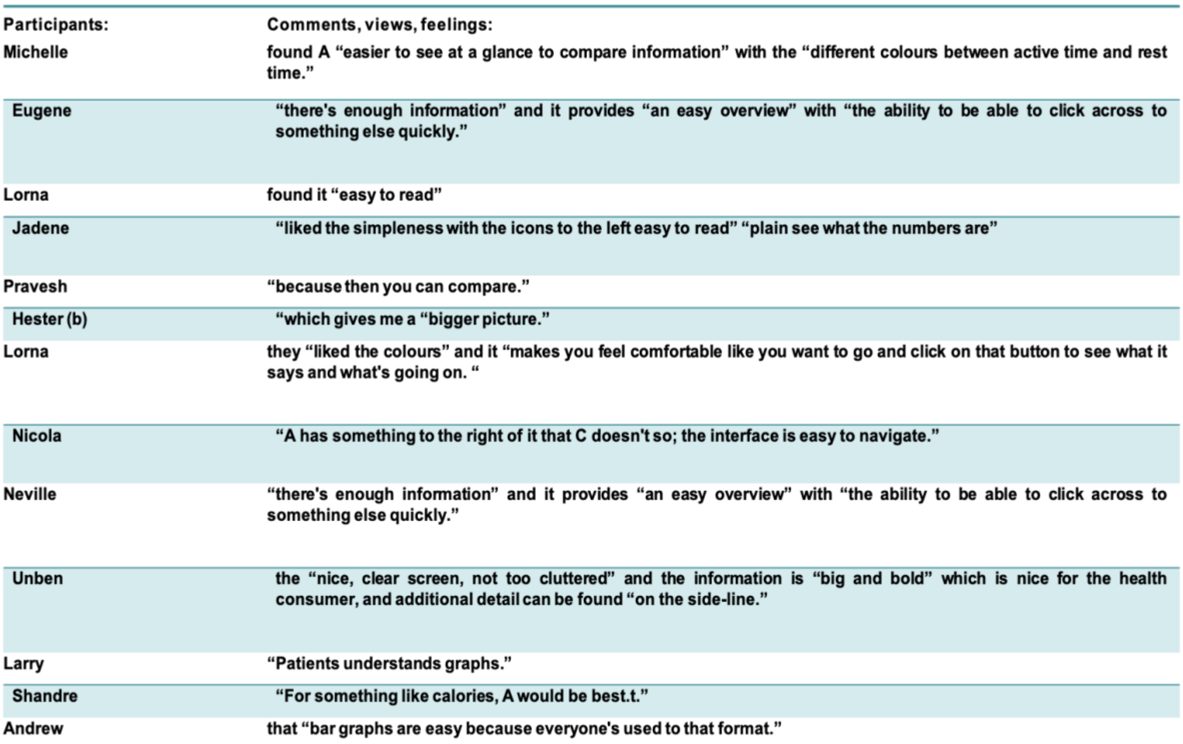
| Participants | Comments, views, feelings: |
|---|---|
| Jadene | suggests that this dashboard be personalisable according to the information "most important" to the health consumer |
| Nevlin | Linking the activity to a specific day and time was also a positive feature & who liked "the graph that shows you your peaks on the day when it's happening." |
| Imraan | selects the "peak graph" that shows a clear "median" line because it "really gives you an indication when you're over or under a particular level" and "you can sort of plot when things are really bad." |
| Jadene | she "would be more interested in seeing sugar levels" included |

**Table 4. 9:Clinician's Critique of C**



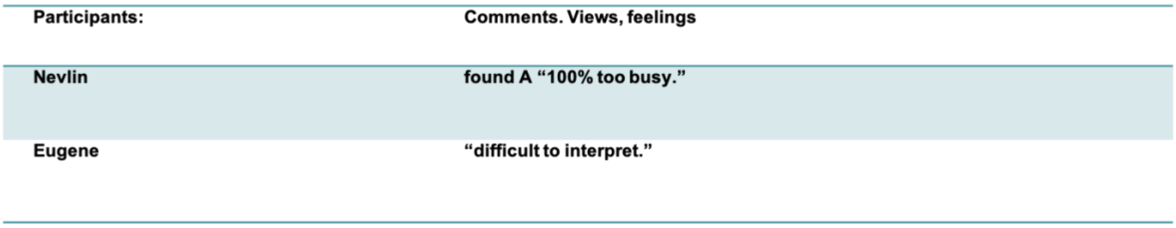
| Participant: | Comments, views, feelings: |
|---|---|
| Michelle | "too focussed on heartrate." |
| Neville | "wanted bit more information on the graph on the option" such as glucose levels" and "distance." |
| Unben | "the timeline "needs more detail". |

**Table 4. 10:Participants Reasons for Preferring A**



| Participants: | Comments, views, feelings: |
|---|---|
| Michelle | found A "easier to see at a glance to compare information" with the "different colours between active time and rest time." |
| Eugene | "there's enough information" and it provides "an easy overview" with "the ability to be able to click across to something else quickly." |
| Lorna | found it "easy to read" |
| Jadene | "liked the simpleness with the icons to the left easy to read" "plain see what the numbers are" |
| Pravesh | "because then you can compare." |
| Hester (b) | "which gives me a "bigger picture." |
| Lorna | they "liked the colours" and it "makes you feel comfortable like you want to go and click on that button to see what it says and what's going on. " |
| Nicola | "A has something to the right of it that C doesn't so; the interface is easy to navigate." |
| Neville | "there's enough information" and it provides "an easy overview" with "the ability to be able to click across to something else quickly." |
| Unben | the "nice, clear screen, not too cluttered" and the information is "big and bold" which is nice for the health consumer, and additional detail can be found "on the side-line." |
| Larry | "Patients understands graphs." |
| Shandre | "For something like calories, A would be best.t." |
| Andrew | that "bar graphs are easy because everyone's used to that format." |

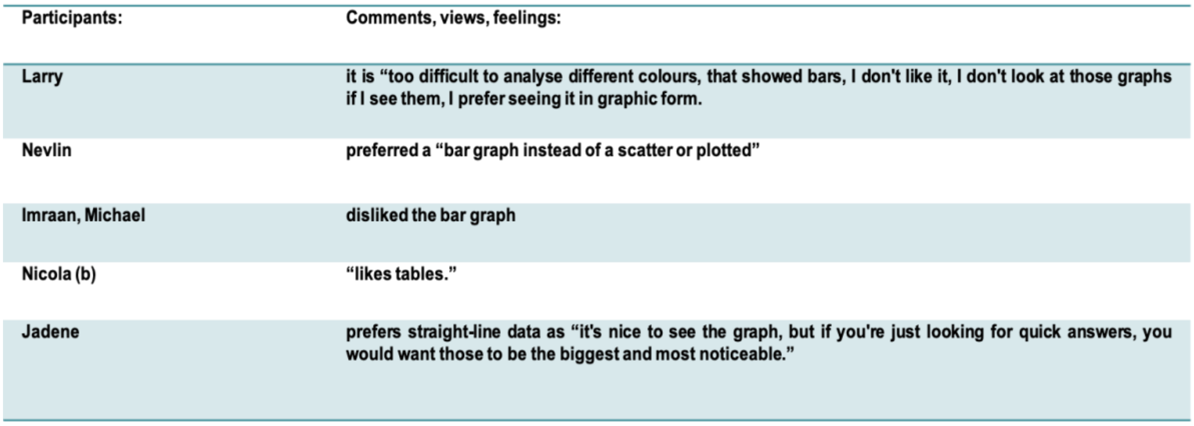
**Table 4. 11:Critique of A**



| Participants: | Comments. Views, feelings |
|---|---|
| Nevlin | found A "100% too busy." |
| Eugene | "difficult to interpret." |

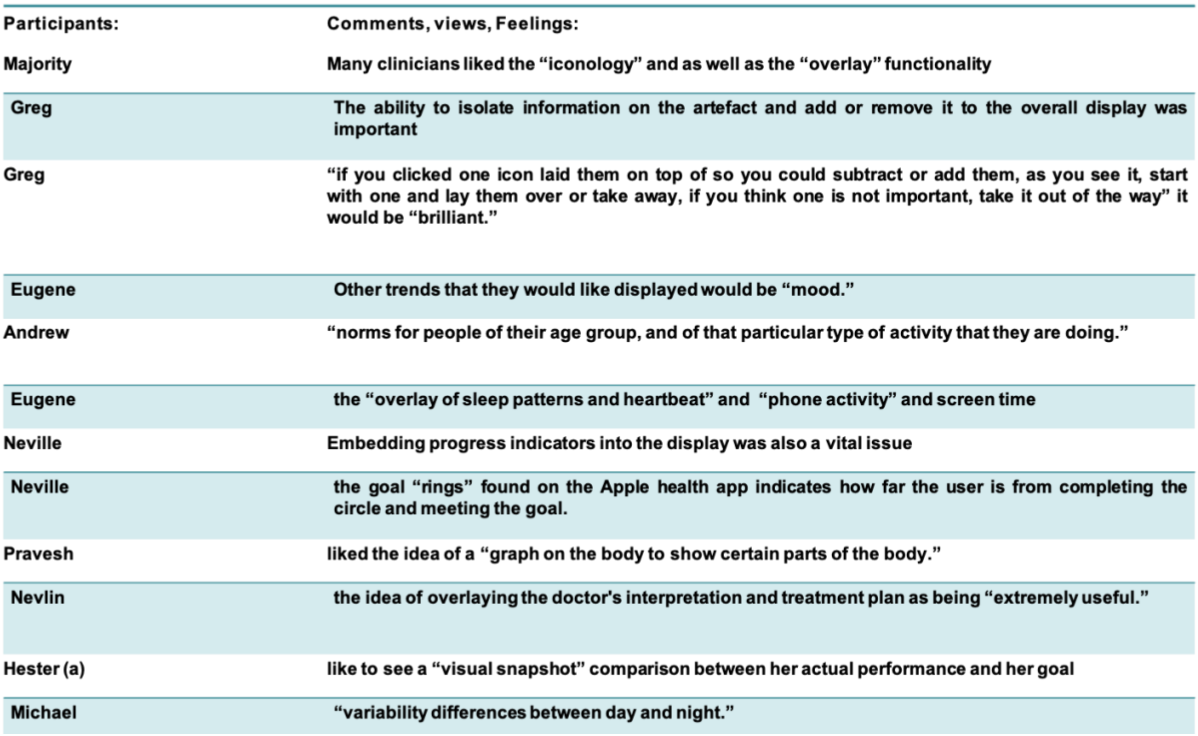
Human reactions to the visual display are critical to ensure adoption (Nielsen, 1994). Most health consumers found B "boring." Furthermore, others were more vociferous, stating they "definitely did not like B at all." Bachmann et al., (2018) was correct in helping understand that task orientation displays extract better outcomes. Participants were disorientated stating: "It seems disorganised". This observation was shared across consumers and clinicians.

**Table 4. 12:Commentary on Graphs and Tables**



| Participants: | Comments, views, feelings: |
|---|---|
| Larry | it is "too difficult to analyse different colours, that showed bars, I don't like it, I don't look at those graphs if I see them, I prefer seeing it in graphic form. |
| Nevlin | preferred a "bar graph instead of a scatter or plotted" |
| Imraan, Michael | disliked the bar graph |
| Nicola (b) | "likes tables." |
| Jadene | prefers straight-line data as "it's nice to see the graph, but if you're just looking for quick answers, you would want those to be the biggest and most noticeable." |

**Table 4. 13:General comments on Dashboards -**



| Participants: | Comments, views, Feelings: |
|---|---|
| Majority | Many clinicians liked the "iconology" and as well as the "overlay" functionality |
| Greg | The ability to isolate information on the artefact and add or remove it to the overall display was important |
| Greg | "if you clicked one icon laid them on top of so you could subtract or add them, as you see it, start with one and lay them over or take away, if you think one is not important, take it out of the way" it would be "brilliant." |
| Eugene | Other trends that they would like displayed would be "mood." |
| Andrew | "norms for people of their age group, and of that particular type of activity that they are doing." |
| Eugene | the "overlay of sleep patterns and heartbeat" and "phone activity" and screen time |
| Neville | Embedding progress indicators into the display was also a vital issue |
| Neville | the goal "rings" found on the Apple health app indicates how far the user is from completing the circle and meeting the goal. |
| Pravesh | liked the idea of a "graph on the body to show certain parts of the body." |
| Nevlin | the idea of overlaying the doctor's interpretation and treatment plan as being "extremely useful." |
| Hester (a) | like to see a "visual snapshot" comparison between her actual performance and her goal |
| Michael | "variability differences between day and night." |

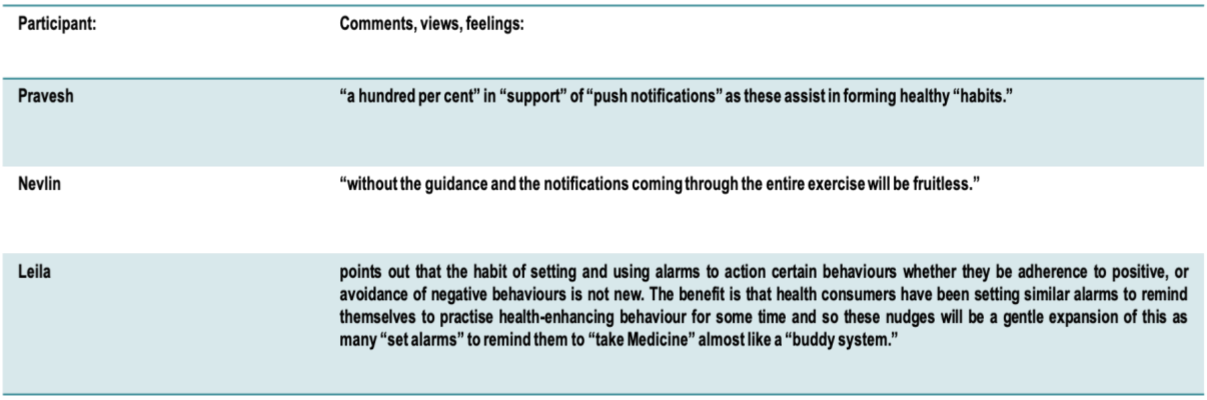
An important latent theme is a need for personalisation. The Researcher realised that this might well be the most discerning attribute of the Artefact. The need to have an interface unique to you dates to antique literature (Bailey & Pearson, 1983). Clinicians noted that *"There could also be varying levels of the display according to patient age and understanding people are very visual, but some will want explanations in the text."*

### 4.5.4 Notifications

Al Participants agree that notifications are a vital source of communication between the clinician and health consumer. However, as Patel (2018) argue, there needs to be a link to performance. The data needs to be in the form of congratulation features, and clinical concerns and, needs to manifest as warnings or negative alerts.

Understanding the format and frequency of these alerts was a core consideration captured in the sentiment below:

**Table 4. 14:Format and Frequency of Alerts**



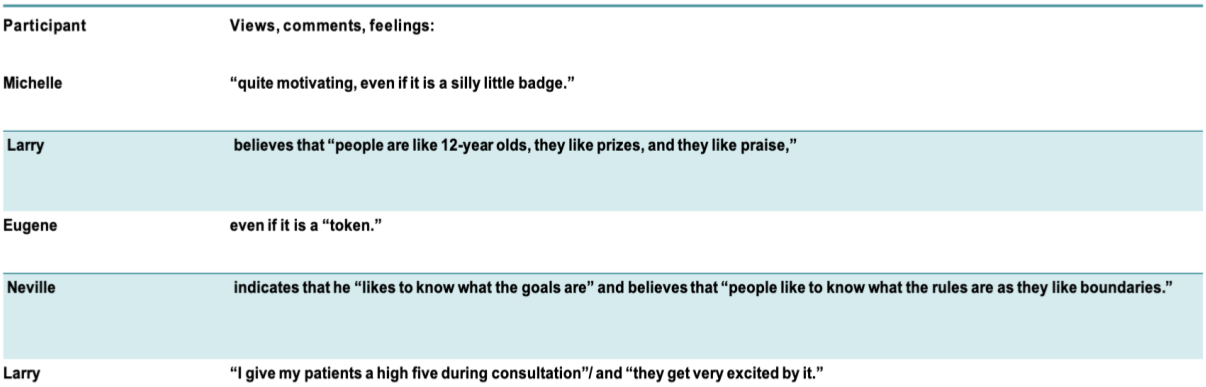
| Participant: | Comments, views, feelings: |
|---|---|
| Pravesh | "a hundred per cent" in "support" of "push notifications" as these assist in forming healthy "habits." |
| Nevlin | "without the guidance and the notifications coming through the entire exercise will be fruitless." |
| Leila | points out that the habit of setting and using alarms to action certain behaviours whether they be adherence to positive, or avoidance of negative behaviours is not new. The benefit is that health consumers have been setting similar alarms to remind themselves to practise health-enhancing behaviour for some time and so these nudges will be a gentle expansion of this as many "set alarms" to remind them to "take Medicine" almost like a "buddy system." |

The different categories of notifications would be divided into congratulations features as forms of motivation and alarm features as forms of warning.

#### 4.5.4.1 Congratulations Notifications

Blandford (2019) and Yeoman et al., (2017) urge clinicians to embrace the patient's personal needs. Consequently, the participants reflected on WAT users noted changes in their behaviour. These were clustered to extract the necessary functionality as recognition behaviours in Table 4.15.

**Table 4. 15:Recognition Behaviours**



| Participant | Views, comments, feelings: |
|---|---|
| Michelle | "quite motivating, even if it is a silly little badge." |
| Larry | believes that "people are like 12-year olds, they like prizes, and they like praise," |
| Eugene | even if it is a "token." |
| Neville | indicates that he "likes to know what the goals are" and believes that "people like to know what the rules are as they like boundaries." |
| Larry | "I give my patients a high five during consultation"/ and "they get very excited by it." |

Clinicians agreed that congratulations would be *"very useful for goal setting"* to help connect with the patient more regularly. Further, it was agreed that the value of WAT is that it created a tool that could help *"push in motivations aiming at personal targets"* and enabled clinicians to look at previous performance and *"negotiate"* new goals.

> *Larry notes that when this PGHD is supplied, "every single one of our patients on every single one of these devices, with very few exceptions, has changed their lives to a positive."*

Participants argued that WAT has *"changed many mindsets."* From *"increasing his steps"* to making her *"stand up or drink water to some using it to manage their treatment plans."*

> *Jadene stated that it "literally changed her life."*

Lupton, (2016) and Swan, (2013) are proven correct when considering the discipline of monitoring PGHD without the need for gratification but potentially with the support of communities living with the same condition. Participants showed that if a need is created within the treatment plan, this is enough to engage and use WAT. Slimily argued by Strain et al. (2020), clinicians stated that *"often in clinical trials, we see patients even on a placebo doing better just by monitoring themselves"*. However, some clinicians are *"against daily congratulations messages preferring weekly* *reflections."* What was called for was *"a weekly message saying, we have picked up the following patterns."* This was where the notion of a clinician Avatar was introduced. It was unanimous that this would be powerful if Avatars could deliver the congratulations or raise concerns.

Participants warn of congratulation features that happen too often *"if it is just a prompt"* to say, *"you reached 10,000 steps for the day well done,"* has little significance. There was also a call for personalisation and direct links to the patient's treatment plan. Participants expressed the value in *"comparisons"* as unlocking the user's *"competitive spirit."* There was a request in line with arguments from Christie (2013) to connect the solution to community groups for motivation and support.

In terms of tangible rewards, consumers offered that *"physically receiving something is not necessary, it needs to be self-motivating."* However, for some health consumers, this may not be enough as the juxtaposed position was argued that *"some people are gift people, so it depends on personality". "If it is just a well done, it is meaningless, but to be told, this month, these levels were all 80% in range, you have earned something."* It was agreed that *"The biggest reward is when you can see your improvement once you put in the effort."*

Clinicians warned, though, that obsessive behaviour associated with rewards can be unhealthy. The Researcher in subsequent interviews probed this notion and received confirmatory responses from other participants, including *"finds it motivating to the point of obsession in reaching goals."*

Some participants only use WAT to *"gather rewards."* On the other hand, when participants reflected on WAT user behaviour, there was an acknowledgement that *"I have not felt rewards made me change too much."*

The participants agreed that congratulations features are essential but should be linked to clinical events and personal goals and be delivered in the first instance by the Clinicians Avatar. Further investigation is needed as to whether the Artefact should be linked to an affinity rewards programme.

#### 4.5.4.2 Warning Notifications

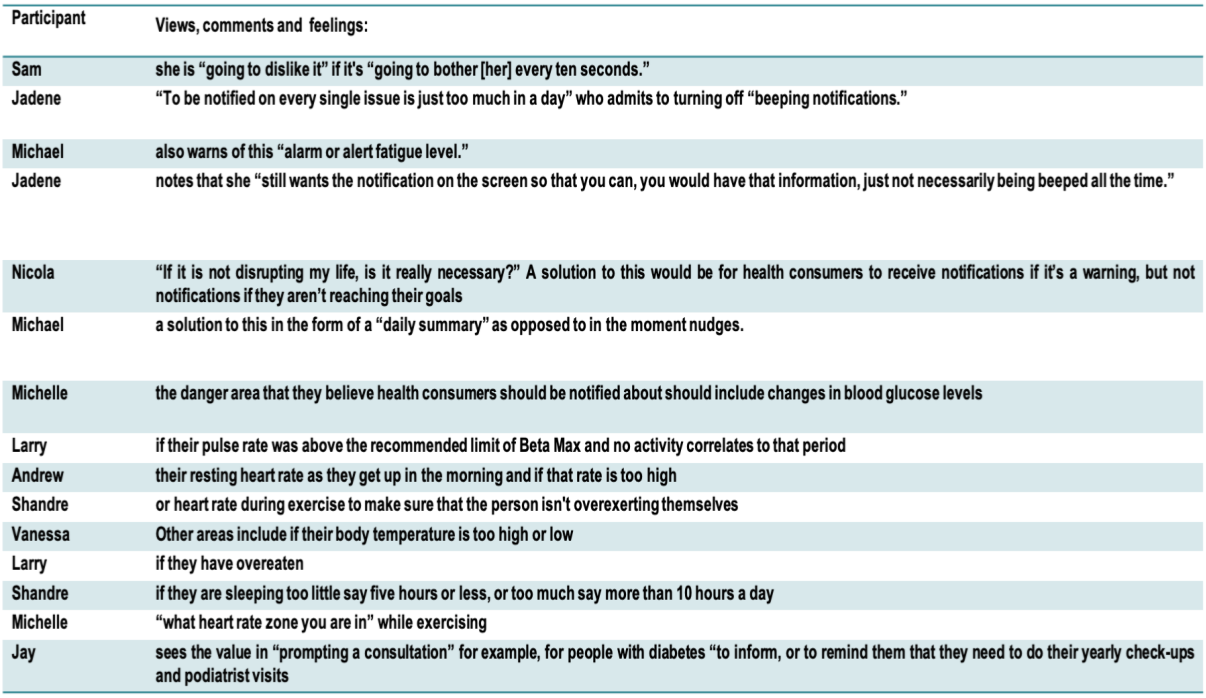
Warning notifications were presented as a call to action and promoting consultations.

There was agreement that the Artefact must *“carry an escalation rating as to how urgent something is.”* Clinicians believe health consumers need to *be “nudged fairly hard”* to understand *“what a normal rate and variability are"* and *“how theirs deviates from this.”* A notification *“from my clinician”* it was agreed is more likely to get patients to go for their consults. Clinicians would like to see whether clinical interventions on the Artefact were successful. These, it is suggested, could be *“displayed on the graph with a star or a summary of what the chatbot said and whether there was a response or not.”*

#### 4.5.4.3 Guiding Insights on Notification Impacts:

Table 4.16 presents a summary of what alarms and notifications should be triggered within the Artefact.

**Table 4. 16:Artefact Alarms**



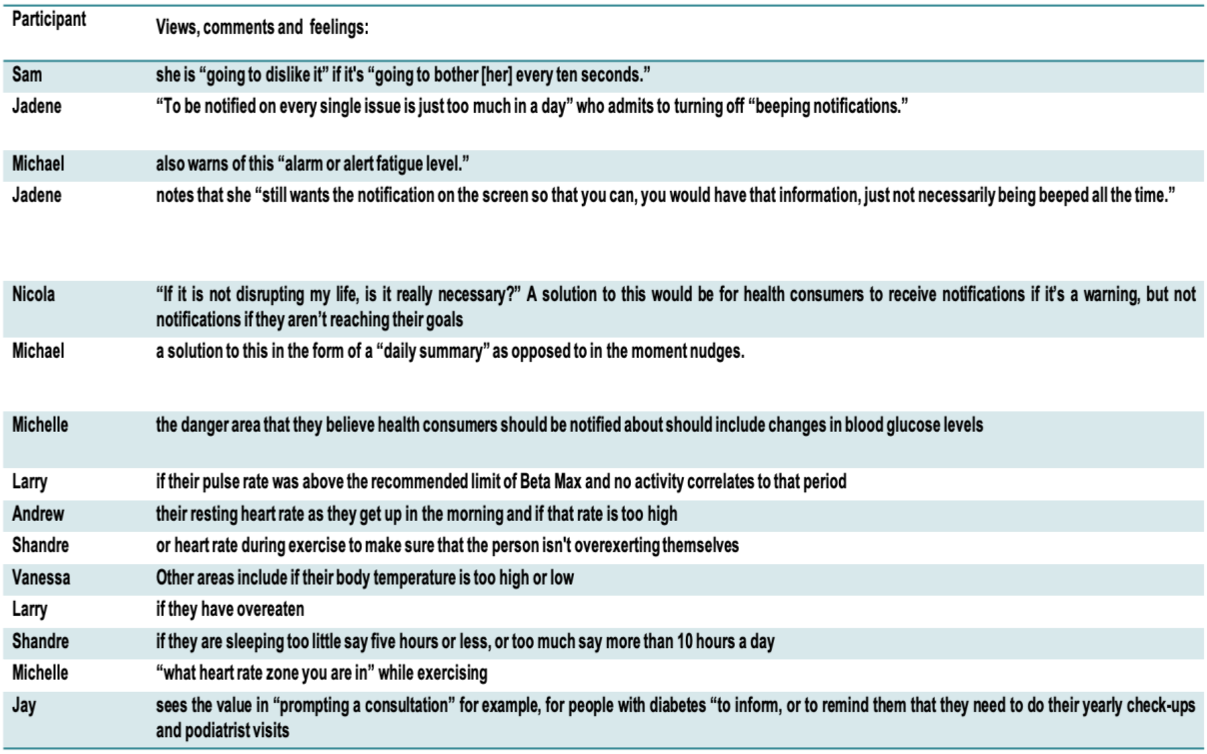
| Participant | Views, comments and feelings: |
|---|---|
| Sam | she is "going to dislike it" if it's "going to bother [her] every ten seconds." |
| Jadene | "To be notified on every single issue is just too much in a day" who admits to turning off "beeping notifications." |
| Michael | also warns of this "alarm or alert fatigue level." |
| Jadene | notes that she "still wants the notification on the screen so that you can, you would have that information, just not necessarily being beeped all the time." |
| Nicola | "If it is not disrupting my life, is it really necessary?" A solution to this would be for health consumers to receive notifications if it's a warning, but not notifications if they aren't reaching their goals |
| Michael | a solution to this in the form of a "daily summary" as opposed to in the moment nudges. |
| Michelle | the danger area that they believe health consumers should be notified about should include changes in blood glucose levels |
| Larry | if their pulse rate was above the recommended limit of Beta Max and no activity correlates to that period |
| Andrew | their resting heart rate as they get up in the morning and if that rate is too high |
| Shandre | or heart rate during exercise to make sure that the person isn't overexerting themselves |
| Vanessa | Other areas include if their body temperature is too high or low |
| Larry | if they have overeaten |
| Shandre | if they are sleeping too little say five hours or less, or too much say more than 10 hours a day |
| Michelle | "what heart rate zone you are in" while exercising |
| Jay | sees the value in "prompting a consultation" for example, for people with diabetes "to inform, or to remind them that they need to do their yearly check-ups and podiatrist visits |

The rates at which clinicians need to be informed about warning alerts was a vital area of the debate dealt with below.

#### 4.5.4.4 Warnings and Alerts to the Clinicians

The Researcher was encouraged by this element as it clearly showed that the clinicians were already adopting the notion of an artefact to help reunite their consumers. Comments précised in Table 4.17 evidenced the need.

**Table 4. 17:Warnings and Alerts**



| Participant | Views, comments and feelings: |
|---|---|
| Sam | she is “going to dislike it” if it’s “going to bother [her] every ten seconds.” |
| Jadene | “To be notified on every single issue is just too much in a day” who admits to turning off “beeping notifications.” |
| Michael | also warns of this “alarm or alert fatigue level.” |
| Jadene | notes that she “still wants the notification on the screen so that you can, you would have that information, just not necessarily being beeped all the time.” |
| Nicola | “If it is not disrupting my life, is it really necessary?” A solution to this would be for health consumers to receive notifications if it’s a warning, but not notifications if they aren’t reaching their goals |
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| Vanessa | Other areas include if their body temperature is too high or low |
| Larry | if they have overeaten |
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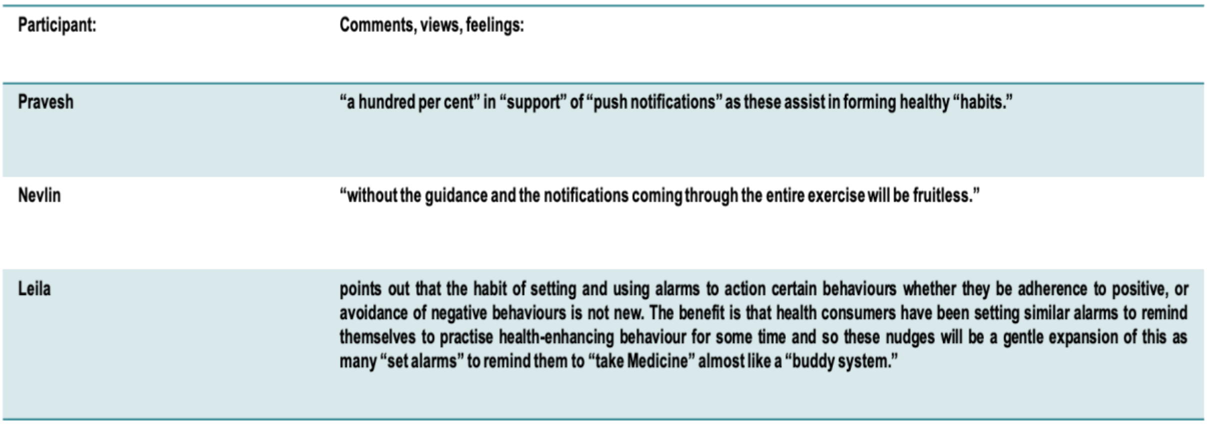
| Michelle | “what heart rate zone you are in” while exercising |
| Jay | sees the value in “prompting a consultation” for example, for people with diabetes “to inform, or to remind them that they need to do their yearly check-ups and podiatrist visits |

Following an acceptance of triggers for notifications, the Researcher needed to assess what medium was best preferred.

### 4.5.4.5 Forms of the Notifications:

While some clinicians preferred emails, it can be concluded that others sought more real-time methods compatible with mobile and web services.

**Table 4. 18:Forms of Notifications**

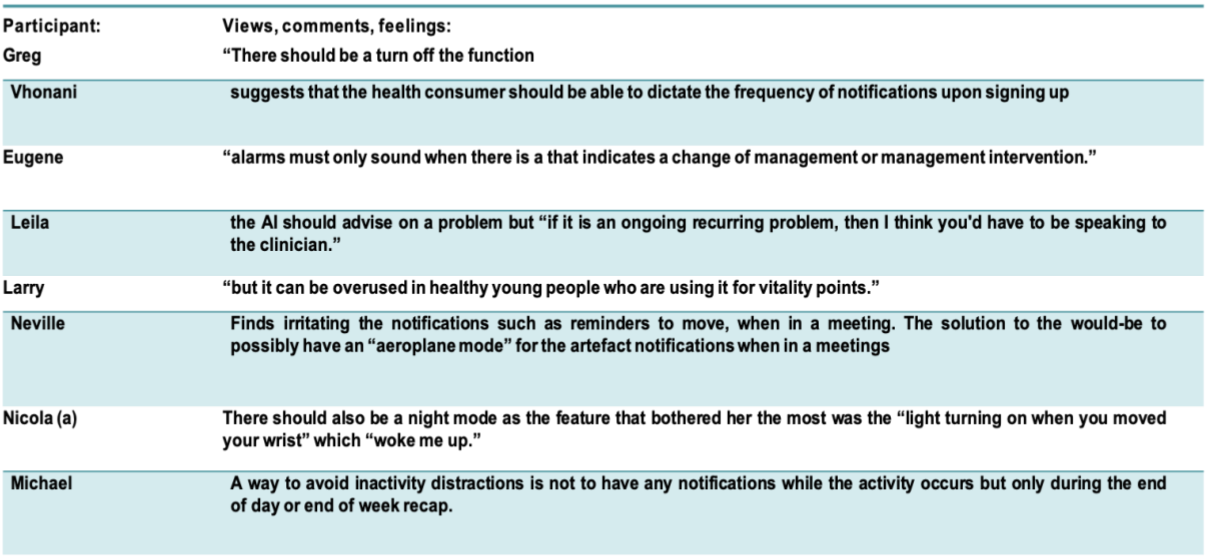


| Participant: | Comments, views, feelings: |
|---|---|
| Pravesh | "a hundred per cent" in "support" of "push notifications" as these assist in forming healthy "habits." |
| Nevlin | "without the guidance and the notifications coming through the entire exercise will be fruitless." |
| Leila | points out that the habit of setting and using alarms to action certain behaviours whether they be adherence to positive, or avoidance of negative behaviours is not new. The benefit is that health consumers have been setting similar alarms to remind themselves to practise health-enhancing behaviour for some time and so these nudges will be a gentle expansion of this as many "set alarms" to remind them to "take Medicine" almost like a "buddy system." |

### 4.5.4.6 Positives and Negatives of Notifications

This element is highlighted through emotive responses to the phenomenon highlighted in Gardner et al. (2019) and Shanafelt et al. (2016) who argued the burnout associated with the influx of digital messages. Added, as Remuzzi and Remuzzi (2020) cautioned, COVID 19 has added to this stress. Many clinicians raised concerns around the perils of having too many notifications. On the consumer side, clinicians argued that *"some health consumers do not like to feel they are being monitored closely,"*

**Table 4. 19:General Feelings around Notifications**



| Participant: | Views, comments, feelings: |
|---|---|
| Greg | "There should be a turn off the function |
| Vhonani | suggests that the health consumer should be able to dictate the frequency of notifications upon signing up |
| Eugene | "alarms must only sound when there is a that indicates a change of management or management intervention." |
| Leila | the AI should advise on a problem but "if it is an ongoing recurring problem, then I think you'd have to be speaking to the clinician." |
| Larry | "but it can be overused in healthy young people who are using it for vitality points." |
| Neville | Finds irritating the notifications such as reminders to move, when in a meeting. The solution to the would-be to possibly have an "aeroplane mode" for the artefact notifications when in a meetings |
| Nicola (a) | There should also be a night mode as the feature that bothered her the most was the "light turning on when you moved your wrist" which "woke me up." |
| Michael | A way to avoid inactivity distractions is not to have any notifications while the activity occurs but only during the end of day or end of week recap. |

The artefact notifications will need to balance between healthy habits and unhealthy compulsive behaviour. Consumers must not be *"driven crazy with too much information"*, and information to clinicians must be filtered. Again, Avatar as a filter was gleaned positive.

*"it can save lives," says* Larry

However, the juxtaposed position highlighted by clinicians was evident in that they do not limit the notifications too much as *"they will save lives."* The conflict between health consumers knowing their body and the Artefact notifying them to push harder coincides with Distiller et al. (2010), who argue that any attempt to engage with a patient regularly must be more beneficial than silence as the alternative. This is supported by consumers who argued that despite any level of *"irritation, the importance of notifications cannot be underestimated for both layman and clinician."* The discussion on dealing with these notifications led to the latent element of education that became foundational within the Artefact.

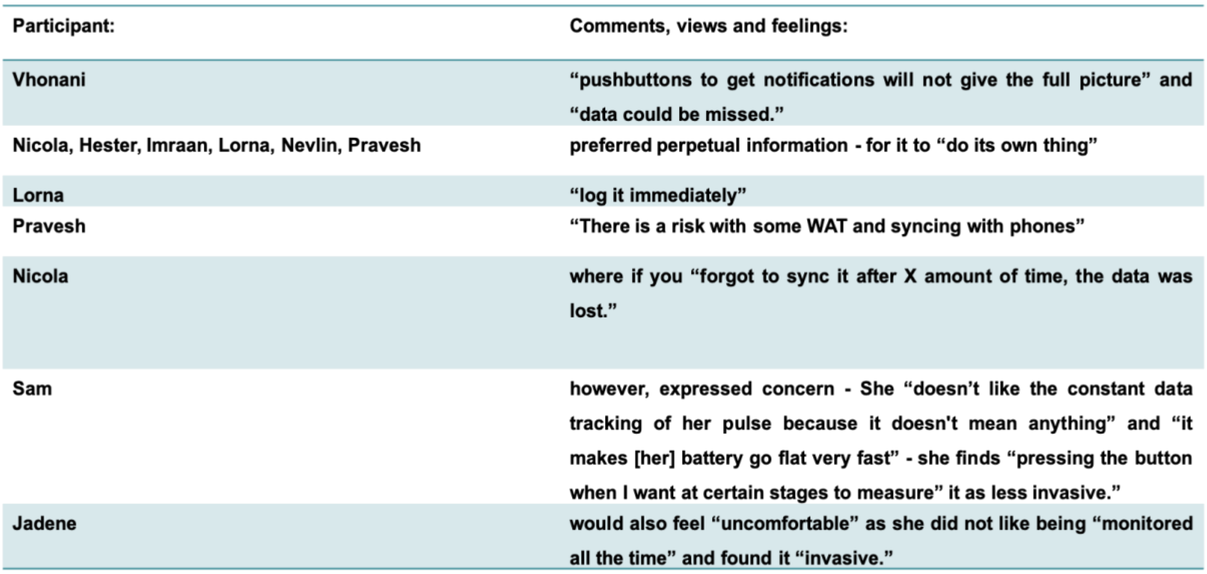
#### 4.5.4.7 Educational Notifications

Clinicians argued that the value in nudges or notifications with options for more detailed *"educational blurbs with every alarm"* is crucial. Pairing specific *"education bites"* with data points would be valuable. Reinforcement of treatment plan content with tailored education is seen as ground-breaking. Delivering these *"bites"* from the Clinicians Avatar also adds gravitas to the consumer. There was consensus that once the clinician populates the treatment plan, the AI can test the diagnosis and treatment methods against global data points and advise the clinician of any contraindications or anomalies associated with the PGHD and other empirical datapoints. Participants began to appreciate that the machine may begin replacing the clinician, as Topol (2019), Tran et al., (2019), amongst other scholars, argued.

#### 4.5.4.8 Perpetual Tracking Notifications

Clinicians unanimously requested that the PGHD be collected perpetually so that clinicians can be notified if their patients are degenerating based on the real-time ambient data being collected. However, it was advised that it must differentiate between specific data getting tracked perpetually, such as *"vital signs that you need to know all the time like your heart for emergency circumstances"* but others such as *"eating habits, sleeping habits,"* there is no need for real-time notifications. Distilling down into the frequency of these notifications, the participants guided the Researcher as follows:

**Table 4. 20:Frequencies of Tracking and Notifications**



| Participant: | Comments, views and feelings: |
|---|---|
| Vhonani | "pushbuttons to get notifications will not give the full picture" and "data could be missed." |
| Nicola, Hester, Imraan, Lorna, Nevlin, Pravesh | preferred perpetual information - for it to "do its own thing" |
| Lorna | "log it immediately" |
| Pravesh | "There is a risk with some WAT and syncing with phones" |
| Nicola | where if you "forgot to sync it after X amount of time, the data was lost." |
| Sam | however, expressed concern - She "doesn't like the constant data tracking of her pulse because it doesn't mean anything" and "it makes [her] battery go flat very fast" - she finds "pressing the button when I want at certain stages to measure" it as less invasive." |
| Jadene | would also feel "uncomfortable" as she did not like being "monitored all the time" and found it "invasive." |

### 4.5.4.9 Adherence Notifications

Consumers highlight that they *"have the choice to do it or not to do it."* This element highlighted the crux of the deliberative consumer rising out of paternalism and the clinical hierarchy (Taylor, 2019) that can be argued was the reason for consumer disengagement. Consumers were belligerent on this point, stating that clinicians need, as Zhang et al., (2017) argued, to embrace consumer needs and *"to respect it"* because *"that has got to do with autonomy"* and:

> *the health-consumers "right to decide [their] own future."*

Demiris (2016) argued that patients would be in command of their health. The clinicians adopted this notion, and the Researcher saw a paradigm shift from the threats highlighted by Krittanawong (2018) that threaten practice sustainability to a collaboration with the consumer needs. The Researcher experienced a pragmatic and reconciliatory demeanour from the clinicians. Clinicians softened the subject and offered that adherence to instructions depends on psychology. Sometimes people *"just need a break"* because *"they got tired of their condition"* and *"they just do not care what is happening even though they know things are not going so well."* The paternal ambivalence argued by Thaler and Sunstein (2003) was muted as the clinicians focused on the Artefact and that they had to help build trust in the solution. The clinicians offered that PGHD can help identify trends and assist the clinician in entering intelligible interactions more frequently with their patients.

#### 4.5.4.10 Positive Reinforcement Notifications

Clinicians believe notifications delivered by the clinician's Avatar *"will prompt people to do the normal thing and will provide a sense of security, that going to the consultation is the right thing."* However, the question remains, will they lose their narcissistic approach to self-care identified by Norman (2017) when the Artefact raises anomalies from the data and prompts a need for a consultation.

> Greg *adds, "patients have noted something on their activity" and have "moved their appointment earlier" because "something had happened."*

Clinicians raised the notion that health consumers are often uncertain on the severity of their condition, and questions raise a need for a clinician. These clinicians argued will help *"neurotic"* patients not panic unnecessarily *"patients are not well-controlled in monitoring their levels, and so they panic with just one out of range number,"* but:

> Eugene *added, "if there is a device that can exist that will be informed when the right time is to be content and when is the right time not to be content, it would help consumer and clinician."*

As corroborated by Ganguli et al. (2020), it will assist those who have an aversion to going to the clinician. Interestingly, participants described a phenomenon of *“not wanting to bother the doctor.”* It was adopted that if there is a digital connection to the doctor through the Avatar, consumers would be more engaging. Clinicians argued that when the Artefact prompts the health consumer to book a consultation, they must receive validation that their condition is severe enough to do so.

### 4.5.5 The Artefact for Efficiencies

Clinicians agreed that the current structure of care is not sustainable (Lee and Porter, 2013) and is cause for *“concern”* as private practice, as Shetty (2020) argued, is at risk of perishing. However, responses argued that they had been stifled by patients placing them on the periphery until required (Dedding, et al., 2011). Juxtaposed, the clinicians argued that when they see the patients, the consults are belaboured with unrelated information from web-based sources (Maher et al., 2017). Clinicians added that engaging with the needs of patients, as described by Zhang et al., (2017), is stressful as *“a consult will be half an hour, and then [he] receives 20, to 60 emails in the day”* where he needs to *“interpret for the patient”* and questions how anyone can *“cope with that?”* Clinicians stated that they are *“data overloaded where that data is not analysed”,* and clinicians are either getting too much information or not enough (Shanafelt et al., 2016).

> *An artefact* Greg *believes is "essential" as one "cannot manage health in the future without it."*

Added clinicians agree with Razzaki (2018) that *“especially in South Africa, we have a limited number of clinicians”* and:

> *“We have got to think of innovative ways to increase our patient load without increasing the risk."*
> \- *Larry*

The principle of lessening unnecessary time in consultations has occurred in many practices (Pulis & Victoria, 2014). For example, clinicians stated that *“if other symptoms or other issues are going on,* they encourage patients to *“send through data”* so that they can advise them telephonically and ironically avoid the consultation.”

Clinicians stated that structured PGHD within the Artefact could help save time spent creating the context in consultations instead of relying on the health consumer for data. The clinicians add that the Artefact could *“save me 10 to 15 minutes of questioning,”* the health consumer, *“because I can home in”* through the *“triangulation principle using 10 or 12 parameters, and where the possible problem lies, and ask much more focused questions quickly.”*

Consumers concurred that the Artefact *“will give more time to spend with your clinician”* where the clinician can *“really assess you and talk to you about what may be right and what may be wrong.”* Clinicians argued that the Artefact will assist in *“walking the journey with the patient.”* The idea of a clinician Avatar being a health coach within the Artefact was gleaned valuable adding to a continuous digital engagement that could extend the presence and enhance the clinicians' services to patients.

### 4.5.6 Remuneration Models

Getting health consumers to see the value and pay for virtual consultations has been an obstacle. However, consumers were enthusiastic about the *“value gained by real-time assistance.”* Most believe that *"you cannot put a price on that."* There needs to be a balance between using the PGHD to save time and clinicians, as consumers stated, *“taking advantage of this and just shortening their consults.”*

The COVID-19 pandemic and shift to digital *and “telephonic consults,”* health consumers were not happy about *“being charged”* the consultation fee as in their minds as evidenced in the literature (Wong et al., 2020; Nagy & Sisk, 2020; Kapoor et al., 2020) feel they *"did not see the doctor".*

Clinicians suggested a solution could be a *“predetermined fee.”*

> Neville *supports the idea of "a monthly annuity" or "subscription" as he sees this as "easier to handle" as "it is an easy to understand" payment model since health consumers "maybe do not understand it quite as well as we do, because we do it all through the medical aids."*

The Researcher intends to study this model further and establish the best economic structure to suit all stakeholders.

### 4.5.7 Data Gathering

Clinician’s “ability to collect data has transcended the healthcare professional’s insight.”

> Unben *supports this by noting that “going forward, how we manage our patients is going to be based on how much of data we can get from them.”*

Clinicians agreed that the ability for the Artefact to collect data is crucial as “*99% of deciding what to do is just clinically confirming the data.”* In addition, the Artefacts' ability to see data from other health-related consults conducted by other clinicians was considered vital. The Researcher was encouraged that the clinicians voiced the need argued in the literature (Blandford, 2019; Yeoman et al., 2017) for a *“patient-centred approach”* where all clinicians *“across professions from doctors to psychologist, to physios, biokinetics can work together as a unit across the board”* which provides *“a better network for everyone to function.”* The participants asked for *“a single platform that combines data from different sources”* and that they *could “access data from the cloud”* so that *"a patient does not always need to be in front of us."* Furthermore, the clinicians saw that they could use the data on the Artefact to *“actually do a full assessment of the patient over a period of time without actually having to see them.”* Added, *"I think especially it will help prevent* hospitalisations as sometimes there are signs, we miss” *and “if we have all this data, we would have been notified, and we could have picked it up much earlier.”*

> In the words of Eugene, "continuing the helping hand of a clinician after the consultation process is done through home care monitoring."

### 4.5.8 Improved Quality

Clinicians argued supporting Razzaki (2018) that *"Socialist health care is pushing everyone to the lowest point on the care continuum, but there are not enough clinicians, but with the Artefact, I would be able to extend access to people who would not be able to access me, we would be able to increase care to more people."* There was consensus that the Artefact would increase the quality of care while increasing access at a lower cost.

### 4.5.9 Limitations

Clinician participants raised limitations in the Artefact as *"it may only appeal to a certain group of patients, probably not the elderly"* who might have *"technological limitations."* However, the Researcher cited Strain et al., (2020) illustrating the average age of 62, and the Apple heart studies, which seemed to quell this concern, but the Researcher noted this as an area that requires further research.

### 4.5.10 Compliance Assistance

*"I think the Artefact could be very useful for compliance,"* was argued by most participants. *"It could alert a health consumer that their blood-pressure is high"* and advise them to *"check that you took your medication this morning."* Clinicians also argued the Artefact could help the patient be more aware and *"remind them of their scripts"*. Finally, participants agreed that it would be *"beneficial to the doctor-patient relationship"*, instilling trust and better compliance to the treatment plan housed within the Artefact.

Jadene*: sees the value in the Artefact as a "health companion when you are home on the*

### 4.5.11 AI and Chatbots

Contrary to Tran (2019), the incorporation of AI into the field of medicine was viewed as positive by most clinicians and was described as *“very helpful”* by clinicians. Furthermore, clinicians added, *"integrating AI is crucial to achieving a socialist form of medicine where everyone gets the same level of care.”*

AI's role in saving time was considered vital to helping alleviate the stress on *“busy clinicians with a huge administrative and clinical burden”* (Gardner et al., 2019; Norton, 2018). AI within the Artefact will help us get to a point in the care path where *“we need to get to get to where we as clinicians are intervening by exception.”*

Health consumers were more open to the use of AI than clinicians predicted. Clinicians argued that *"health consumers are becoming more and more accustomed to AI; they are using Siri, Google and Alexa."* As Longoni et al., (2019) argued, incorporating, and adopting AI was crucial was unanimously accepted as core functionality for the Artefact.

> *"If I had something that could sift through all that information to provide me with information that I need, then why not? Technology is there to be used," says Nicola.*

#### 4.5.11.1 Positives of the Clinician and AI Relationship

Clinicians have begun to see the machine Topol (2019) argued would replace them as more *“friend than foe.”* They argued that *“by working with AI, you can improve yourself as not only a clinician but also just awareness, working alongside technology would make us better professionals.”*

> Greg stated: “many clinicians" need to "take a little backstep and say that, look, we are human, and we are fallible, we make too many mistakes, and we need to be guided by the technology behind it."

Consumers argued that clinicians should use AI and the Artefact to increase *“trust.”* They would *“prefer to have someone who actively keeps up to date with information, and if they need to use AI to do that, then I feel completely comfortable with that.”* Clinicians saw AI as a diagnosis prediction tool as *“AI can diagnose X-rays at a greater level of accuracy than experienced radiologists”* – in line with findings in Bhavnani et al. (2016); & Bouchard (2019). Participants, in general, considered *“AI takes a lot of the guesswork out of the diagnosis and management*– and would be beneficial to both stakeholders.

### 4.5.11.2 AI as Monitoring Tool

Encouragingly clinicians were aware of the notion of disruption raised by Christensen et al., (2017) and Karches (2018) and acknowledged that clinicians think *“they cannot be replaced by a computer”* when in fact *“, you can automate many processes in medicine.*” Clinicians were pleased with AI becoming a trade tool and were *“very happy”* with AI monitoring certain elements. Clinicians are aware of trends argued in the literature like Fogel and Kvedar (2018) and agreed that in *“X-rays and radiology, AI has been much better.”* They offered thinking that *“in terms of processing data, AI is better and agree we will learn a lot from the use of AI in the future."*

Incorporation of AI would also assist with *“fatigue with Big Data”* as clinicians *“are on computers the whole day long”* and are *“bombarded with emails”* (Gardner et al., 2019). Participants also agreed that the value of AI would be in early detection as *“it would be one of the finest early detection things you have out in the marketplace.”* Clinicians added that *“in a rare diagnosis, clinicians should want a machine that looks at 10,000 papers on a certain condition to come up with the answer.”*

Clinicians added that they see the ability of AI *to “create a list of possible diagnoses taking away admin and guesswork where the clinician’s role is just the human facilitation and oversight.” “It is always useful to have a go-between who understands what is happening.”*

> Michael *stated that "in 10 years, a doctor may be obsolete and relegated to the role of research technicians to help fuel or to feed the academic intellectual requirements of an AI platform."*

To extend the clinician's reach with an Avatar linked to AI was seen unanimously as ground-breaking and a resolute position for consumers to see them as accessible *"24/7."*

#### 4.5.11.3 Avatar Chatbot as Messenger

Health consumers were favourable to the idea of a clinician Avatar chatbot. Consumers liked the idea of having something *"educate and dissect it for them."* Consumers saw the Avatar as a *"bot that can advise you on what you need to do rather than going to see that clinician"* the chatbot was considered as a *"virtual coach or adviser. Consumers find it useful that this would be real-time assistance."* And that the instant nature of the education is crucial *"that helps not having to wait for an appointment"* and *"information on tap."* However, the Researcher acknowledges that convincing health consumers that the chatbots advice is accurate and credible will still be an obstacle. Nevertheless, consumers believed that information accuracy from the Avatar would instil confidence.

#### 4.5.11.4 Negatives of the Clinician AI Relationship

However, clinicians did warn of consumer scepticism, *"my practice is an older practice with mostly older people, and they are not into AI."* This was true for younger consumers, too, as some had had *"negative experiences"* with chatbots *and "finds it infuriating that the chatbot is not giving you what you want."*

Clinicians had an issue with AI is that *"they are not as good as knowing people and understanding people and understanding emotions."* In addition, many clinicians warned that AI lacks the *"clinical intuition"* or *"gut feeling"*, which is seen as a *"highly valuable tool especially at the intersections between life and death."*

Clinicians also feel *that "COVID has brought a degree of social isolation and lack of humanity that people are craving"* and worries that if *"warm-bodied human intervention"* does not happen, we will *"become a very disconnected species."* It was agreed that the best solution is a marriage between the warm-body and digital delivery of care. There was also a view that *"AI could capture the essence of the therapeutic touch. If we could integrate the analysis of body parameters like pulse or sweat on the skin."* Nevertheless, clinicians warn that we must ensure that the Artefact does not become the new uncontrolled Google. As Longoni et al., (2019) argued, misinterpretation happens if left unfacilitated by clinicians – we cannot *"trust AI alone."* We can gather *"data from wonderful sources, but the interpretation of data at the patient level is the problem."* In terms of AI becoming a threat to clinicians, participants agree with Bouchard (2019) & Topol (2019) that AI will *"disintermediate [him] as a clinician."* However, most clinicians did not see AI as a threat and *"as clinicians are not going to be doing less work, it is going to make what you are doing much more effective."*

### 4.5.12 Privacy and Data Protection

#### 4.5.12.1 Arguments for Strong Protection

While there were concerns that data could be leaked. However, standard device protections like *"face, password, potentially iris and voice recognition would suffice."*

Clinicians, however, suggested a layer of authentication as a form of *"validity"* to *"prove"* that "the person is creating the information to collect the information from is important."

#### 4.5.12.2 Arguments for Lower-Level Protection

Participants agreed that *"normal security* measures should be fine. *I would not need further protection."* Consumers suggest that PGHD be stored *"in the cloud."* Most do not have concerns about protecting data. Clinicians argued that *"confidentiality is often a scapegoat used by clinicians."*

Clinicians warned of the Artefact becoming so unfriendly due to overcomplicated confidentiality. Consumers also warned that making security levels too complex as to limit access in an emergency:

> *"If you are busy having a heart attack and you need to get access to it", you cannot "type things", so "perhaps biometrics is best."*

### 4.5.12.3 Limitations on Access

Most health consumers wanted to have full access to their health information, including the clinician notes. In addition, consumers added that they want 24/7 access to all their data.

> Nicola *says, "You should easily access all the information that everyone has on you so that they can provide the best possible care."*

> Sam *wants to "have [her] own file at home containing all information, everything, even the notes that the doctor so secretly writes."*

*"I do not see it being a problem because it is the patient's data,"* argued some clinicians. *"What is there to hide?"* It was unanimous that health consumers must be the *"owner"* of their records and, it *"would be nice"* for health consumers *"to be able to see and keep track."* However, a very important subtheme emerged when clinicians added:

> *That it would be best to have "two parts to the patient record" "especially when you are dealing with psychiatric issues, there must be some private area for the clinicians' private thoughts and reflections that the health consumer cannot access –* Eugene, Larry.

Once probed, other clinicians agreed, and they warned against *"free access"*, Noting that comments "are sometimes not helpful or useful", and the health consumer may *"feel exposed."*

> Greg *goes as far as to say that sharing all the information could "become an obstacle to care."*

Clinicians stated that certain patient’s behaviour issues are sensitive and they:

> *"persistently ignore everything I have said to them, well-educated, understands and is fully aware of the complications, but still refuses to make any changes. Having an artefact as support would be very valuable"-* Greg

However, the clinician’s *“interpretation*” of the *“patient’s personality”* should not be shared. *“Our thoughts about the patient may not be flattering in terms of attitude or compliance.”* Observations such *as “you have got a personality disorder, you are narcissistic, your relationships are flawed because of this.”*

> Eugene *sees it as “my information” that is “an interpretation of your information.”*

Notes are essential as the clinician *“would need to be reminded of it”* for future consultations as *“a reference to what you were thinking around the patient the last time.”* It is also essential if a clinician wants to *“pass the message to the next health professional.”*

> *Clinicians opined that "there is some communication that should go between health professional to the health professional, and the summary that can go to the patient."*

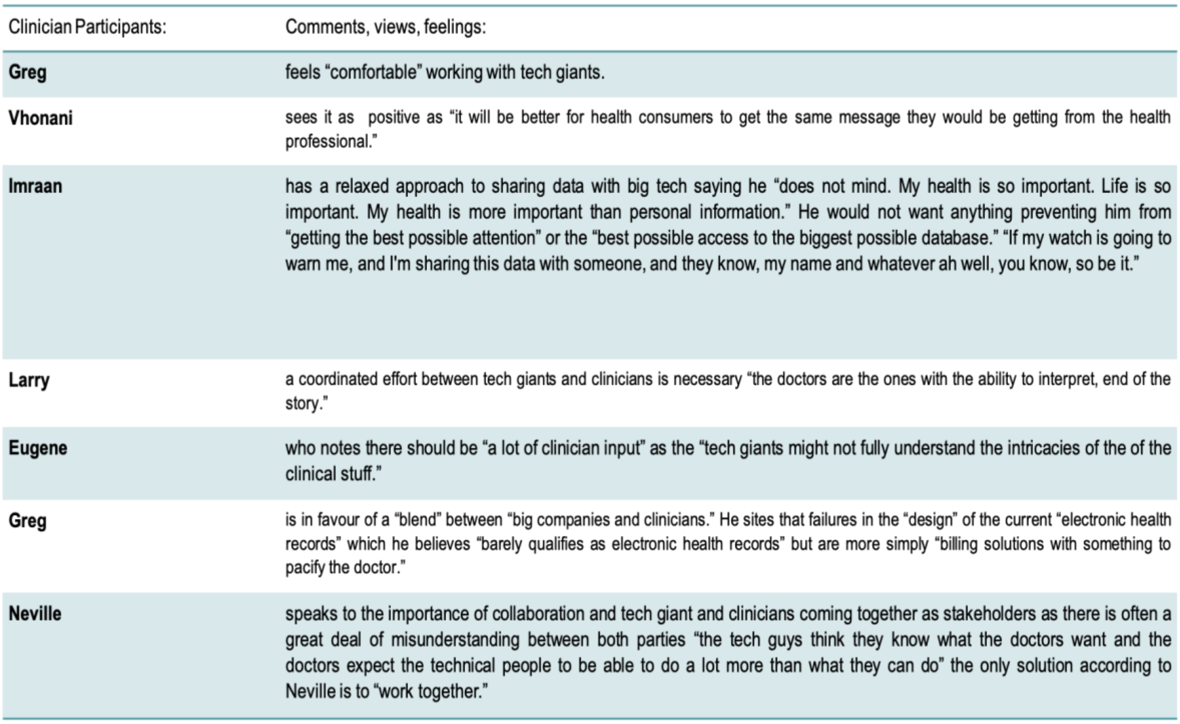
Clinicians believe that a form of self-censorship could occur, *“I write notes with the view that I am going to be the only one to see them.”* A way for the health consumer to have this sense of ownership is to choose who to *“grant access to.”* There are, however, some drawbacks *a health consumer was “quite shocked” when:*

> *her clinician was able to access her information during the consultation and “was able to see that she had high blood pressure for the past three years based on information from PGHD health* checks" - *Leila*

### 4.5.13 the Artefacts Relationship with Big-Tech in Medicine

The role of Big-Tech in the future of health also received mixed responses from the participants. Previous attempts to digitise the CDE clinician workflow had been in the form of asynchronous messaging that excludes the consumer of the services (Bouchard, 2019) or EMRs to which patients have no access or, telemedicine and clinical remote monitoring (Liddy et al., 2019). These findings evidence the challenge of "burnout" due to the belabouring administration imposed primarily by payors, as argued by Gardner et al. (2019); and Shanafelt et al., 2016). However, when positioned within the Artefact as an enabler, the participants had the following views:

**Table 4. 21:Artefact as an Enabler**



| Clinician Participants: | Comments, views, feelings: |
|---|---|
| **Greg** | feels "comfortable" working with tech giants. |
| **Vhonani** | sees it as  positive as "it will be better for health consumers to get the same message they would be getting from the health professional." |
| **Imraan** | has a relaxed approach to sharing data with big tech saying he "does not mind. My health is so important. Life is so important. My health is more important than personal information." He would not want anything preventing him from "getting the best possible attention" or the "best possible access to the biggest possible database." "If my watch is going to warn me, and I'm sharing this data with someone, and they know, my name and whatever ah well, you know, so be it." |
| **Larry** | a coordinated effort between tech giants and clinicians is necessary "the doctors are the ones with the ability to interpret, end of the story." |
| **Eugene** | who notes there should be "a lot of clinician input" as the "tech giants might not fully understand the intricacies of the of the clinical stuff." |
| **Greg** | is in favour of a "blend" between "big companies and clinicians." He sites that failures in the "design" of the current "electronic health records" which he believes "barely qualifies as electronic health records" but are more simply "billing solutions with something to pacify the doctor." |
| **Neville** | speaks to the importance of collaboration and tech giant and clinicians coming together as stakeholders as there is often a great deal of misunderstanding between both parties "the tech guys think they know what the doctors want and the doctors expect the technical people to be able to do a lot more than what they can do" the only solution according to Neville is to "work together." |

However, the Researcher uncovered positions akin to the literature in comments like:

> The current systems, in his opinion, are "clearly not designed by clinicians, because they do not meet in any way our needs" and have "always had no clinical value" but rather "increase work, increase anxiety making the doctor's life harder."

Consumers added that Big-Tech *companies "do not understand how the body functions as clinicians do."* While clinicians may have a favourable view of the idea, many health consumers have an issue working with Big-Tech. Consumers expressed concern about the use of their data and the intentions of these global corporates.

However, clinicians also highlight a key concern around the commercialisation of consumer data. Consumers argue that *"personal information could get abused, hacked, leaked."* Consumers see clinicians as *"having your best interests at heart"* and therefore expressed a condition that they do oversight on any elements from Big-Tech to ensure *"trust"* and *"protection."* There is an overall scepticism of Big-Tech but a pragmatic understanding that we should include functionality like the links to Facebook communities on a platform basis. Participants argued that the Artefact should *"be different to the platforms from the giants."* However, participants did see that protection in line with the latest legislation such as the POPI act as *"absolutely imperative."* These and other personal needs are addressed in Theme 4.

## THEME 4

### 4.6. CONSIDERATIONS FOR PERSONALISATION

The previous themes made tailoring, differentiation and personalisation of the artefact a matter of need to ensure adoption and consumer-centricity. This theme deals with findings from the sentiment analysis which falls squarely in line with studies in healthcare that demonstrate that clinicians must focus on consumer demand for patient-centricity (Blandford, 2019; Yeoman et al., 2017). Paternal and hierarchical clinician practice has generally not been geared around knowing the customer rather than servicing a patient (Blandford, 2019; Yeoman et al., 2017). Being disconnected from customers makes it difficult for clinicians to service patients (Kravitz & Melnikow, 2001). The Artefact must be set up to create the intimacy that transforms the way we deliver healthcare.

| (a) Clinicians' perspectives | | |
|---|---|---|
| **Theme** | **Word cloud** | **Sentiment analysis** |
| **Personalisation** |  |  |
| (b) Health Consumers' perspective | | |
| **Theme** | **Word cloud** | **Sentiment analysis** |
| **Personalisation** |  |  |

**Figure 4. 6:Personalisation - Compiled by the Researcher**

### 4.6.1 Collaboration

Participants unanimously agree that COVID has meant health consumers are moving to self-management (Pépin et al., 2020; Rubin, 2020). Clinicians acknowledge that this has compounded that *“the health consumer is playing a more active role in the direction of their care, and these behaviours show no indication of subsiding”* (Lupton, 2016; Lupton & Jutel, 2015). Consumers made it clear that *“the best solution for a clinician is not to try and take back power but step into a partnership with a renewed focus on patient-centricity and stick to a health plan that is co-created between a health consumer and a clinician.”* Consumers add that *“collaboration is crucial because the clinician will see it from a different perspective, they should set the suggested goals and say I recommend this what do you think”.*

Clinicians offered that *“the role of the doctors is more one of the education processes and they must spend more time educating the patients in discussing the data with them than they do at the moment.”* Further, clinicians argued that *“the health market needs platforms that are patient-centric, there is a platform called Health ID, but it is doctor centric, and very little of the data is presented back to you.”*

### 4.6.2 Patient-Centricity in Data Security

Clinicians began adopting the Blandford (2019) argument for, a need to bring an essential step of patient-centricity and *“personalisation”* into all aspects of data security. Opposed to user system access security personal setup and navigation of who they will allow access to their data within the Artefact is important.

Added *“health consumers should sign a declaration to agree that [their] information sits on the site.”* Clinicians highlighted the importance of asking the health consumer for approval at every step. *“The health consumer should be notified that someone is opening their health record.” “The artefact must give personal control.”*

### 4.6.3 Personalised Feedback Opportunities

Participants agreed that the greatest method of personalisation is in gathering constant *“feedback with daily or weekly summaries.”* There is a need for the Artefact to create opportunities for feedback *“very much like you should do in a consultation –*

*how did you enjoy this consultation? Was there anything that was said that worried you? Or that has offended you?"*

*Participants agreed with Hamzah & Wahid, (2016) and argued that "Personalisation is important not only for the health consumer but for the clinician as well as the user journey of both parties is important. In this sense, the clinician should be able to personalise and set their parameters for when they would like to be alerted."*

### 4.6.4 Personalised Goal Setting

Clinicians highlighted the importance of personalisation in goal setting.

> *Greg believes that "personalised goal-setting within the artefact will lead to greater compliance as the health consumer and clinician can we negotiate targets jointly at a consultation to achieve the goals we set ourselves."*

Clinicians agreed, *"Patients like to get affirmation from doctors"* and the Avatar should be consistent in monitoring these goals allowing the patient to feel continually supported.

### 4.6.5 Personalised Display and Notifications

Participants felt display is the most important aspect to be personalised. These should be adjusted according to the treatment plan presenting the attribute of the specific treatment in the foreground of the display. *"Congratulations and warning features should be personalised in terms of the health consumer's previous performance."* Consumers want to know that there has been an improvement in their *"own levels."*

### 4.6.6 Personalised Habits

Consumers stressed the need for personalisation of features for different health behaviours.

> *Vanessa highlights that some health consumers would want to try "natural remedies first" so the artefact needs to cater to this.*

Consumers highlighted differing behaviours such as an over willingness or under willingness to see a doctor. They noted an example where a health consumer *“could have died”* but *“didn’t want to bother”* the clinician and there are many intelligent, clinically trained people who feel that *“they do not want to be judged as wasting someone’s time”*, and so the Artefact needs to address this.

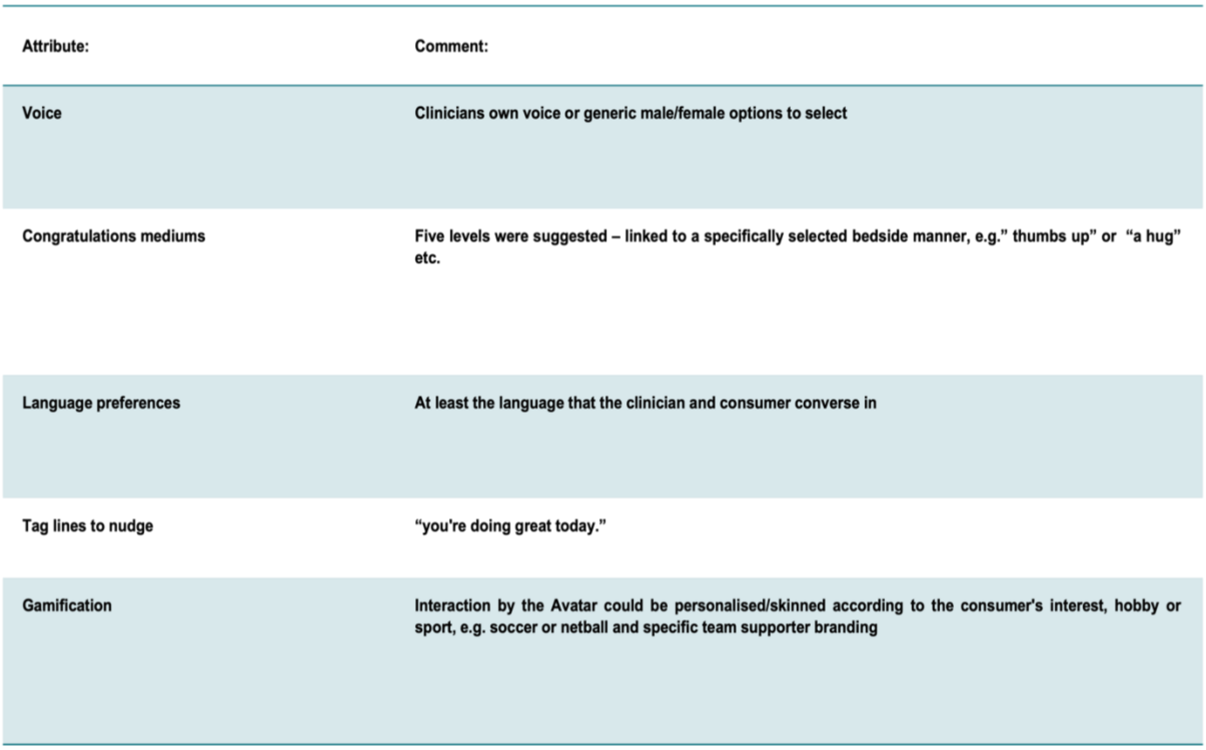
Clinicians opined on the “*head in the sand phenomenon”* where *“most people would rather not know.”* Consumers suggested clinicians should assess not if but when it is best for health consumers to see information and the Artefact should be personalised accordingly. However, consumers warned that they would not want their PGHD sent ahead of the consultation appointment as *“giving the information on the PGHD before a consultation could mean that if you are put on the spot, it will allow you to think of excuses not to divulge the truth.”*

### 4.6.7 Personalised Style of Communication

Clinicians highlighted the need to personalise and capture in the Artefact the *“direct personal relationship between the doctor and the patient” and determine why health consumers see one doctor for 20 years.”* Clinicians concurred on the value of the clinician look-alike Avatar as it captures *“health consumers need for a contact.”* Participants however acknowledged that we must protect against the risk that “*some healthcare providers have just got no bedside manner, and if that’s translated into an AI environment that’s going to be positively harmful.”*

To address this the participants suggested some generic attribute’s including:

Table 4. 22:Suggested Personal attributes of the Avatar



| Attribute: | Comment: |
|---|---|
| Voice | Clinicians own voice or generic male/female options to select |
| Congratulations mediums | Five levels were suggested – linked to a specifically selected bedside manner, e.g." thumbs up" or "a hug" etc. |
| Language preferences | At least the language that the clinician and consumer converse in |
| Tag lines to nudge | "you're doing great today." |
| Gamification | Interaction by the Avatar could be personalised/skinned according to the consumer's interest, hobby or sport, e.g. soccer or netball and specific team supporter branding |

Language must extend to the tone of the congratulations features which, if *"hyper-personalised"* to the clinician's voice, would be the *"ultimate prize in terms of your clinician giving positive feedback,"* requested the consumers.

> Hester *says that she is a "smiley face person" and her "patients get smiley faces in their files☺" and so the congratulations notifications should mimic this.*

### 4.6.8 User Profiling

Participants suggested using "*profiling technology"* to create a set of questions to develop a user's psychological profile according to *"group characteristics"* so that the tone and nature of notifications align with what the health consumer will respond to best. For example, they suggested *"languages, income levels, the highest level of education"* or questions understanding the *"spiritual or cultural points of view."*

*"Psychological profiling"* is needed as information should be gathered – *"is this person pragmatic? Do they want to know the full extent of their diagnosis?"* Increased

personalisation would also increase the frequency of use and adherence to the Artefact. For example, when measuring UV detections, questions about the individual's skin would need to have been asked to create personalised results according to their melanin levels.

### 4.7 REFLECTIONS ON THE DATA

The health consumer survey initially left the Researcher sceptical as to whether the Artefact and its link to WAT could be the catalyst that reunites the clinician and health consumer. Primary data, however, dispelled this concern with overwhelming evidence supporting the proposed solution. The primary findings support the survey findings that health consumers do not trust their own intuition nor the online responses and would prefer their clinician to be involved with their PGHD. This research supports this and goes as far as to show that the clinicians themselves want to find an efficient way to engage with their patients' data rather than leaving them to online resources. This is supported in the pre-thesis survey when showing 90% of responders trust their clinician despite the convenience of online health support.

Primary data shows that behaviours change treatment pathways when there is continuous interaction with WAT and, the reasons for using and understanding the data is meaningful to the user. Clear is that the health consumers seek whatever help they can get to elucidate raw PGHD if it connects to their symptoms. The two data sources considering patients concluded that the quality and clarity of the data in an artefact would be valuable. It is accepted that behavioural obstacles to usage can be addressed through a treatment plan that integrates AI, Avatar, chatbots and warm-body clinical interactions. Primary data supported survey findings around consumer's willingness to share their data. Primary data-guided frequency, content, and design to demystify the data points in relation to the treatment plan and personalised outcomes.

The primary research exposes that there is a lack of understanding of the data on the part of both consumer and clinician. Findings also show that the Artefact can add significant value in a connected digital relationship circumventing the commercial and health risk side-effects of disease as was proven by COVID-19. However, connecting the key attributes uncovered in the semi-structured interviews remains provisory to the ability to actively address the diminishing consults both directly and indirectly due to COVID-19.

Results from the clinician survey presented that the clinicians had a reasonable understanding of the data available on WATs. The primary research, however, uncovered a flaw in the survey findings in that neither clinician nor consumer really understand or could interpret PGHD.

Clinicians themselves said that they would change habits as a direct result of WATs and more so if the data was presented by patients in a way that was easy to use. However, the willingness to change was higher in clinicians than with consumers. This presented a notion that knowing more about what the data is trying to tell you is likely to keep you engaged. The value of the data in the context of the treatment plan was seen as an integral HCI function of the Artefact (Rogers; 2012).

Survey findings dispelled the hesitancy to engage consumers face-to-face on their PGHD. However, primary research revealed a phenomenon that clinicians are not comfortable deciphering unfamiliar data and would prefer to be assisted and have their patients managed by the Artefact. Furthermore, as Mandel (1997) and Mandel (2002) argued they would be comfortable to allow the users to be empowered and use the functionality within the Artefact with clinical oversight, to manage personal treatment plans. It is noted that both primary and secondary research findings are concerned with the dangers of self-diagnosis and disease maintenance using WAT PGHD without clinical oversight (Razzaki et al., 2018). This is mitigated as clinicians are open to the Artefact presenting them as an Avatar to patients using AI to decrease risk.

## 4.8 SYNTHESISING MACRO AND MESO INSIGHTS

> *"48% reduction in General clinical consults and a very worrying 30 % reduction in chronic care consults"*
>
> *Dr Ron Wheelan - Discovery Health*

This thesis problem is succinct in the above quote by the summit participant Chief Commercial Officer of the largest private payor in South Africa. The summit concluded that the future of care cannot be delivered without the consumer and their PGHD being central. With COVID-19 at the top of the Researchers mind, it was helpful to relook at stakeholder engagement. In line with findings from the primary research, both the payor and clinician representatives stress that clinicians must remodel themselves to create parity with the Big-Tech and big payor initiatives.

The summit agreed there is statistical and empirical evidence that show the steady decline of clinician visits and associated diagnostic tests and these changes as argued by Krittanawong, (2018) are threatening the sustainability of private practice. The payor also made it clear that they independently are going to ramp up the ability to engage virtually with patients but would prefer clinicians being empowered to participate in this new care delivery model.

## 4.9 CONCLUSIONS

The ideate/inventive/design steps have informed which behavioural-attributes can be successfully integrated into the treatment plan. Elements that are easily inscribed will be developed first to effect early adoption status. Effective for development also present opportunities that are unseen in previous literature. To complete the Artefact, it will have several different data sources, from WAT and IoT devices, external applications, clinical data, pathology data, and draw from education databases. The Artefact will incorporate both clinician and health consumer social behavioural elements not yet seen in other health-tech applications (Fischer et al., 2019). These include but are not limited to the ability to incorporating a collection of ambient vital statistics, activity, sleep, calories, and activity data amongst others into treatment plans. This data shows that features like skin assessments (hydration and UV damage), Blood-Pressure, ECG and glucose levels from WAT are rarely incorporated in the diagnosis or subsequent treatment plan however, as these are not usually accessed from PGHD, it can be expected that clinicians will have to go through significant change management and training processes.. The inclusion of pathology requests that allow immediate submission to the selected laboratory in anticipation for the patients consultation is uncommon but, again to move behaviours from legacy based processes, will also require intensive change management. UX's that address the need for "shared language" as argued by Simonsen, (2013) and Bass et al., (2014) and ease of use (Nielsen, 1994) so that patient data presented within personalised displays can be easily discussed, and clinical notes can be interpreted with education bytes explaining diagnostics, incorporated within treatment plans, evidently must also become part of the change management and educations programmes. Functionality (including facial diagnostics) linked to the functional biometric access to the platform it is suggested can carry novelties that encourage safe and ongoing use. While, a treatment plan as the 'contract' between clinician and patient housed within the Artefact between the clinician and the patient is seen amongst the participants as ground-breaking, it also needs to be considered on balance with the challenges that come along with disruptive innovations.

AI chatbot notifications in the form of the Clinicians Avatar and prompting alerts outside treatment plans, including but not limited to deviation to medicines and other tasks or goals are also opportunities to encourage continuous engagement and adoption. Cognisance has been taken of how human values and behaviours (Brown, 2008; Brown & Katz, 2019) are triggered when incorporating congratulatory features using the novelty of gamification with clinicians' Avatar's as the 'high five.'

Education chosen by AI into the platform at opportune moments when for e.g. the consumer has bad sleep patterns, low activity etc. to enhance compliance and adherence are also helpful to humanise the Artefact. However, while the use of alarms that alert and triage patients who are picked up as continuously outside the treatment plan or have vital sign concerns that can notify the team of clinicians will be based in rules associated with raw data, the risks associated with the use of untried and tested AI may pose risks that will require in-depth investigation and mitigation to avoid harm. Making it the patient's tool so the record moves with the patient and does not vest only with the clinician is not openly available in the market.

Patient control over which clinicians have access to their data is not apparent in the literature. Data collected will be categorised in ‘Zones’ – risk levels – HIGH, MEDIUM or LOW in line with the agreed clinical protocols aligned with insurance benefits(Matisonn, 2000) and, only functionality that has been signed off by the clinical specialist committees, will be allowed to be managed by AI. Only functionality signed off will be embedded to mitigate the possibilities of harm and litigations to patients.

The Artefact will have to be restricted to not include clinicians’ clinical notes but incorporate as Razzaki et al., (2018) argued, the clinicians judgement, until ways are found to appease clinicians. Research. Embracing the growing self-quantified movements (Lupton, 2013; Lupton, 2016; Swan, 2009; & Swan, 2013), allowing the Artefact to integrate and create new communes with communication messaging and popular social media sites and be accessible and agnostic to WAT’s and App platforms is also distinctive. Integration with rewards programmes like Vitality will first have to be negotiated with the different stakeholders but the brief to the developers will be to include open access to these partners. The clinician Avatar which has a virtual relationship as an assistant and extension of the clinician outside the practice warm-body or digital consultations with AI as the centre/core of the application has not been presented in the literature.

Consequently, the researcher has developed a brief which has been handed to practice and the actionable outcome is evident in the Artefacts topography as illustrated in Figure 4.7 below:

**Figure 4. 7: Functionality of the Artefact from Primary Findings**

# 5 Reflections and Contribution to New Knowledge

## 5.1 INTRODUCTION

In this chapter, the Researcher reflects on the tangible and intangible behavioural themes from the findings that resulted in a proven research question. The design process capturing participants digital behaviours into an artefact he believes, has added new knowledge to clinical workflows, and highlights new approaches to AR and HCI studies (Holzinger, 2013). He looks at the impact of this ADR on the practical problem within his practice, his personal growth, and he identifies areas for future research. This study looks at the epistemology of human belief and opinions around actions within digital environments (Harrison et al., 2007) and the impact on health systems. The Researcher hopes to move the topics beyond what Angrist & Pischke (2010); Forlano (2009); and Gordon et al., (2015) suggested of just the need for stimulating innovation, towards what the Researcher argues is the need for health systems (Holland, 2006) revolution to meet the challenges of Health 4.0 (Chute & French, 2019). The Researcher argues that this study shows the benefits of the Interpretivist research that investigates the social world participants are living in, with them opposed to looking at them, in their world in HCI studies (Rogers, 2012). The chosen Interpretivist paradigm allowed for a confluence of unique data flows and because he did not position himself as a patient nor a clinician and, had established that he wanted to present a practical solution (the Artefact) to a practical problem, chose co-design ADR instead of ethnography. This study shows that clinicians are willing to be more open to working with consumers who are self-quantifying (Lupton, 2016) if enabled with tools within which they have joint design equity.

To achieve a robust solution that is not a single dimensional study. The Researcher wants to strengthen the academic position by proposing that empathy becomes a more a fundamental element of ADR (Plattner, et al., 2009; Leifer, et al., 2013). Added, human values (Brown & Katz, 2019) during the needs, ideate and design stages must be more central to ensure a granular understanding of user needs, motivations, emotions, and experiences. This will reduce disparities between participants as was argued is often an attribute of DT by Henderson et al., (2013). The Researcher believes that empathy enhanced ADR helped generate collective reflection that opened each participant mind to the needs of the other users. The process also benefited from rigorous ADR cycles (Baum et al., 2006). Submissions in this chapter that reflect on the findings prove that the use of ADR incorporating the standardised guidelines of DT (Dix et al., 2004) helped evolve an actionable solution that will transfer into users' daily lives. The Researcher could not have treated this as an ethnography or phenological experiential study as he was/is personally embedded in the study to facilitate and build on his conceptual solution.

## 5.2 THE DRIVERS ENABLING OR FRUSTRATING THE ACTIONABLE OUTCOME

### 5.2.1 Clinician Asking for PGHD

Findings show that clinicians engaging with PGHD, adds value to human-on-human healing. Although haphazard and without structure, it shows that clinicians who embraced WAT consumer-behaviour, as Razakki et al., (2015) argued, seek ways to get closer to their patients. Findings also showed a willingness from consumers to engage bravely with these clinicians around their PGHD. When probed, it was juxtaposed to Williams, (2016) that the clinicians would ask for PGHD to contextualise and understand the data. The proposed Artefact defined by Orlikowski & Iacono, (2001) became a cycle of designs from what was conceived as a dashboard of data to a full interactive knowledge-based platform incorporating personal treatment plans that benefited from a confluence of data including but not limited to PGHD.

### 5.2.2 Exploring AR as a Problem-Solving Process

This AR as a collaborative problem-solving process to help deal with the digital divide (Razzaki et al., 2018) was a human interactive process (Bevan et al., 2015) extracting new knowledge that introduces critical human data through the Artefact back into clinician-driven care.

Concerning but understandable, experience and understanding of the research partners' core element of the study (PGHD) were superficial. However, as the data grew and each interview became a build on the last participants it began to intersect the areas of social science, behavioural-science, and the machine (Carroll, 2003). Awareness developed as participants introduced human-centred elements important to them into the design with each interview (Rogers (2012). Open discussions helped the Researcher initiate debate and stimulated new ideas like the inclusion of education and personalised treatment plans into the Artefact continuously moving PGHD from peripheral supporting data to as Lai et al., (2017) argued, "usable data." The importance of PGHD, as described by De Zambotti et al., (2016), then grew as value in the hands of the participants.

The study supports Blandford (2019), who argued that knowledge between two disparate cohorts of participants can be shared effectively when the participants discuss a common domain. For example, when clinicians use WAT and PGHD themselves, they are more likely to be receptive to their consumer offering their PGHD. However, it appears that some clinicians only look at certain data points, and so to incorporate the human value described by Brown & Katz (2019), the participants resolved that the Artefact will be positioned to empower both stakeholders, tooling them with sensible data linked to tailored education. As argued by Simonsen (2013) and Baas et al. (2014), this study created new learnings when concepts are delivered in a mutually understandable language and void of jargon (Baas et al., 2014).

A concern was that clinician's scope of practice narrowed the lens into the element of PGHD dictating levels of interest. Dieticians were most interested in calorie counts, and bio-kineticists and physiotherapists inactivity showing that clinicians are calling on data points relevant to their discipline. The Researcher, cognisant of the risk of conflicting perspectives and bias argued by FitzGerald and Hurst (2017), therefore presented the Artefact as an opportunity to help connect care teams, cross skill, and share knowledge that could show the relevance of the data across the different disciplines. This the Researcher argues, will help participants set aside their bias and encourage them to explore the confluence of data categorised and contextualised as a part of their personal social discourse (Mantzana et al., 2007).

Unique is that both participants accepted the notion of AI and chatbots presented as clinician Avatars to achieve what Burns et al., (2019), Lai et al., (2017), and Shapiro et al., (2012) argue will help reconnect and reunite them. This, the Researcher believes, is a tacit adoption of a digital medium that facilitates continuous engagements that empower reunification. The Researcher came to a realisation that clinicians are also human and have limitations that inhibit them from inviting discussion on subject matter around things they do not know. However, Bass et al., (2014) argued as was evident in this study, that learnings within a new field of knowledge that has mutual interest opens minds to new ideas. The following example illustrates the point:

One of the research participants is a psychiatrist. Highly skilled in addressing mental health data points, including stress levels, sleep indicators, diet, and exercise. However, because the clinician is not a cardiologist, the clinician was hesitant to consider heart rate dips in REM sleep. He considered discussions around if the Artefact could mark these data points as critical factors when considering the patient's stress and anxiety levels. The Artefact could then present a holistic view drawn from PGHD, pathology, the PubMed literature, amongst other clinical inputs and present a credible view of patient's holistic diagnosis. These prompted new insights helped break down the barriers, Gask et al., (2003) and resulted in the psychiatrist adopting that it would result in a more thorough treatment plan. This, as Hamzah & Wahid (2016) argued, helped the participants straddle new knowledge domains. This concludes that parochial use of PGHD is related to the lack of confidence and education for both clinicians and health consumers.

The novel solution through the Artefact showed that it could potentially do more than just offer a structured environment to present PGHD. It showed that daunting elements if presented in new contexts, can open minds to unknowns and elucidate multiple-dimensional understanding of problems and elevate the quality of care.

### 5.2.3 Paradigm Shifts

As the interviews progressed, it proved, as Guba & Lincoln (1994) argued, a shift in clinician and consumer HCI paradigms as the understanding of value and benefits to each user grew. Lupton (2016) was correct when they argued that consumers were engaging more with other forms of care. However, leveraging this theme, as cycles matured, participants acknowledged that behaviour change through ubiquitous PGHD (Shin, 2019) being used by clinicians can directly increase the value of the consultation and change clinician and consumer clinical behaviours (Ryan, 2019).

### 5.2.4 Latent Emergence of New Barriers to the Actionable Solution

Subthemes raised new barriers that concerned the Researcher around the impact on the actionable outcome. These included specifically, the barrier of fear, apparent for both cohorts of participants, besides the underlying themes of paternalism and hierarchical patient-clinician relationships argued by Taylor (2019) and Yeoman et al. (2017), the Researcher believes that a mutual fear of data itself is more concerning and is a barrier that requires further investigation. While as addressed in 5.4.1.2, this is somewhat mitigated by introducing the clinician Avatar and incorporating education and upskilling within the Artefact, fear was a hindrance in the study that made it difficult for constructive discussions around the introduction of practical solutions. However, research through design (Frayling, 1993) processes using empathy, helped the

Researcher make the participants feel empowered with personally applicable knowledge. Furthermore, the Researcher used participants needs combined, with encouraging them to act as researchers in ideation, to find affinity with the problem. Participant’s behaviours in the interviews showed satisfaction when their ideas were recognised (Bailey & Pearson, 1983). This, the Researcher argues, helped achieve what Ward (2018) argues is necessary for rebuilding trust and respect with feeling empowered (Rizzo, 2011; Halse et al., 2010), the requirements, argued by Denzin and Lincoln (2018), necessary to address a socio-behavioural problem.

Findings raised another socio-behavioural concern requiring further research, showing that consumers may be unwilling to submit data that shows non-compliance and non-adherence. This is compounded when clinicians are presented with a collection of complex symptomatic data points that they dispel due to ignorance of how they correlate. This manifested in participants showing signs of withdrawal so as not to be exposed.

Further, suppose we consider Mandel (2002), who proposes that 30% of HCI relies on the user’s interaction with the tool and 60% on the relationship. The Researcher argues that researchers using ADR and DT must carefully consider the probing element of their questionnaires to address issues affecting different cohorts of participants. An example is that this solution had to evolve to address administrative barriers specific to clinician fatigue and burnout, argued prevalent by Gardner et al. (2019) and Shanafelt et al., (2016). The Artefact had to design specific functionality to book consults and prepare clinicians with a patient dashboard pre-consultation to allay fears of belabouring administration.

The Artefact had to also address practical communication constraints (Lindström et al., 2003) and introduce telehealth platforms allowing clinicians to connect with their patients in real-time, breaking down visual, proximity and time restrictive barriers. The Researcher realised a need for behavioural-science thinking in HCI studies that deal with change management strategies. While this is a latent theme, he argues that these should run sequentially to design processes in HCI studies.

Consequently, the Researcher proposes that scholars using ADR seeking solutions that help move from clinical intuition (Chaudoir et al., 2013; Longoni et al 2019 & Morris et al., 2011) towards what the consumer feels is necessary which Longoni et al., (2019) argued is a lack of post consult collaboration, should graduate the use of empathy and include more behavioural-science techniques. However, the Researcher argues that if we are to achieve this, we need to engage more widely than the make-up of the in-study participants. He argues that ADR models require another research dimension and must engage a wider group of secondary participants. In this case, value would have been added by including the patient's payors, their employers, family members, change management consultants and potentially behavioural psychologists with the intention of garnering support and wider acceptance of the Artefact as a solution. These will now be engaged post facto.

Further barrier mitigations offered by the participants were more granular. They included practical solutions, including the need to translate vital signs and other clinical data like AI pathology and AI fundoscopy diagnosis. The Researcher notes that due to his following Reis et al. (2011), making each fellow researcher/participant feel that they were empowered and involved in an exciting project, helped dissipate barriers that initiated interest and exploration of these previously intimidating clinical innovations and data sources.

### 5.3 THE IMPORTANCE OF UNDERSTANDING YOUR PARTICIPANTS PERSPECTIVES

Cognisant of behavioural impacts, the Researcher sought to explore a deeper understanding of what Norman (2017) exposed, as the dangerous consumer clinical narcissism that has grown from the reliance on online health services, by looking at this phenomenon through an empathetic lens (Meskó et al., 2019). This made the Researcher realise that it is not just data and, he needed to glean a keener understanding of participants personal perspectives. When participants proposed that the Avatar within the Artefact must become their concierge to online health services and filter personally nuanced information (Christie, 2013) it showed how patients had not yet found a place of safety (Astrup, 2018) and, sought a bridge between the two. Participants were encouraged to debate this. As the discussions evolved, it was argued that presenting the clinician as a 24/7 Avatar will reposition the clinician as a more credible, trustworthy digital and warm-body resource. Consequently, consumers begun defending the clinician's position by arguing that a clinician's Avatar has an advantage over Dr Google. This was then seen as an advantage as it would save countless hours of web surfing and restrict erroneous and sometimes dangerous advice from Dr Google.

The Researcher realised that sometimes subthemes loop back and help address the root problem. In this study, it is that Dr Google is not, as Ip (2019) argued, first-line anymore; it is already doing complicated diagnostics, and if connected to the consumer, Google will be attributed more value. However, if compared clinicians emerge as more trustworthy.

### 5.3.1 The Importance of Probing Questions in Semi-structured Interviews

The Researcher was challenged by the continual increase in scope as the study began exploring emerging HCI psychological human themes (Creswell & Creswell, 2017). It was apparent that an inherent risk in qualitative research is that if emergent themes are left unresolved, they may compromise the action in an actionable outcome. As an example, this research exploring the deliberative consumer (Emanuel & Emanuel, 1992), meant understanding what the consumers were searching the web for. Sharon (2017) was correct, in assuming “blind belief” as consumers enter the web using usual search behaviour hoping to hit an appropriate response based on symptomatic raw data. Probing questions exploring this deliberative consumer-behaviour, made participants conclude that the likelihood of a well-defined, safe web response remains limited.

There was support in the literature showing that consumers are digitally cohabiting within communities, which helped the researcher appreciate participants context. Guided by Denzin & Lincoln (2018), he used probing questions to explore the socio-behavioural phenomena as participants indicated that they sought to understand their data in the security of groups struggling with similar disease. New questions were introduced to see how to leverage the Artefact to support these communities (or, as the Researcher refers to them, health communes) which Christie (2013) argued were necessary to increase the human support for the human-computer interaction. Lupton (2013); Lupton, (2016); Swan, (2009) and Swan (2013) gave insight that helped the Researcher position the study to ensure that we do not disturb current search behaviours that may be extracting value from resources that might be valuable to the solution. The Researcher argues that problem-solving should not always be a new broom approach and that it is important that actionable outcomes align with residual good behaviour. Participants agreed that offering tailored search profiles that result in uniquely responsive education, mental health support, and overall health literacy helps merge current behaviour with new functionality and, helped the Researcher find solutions for some of the psychological research challenges in HCI (Creswell & Creswell, 2017). Participants concluded that the Artefact should analytically operate as a web search field guide to make searches more personally relevant and to distil out the irrelevant, distracting and potentially dangerous information discussed in more detail in 5.7.

### 5.3.2 Quality Digital Clinical Care to the Economically Distressed

Participants argued that searches emanate from socio-economic factors as Dr Google is cheaper than the clinician. The Researcher had not adequately considered the driver of the economics as a socio-behavioural problem (Denzin & Lincoln, 2018) driving consumer's decisions to seek Google's advice first. He believes there is a gap in the literature dealing with economic stress factors driving patients to self-quantification and how this influences the consumption of digital healthcare. Further the Researcher proposes that research is required to understand the impact Gini coefficients have on HCI studies. In South Africa this statistically is high (0.65)[36] and consequently he realised in post literature reviews, this also influenced reducing warm-body consults and increases digital search alternatives Niyimbanira, (2017). The Researcher presented the notion that Avatars within the Artefact can alleviate these economic and emergent COVID-19 challenges by becoming the vehicle that brings quality care at a lower cost to more people. This not only addresses individual health needs argued necessary by Hamzah & Wahid, (2016) but adds value to the communities that are becoming an embedded part of the solution. Added, CDE's economically distressed clinicians can use the Avatar as an extension of themselves and earn high volume lower margin annuity income from the uninsured, paying value-based fees to access their clinicians digitally. This highlighted that qualitative research

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[36] http://www.statssa.gov.za/

using probing can present opportunities that extend beyond the specific research question.

### 5.4 THE CONSEQUENCES OF KNOWLEDGE GAPS

The Researcher was challenged by the need to explain terms in lay speak. Terms like value-based care, self-quantification, amongst others had to be continually explained using literature as references. This builds on Simonsen, (2013); Teli, Di Fiore, & D'Andrea, (2016), who argues that researchers must develop a guide with appropriate terminology for their participants. As a result, the Researcher proposed to participants that the Artefact would incorporate a glossary that can dynamically build in a Wikipedia type fashion. Web search capabilities will be developed as a navigational feature that connects the solution to clinically approved websites. The Avatar and the clinician will address what Lai et al., (2017) argued is an inherent systemic lack of education across the system. We noted that the CDE clinicians pull education from webinars and pharma representatives but are parochial to subject matter and result in knowledge gaps. The Artefact will cross-reference credible sources of literature and build a unique compendium for each user.

The Researcher believes that the debate around self-quantification (Lupton, 2013; Lupton, 2016; Swan, 2009; Swan, 2013) was enlightening for clinicians. They resolved that the Artefact should present them to these communities encouraging relationships with clinicians. We can then institute focused group coaching making good medicine central to these groups.

### 5.5 DOMAIN EXPERTS?

The Researcher argues that the boundaries depicting users as domain experts as Mandel (2002) argued, have been disrupted. Dr Google's misinformation or consumers misinterpretation of online content related to PGHD raised by clinicians showed that there is a false sense of medical expertise derived from online sources in consumer minds. Clinicians argue this manifest in people getting sicker. AI within the Artefact may help rectify this by distilling the information to the point that it unique to each patient and has been tested before it is incorporated in that patient's treatment plan. Clinicians argued this can potentially predict and detect severe diseases and save lives. The Researcher believes incrementally increasing credible education will increase knowledge and begin building domain experts.

### 5.6 DIGITAL VERSUS WARM BODY

The Researcher also tested whether arguments from Caiata-Zufferey et al. (2010), Dedding et al. (2011) and Sommerhalder et al. (2009) were correct. Findings agree that indeed, clinicians feel left on the periphery as consumers mostly go-to Dr Google first (Ip 2019). However, as Zhu et al., (2016) argued, if consumers have the data from PGHD and comments from Dr Google, they seldom share these insights with their clinicians. We learned that clinicians are further disintermediated, as Zhang et al., (2017) argued, they are unlikely to ask for the information either. As Lupton (2016); Lupton, (2013); Swan, (2009) and Swan, (2013) argued, consumers carry their data away from clinicians seeking more agile digital receptors. A latent theme arose – the "freak out" factor. Some consumers only trigger-reason to seek clinician's advice is sensationalism of web-based responses to symptoms. While WAT, PGHD and Dr Google are some reasons for consumers rising out of paternal care and, through the move to deliberative consumerism (Taylor, 2019), they have disrupted clinical pathways and created health-confusion. Findings concur with Topol (2019), who argue that self-diagnosis, care maintenance, adherence, and compliance, specific tools of the clinician's trade, are at risk of being replaced by machines but, remain uncontrolled.

Taylor (2019) arguments were also confirmed in that some clinicians naively hold onto the belief that *"nothing replaces hands on the patient."* The Researcher argues we should not replace but, instead find ways to include and eventually replicate the caring hands of the clinician's human touch. The Artefact relies on the arguments offered by Burns et al., (2019); Lai et al., (2017) and Shapiro et al., (2012) that the warm-body clinician and the patient can be reunited in a relationship with mutually beneficial data. Added, clinicians believe themselves that they can re-establish themselves as caring as they help increase knowledge for the consumer (Ajana, 2017).

### 5.7 EXAMINING PARTICIPANT HABITUAL APPROACHES TO DATA IN HCI STUDIES

Clinicians addressed the lack of clinical response (Wellman et al., 2002) arguing that as they were naturally more confident with WAT, they felt comfortable offering interpretation to external symptomatic PGHD behaviour. However, when probed, asking the following question as an example: *“do you understand pulse rates during REM sleep patterns, and do you understand the associated data points?”* clinicians realised that they may be offering incorrect information as they could not answer the question with confidence.

The Researcher opined that confidence levels solicits varied responses, and researchers need to balance this with further probing to avoid including data on specific subject matter at face value. When participants appreciated the purposeful use of WAT’s, usable research actions (Argyris, 1995), became more robust.

Using accuracy concerns to test behaviour and confidence in the data responses, the Researcher probed opinions on the accuracy of the WAT’s. Ardent users were confident and forthright and agreed with the arguments presented by Turakhia et al. (2019), who concluded that WAT delivers reliable data worthy of clinical studies. However, less confident users related more sedate experiences and the Researcher felt withdrawal from a few participants on the subject matter. To mitigate and balance the data, the Researcher then relied on Bilandzic & Venable (2011) and sought to normalise the perspectives. He expanded conversations to mutually comfortable introducing design features that for the clinicians would incorporate data from familiar medical equipment and for consumers, familiar IoT’s to compare data, and help build confidence encouraging them to adopt the Artefact as their solution. This inspired new thinking and resulted in invaluable data but exposed the danger of false data points. The Researcher believes that as Schmidt et al., (2017) ar’ues, we must be careful as researchers as we deal with participant confidence in qualitative data as these can erroneously skew outcomes.

### 5.8 USING THE ARTEFACT TO ADJUST HUMAN BEHAVIOURAL TRENDS

Working with the notion of habitual trends, the Researcher reflected on the participant’s behaviours and routines highlighted in Schmidt et al., (2017) and the impact on the research outcome. The Researcher realised that as Dix et al., (2003) argued, if we addressed users’ situational needs, we would create routines by prompting reasons to check PGHD, resulting in increased frequency of use. Participants had an acute understanding of the need, as Harrison et al., (2007) argued, but not the how, we had to create user specific environments within the Artefact. Participants resolved the Artefacts should be adapted to their lifestyles and replicate them in the Artefact. WAT measured routines in the home as an example, bring the Artefact closer to habitual actions, measuring, monitoring for early detection of non-adherence to treatment plans. Further, if it is built with an empathetic interaction (Plattner, et al., 2009), it can prompt the consumer and create call to actions. If, however, there is no improvement and the data triggers an alarm, the clinician can be proactively alerted to bring in a warm-body intervention. It stimulated further design innovation as now the treatment plans loaded onto the Artefact will create check-in points that may include notifications at certain times of day to ensure compliance and adherence to medication or other actions agreed within the treatment plan. This continuous human-computer interaction, the Researcher realised, has added benefits, as argued by Bevan et al., 2015), and in this study, participants resolved that this *“can save lives.”*

## 5.9 EXPONENTIAL NOVELTY

The Researcher then referred to Pal et al., (2020) and realised that there is an opportunity to join the features and functionality to the human trait of convenience and curiosity. For example, a blood-pressure monitor (BPM) and blood oxygen measurement on some WAT devices, but most participants did not know this.

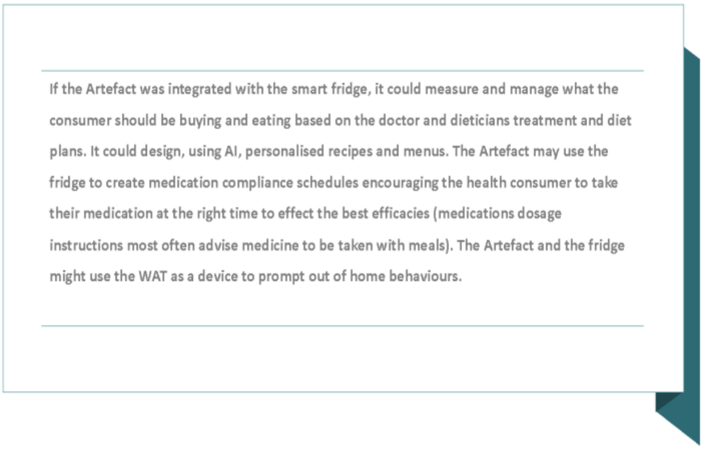
The Researcher observed that when the discussions highlighted a feature that either had an interest for the individual or was surprising, e.g., an electrocardiogram (ECG) linked to the WAT, the responses were enthusiastic, especially from the clinicians. However, participants raised that these new features must be presented as a clinical need, in a gamified way, challenging the users to know their new numbers and then use the functionality to target goals and share the knowledge in communities (Christie, 2013) and their clinicians (Blandford, 2019)

### 5.10.1 Novel Functionality to Add Psycho-social Support

The Researcher reflected on Gilmore and Kenny, (2015) and Kenny and Gilmore (2014) and realised that he needed to connect the Artefact to empowering the users with mental health and psycho-social support features. Participants addressed this by designing functionality measuring sleep, stress, blood-pressure, heart rate, and activity, all seen as critical PGHD mental health indicators. The Researcher believes that positioning the Artefact as a medium for online psycho-social support by clinicians (Meskó et al., 2019) will help position the Artefact as crucial but must be considered as open and caring. Personalisation, mental health questionnaires and connections to clinician based mental wellness programmes, family, and community health communes (Christie, 2013) for support, participants believed should be prominent features. Participants required the need to incorporate social media, telemedicine, and digital communication platforms, like WhatsApp™ and Signal™ to regularise access. Consequently, the Artefact will capture biophysical metrics and vital signs, merge these with the loaded treatment plan and then draw on globally published data to help prewarn potential mental health issues.

### 5.10.2 Integration with Lifestyle IoTs – Support Psycho-Social Needs

Staying with the theme of consumers psycho, behavioural and socio-economic needs, the Researcher explored Van Velthoven & Cordon (2019) views and realised that he had to assimilate the arguments of Harrison et al., (2007) and design the solution within and not around the human's environment. Participants offered that the Artefact must leverage application programming interfaces (API's) and integrate with their other IoT's, like smart cars, smart-fridges, home appliances, and voice assistants (like Alexa™ and Siri ™). Including these as functions will expand the view of the consumer's environmental needs and assist in creating a seamless but continuous gentle touch within consumers daily



If the Artefact was integrated with the smart fridge, it could measure and manage what the consumer should be buying and eating based on the doctor and dieticians treatment and diet plans. It could design, using AI, personalised recipes and menus. The Artefact may use the fridge to create medication compliance schedules encouraging the health consumer to take their medication at the right time to effect the best efficacies (medications dosage instructions most often advise medicine to be taken with meals). The Artefact and the fridge might use the WAT as a device to prompt out of home behaviours.

**Figure 5. 1: Integration with other IoTs**[37]

### 5.10.3 Novel Display – a UX and a UI Human-Centred Perspective

This HCI focused on tailoring around specific user's needs (Hassenzah, 2008), and their environments (Harrison et al., 2007). The participants supported the theory presented by Mandel (2002), suggesting the necessity to achieve a UX that creates a relationship with the Artefact consequently encouraging continuous use. Bailey and Pearson, (1983) defined satisfaction as "the sum of one's feelings or attitudes towards various factors affecting that situation." This study shows that Artefacts UI and UX must graduate beyond currently available underwhelming dashboard displays. Personalisation addresses the arguments by Ives et al., (1983), describing the need for continuous evolution to meet the need for gratification and must address the element of curiosity (Pal et al., 2020).

Hassenzahl and Tractinsky (2006) argued two main types of quality attributes sought by users: pragmatic quality (usability perceived by the user) and hedonic quality (pleasure – product quality). More novel displays like a human anatomy atlas were gleaned as more appealing and could be a valuable educational tool for clinicians and consumers. More behavioural research is required on whether introducing digital replications of the props used by clinicians to explain symptoms and diagnosis in consultations would be beneficial.

### 5.10.4 Novel Notifications to Encourage Goal Setting

Participants agreed with the findings of Patel et al., (2018) that wellness and loyalty programmes have entrenched self-quantification and encourage continuous engagement. Participants suggested these can be enhanced through a compendium of novel communication messaging between the clinician and health consumer, as argued by Ward (2018). While goal setting happens in most consultations, these are

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[37] https://www.kdnuggets.com/

seldom reduced to a usable format. The participants argued that the Artefact could de facto become the tool that records goals, measures, and reports to whom the patient wants to be involved in their care journey. Blandford (2019) argued that personalisation is critical prompting the Artefact to include tailored functionality that allows the clinician and the consumer to choose their preferred encouragement methods.

Further, participants proposed that connecting notifications to the clinician adds gravitas if the clinician's Avatar delivers the notifications. Participants believe this will add more relevance to the data, encourage persistence with the user's treatment plan, and change clinical behaviours, as argued by Mercer et al., (2016) and Ryan et al., (2019). Participants, however, argued that care must be shown that the Artefact does not promote obsessive behaviours. Continuous notifications and prompts may encourage an unhealthy addiction to achieve goals, and we must ensure that we do not harm (Norton, 2018).

### 5.10.5 Added Value of the Artefact

Using the paradigms of HCI (Rogers, 2012) allowed the inclusion of the pre-considered ideas into the ADR that set a wireframe for the design; however, as the Researcher stimulated thinking using Mandel (1997) & Mandel (2002) and nurtured views of letting users do what they want to do, he saw innovations emerge deepening the opportunity for the Artefact becoming a "smart" pivot between raw PGHD, controlled clinical care and the consumer's needs (Harrison et al., 2007). It was accepted that a valuable core feature of the Artefact is that it allows them to track and engage their consumers in an organised and controlled enviroment. It was realised that it could also screen and triage patients and bring a call to action as necessary. The Artefact's added value emerged beyond the restraints of what Benyon (2014) call design inflexibility and has been established as more than just a platform for digital connection. The primary requirement of the solution is positioning it as the catalyst to bring the consumer back into the practice. The Researcher, however, identified areas within the data that stimulate other health risk management and commercial advantages. It has opened practice business redesign thinking to see if the Artefact can be embedded to help overloaded and time poor clinicians (Gardner et al., 2019) with dashboarding the symptoms and creating diagnostic options before the clinician even engages the patient. The participants offered to extend their involvement in this ADR (Sein, & Rossi, 2019), embracing their potential involvement in post-thesis action development cycles proposed by Park & McKilligan, (2018) to help draw out more creative ways to multipurpose the Artefact to address other practice problems.

### 5.10.6 Time-Saving

Consumers were specific that any time saved web-searching, could be reinvested in other clinical and educational services. Changes in thinking by clinicians were palpable, as digital management's advantages through an Avatar extension of themselves were seen as ground-breaking. Added benefits included allowing clinicians to extend consulting time without being belaboured with digital administration (Bouchard, 2019). Selling time has been the clinician's professional model. If they increase the time or replicate themselves, they have more to sell. The Artefacts novelty of replicating the clinician, creates cost and time efficiencies. Multiplying available hours can revolutionise healthcare and reposition the clinicians as a primary stakeholder in Health 4.0 (Chute & French, 2019). The Artefact will incorporate admin functionality mentioned in 5.4.1.4 reducing time around per patient administration (Gardner et al., 2019; Shanafelt et al., 2016). Limitation of time is the CDE practices most significant restriction on revenue generation. The Researcher argues that saving time and increasing access directly impacts revenue, as discussed below.

## 5.11 NEW REMUNERATION MODELS

The participants argued that the Artefact and, more specifically, access to the Avatar and associated clinical and education services are worth paying for; however, further research is required to evaluate options presented moving away from the traps of a fee per engagement as argued by Smith et al., (2017), to an annuity, pay for play, or freemium and premium model. Clinicians and CALC agreed that workshopping appropriate annuity revenue stream models using the ability to extend their services through AI, Avatar and chatbot access, as discussed below, is an *"exciting"* development.

### 5.12 ACCESS THROUGH UNIQUE FUNCTIONALITY

The Researcher had not contemplated that the practice solution could, through adding elements like AI and the Clinician's Avatar, increase access to care beyond its current client base. The Researchers passion and purpose is to help deal with South Africa's deep inequality with many of its people who may be employed but are uninsured due to prohibitive private healthcare costs (Harris et al., 2011). Access to private healthcare is restricted by the basic economic principle of supply and demand. The practice is limited by the number of clinicians who charge for time. Suppose, e.g., AI presented as an Avatar can multiply the clinician and draw on millions of external and internal accredited data points, as Tran et al. (2019) argued is possible. In that case, we can lower our cost of care and offer care products to the underprivileged.

The Researcher also argues that costly clinical diagnostic experimentation that is potentially dangerous (Distiller et al., 2010) can be minimised using predictive AI modelling within the Artefact.

### 5.13 THE MACHINE – CLINICIAN'S FRIEND OR FOE?

The literature offered little in the way of machines collaborating with clinicians, but often argued that machines are replacing clinicians (Karches, 2018; Topol, 2019). Contrarily, clinicians saw AI as *"friend not foe."* Participants agreed that clinicians are human and are not *"infallible"* but that clinicians would appreciate the continuous support from AI both in and out of the consultations. The consumer-participants indicated that they would feel more comfortable if they knew that their clinicians were being supported by AI seeking new knowledge associated with their individual needs (Holzinger, 2013) stemming from a wider confluence of data points (Ajana, 2017). Participants argued they would become more trusting of their clinicians (Ward, 2018) if consumers knew their clinicians were using AI and PGHD to diagnose. Findings show that our clinicians are aware that AI can diagnose certain conditions better than clinicians (Topol, 2019) and were agreeable of arguments that show AI reading of radiology, fundal eye photographs, or pathology can become a vital tool in the clinician's hands (Tran et al., 2019; Yu et al., 2018).

Clinicians argued that if AI can reduce the guesswork, the Artefact's secondary effect could reduce extraneous costs. It must then act as the intermediary that can absorb

PGHD and process it for the clinicians to prevent data misinterpretation and digital fatigue (Gardner et al., 2019). The Researcher argues that the AI within the Artefact can prompt clinicians if they have missed the need for a specific diagnostic test. However, the Researcher picked up elements of denial and fear associated with AI from a few participants. The digitisation of clinical processes was fore on minds, and while some see this as enhancing efficiencies, others see it, as Karches (2018) argued, as a threat.

Clinicians believe that currently, their only defence is the *"human touch."* However, participants agreed that in the main, the machine could add more value than not.

### 5.14 THE ARTEFACT – STIMULATING NEW SERVICE OFFERINGS

Reflecting how the Artefact had expanded its scope from only dealing with WAT PGHD to include other functionality, he began to explore other possibilities of leveraging the Artefact for other commercial opportunities. As an e.g., he presented it to CALC as a medium to manage continuous medical underwriting for health, life, and disability insurers. Context – insurance underwriting is done at the point of policy take on. However, there is no subsequent continuous risk underwriting. The Artefact could live with the policy holder and measuring their health and converting the data to manage risk-rated premium adjustments. Using the Artefact as a continuous monitoring tool can initiate an immediate clinical call to action to adjust unmanaged risk. Healthier, more aware policyholders who are reacting to calls to action will likely live longer and increase premium persistency. The Artefact can be used to adjust premiums in real-time according to compliance and adherence.

### 5.15 CONSUMER INTIMACY THROUGH THE AVATAR

Access to the clinician Avatar at consumers fingertips was considered by participants and subsequently by the CALC, as ground-breaking. The Avatar functions as a medium for newfound real-time knowledge (Ajana, 2017) and is presented, as a *"personal health coach"* enhancing inter-party relationships. The intimacy of a *"real-time"* relationship through an Avatar was enthusiastically embraced as a unique feature of the Artefact. The Researcher has reflected on the subtheme of WAT-based online behaviour change identified by Mercer et al. (2016) and realised that while Dr Google carries favour, a replacement presented as a *"walking talking"* replication of the clinician may outrank Dr Google. However, we must be cognizant of the trust factor (Ward, 2018). Suppose the Avatar presents as inadequate, non-performing or is non-responsive. In that case, the clinician will lose patient trust and consumer intimacy. The following Artefact elements helped instil consumer trust.

### 5.16 PRIVACY & DATA SECURITY – HOW FAR MUST WE GO?

Participants were mixed on the need and ability of the Artefact to fully protect their data. The spectrum left the Researcher requiring further cycles of in practice ideation (Park, & McKilligan, 2018). CALC resolved that it would be irresponsible to not include password protection or multi-biometric layered security access. This also adheres to specific regulatory requirements necessary to protect personal data. WAT technologies are already making use of the hardware functionality to assess symptoms.[38] An opportunity exists where the security access point scans the face and iris, takes a voice prompt, and then incorporates this symptomatic data, and could add it to comparative PGHD within the Artefact, delivering secure access and added clinical diagnostic data. This, with the clinician's input, can triangulate data points and offer a more rigorous view of vital signs and symptoms. The Researcher considered the arguments of Cilliers (2020) and concluded that while there was a somewhat distorted view of the necessity, data security cannot be compromised as this will directly impact trust. Consumers will have to authorise access to any third party, including other attending clinicians, which raised the element of access.

### 5.17 EMERGING RESTRAINING THEME – CLINICIAN NOTES

The Researcher was surprised by the clinicians who argued vociferously to protect access to their written clinical notes. Consumers believe they have a right to all their data. However, it was revealed that clinicians will hold their thinking part of the notes to themselves and other attending peers. The Researcher found gaps in the literature and proposes more reflection and research as the consumer wants unfettered access but, and this may cause the clinicians to dilute the richness of their notes. The Researcher has raised this as an agenda item in practice clinical committees and

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[38] https://www.binah.ai/

hopes that a more open resolve to sharing can be achieved without compromising the value of the notes.

## 5.18 TRUST – BIG TECH IN MEDICINE

Mgudlwa & Iyamu (2018) showed that Big-Tech systems are not designed with all the users' input in mind which erodes trust in and adoption of some of these systems. Ironically given the view on data security above, participants do not trust the obscurity around where the data is going when dealing with Big-Tech. A competitive advantage of the Artefact has over Big-Tech is that *"Big-Tech are not health specialists and do not understand healthcare's clinical component."* However, the Researcher's reflections across all previous elements indicated that the Artefact would need to find ways of instilling trust so that we can work with Big-Tech as they bring development strength, deep research and expertise that is commercially challenging to replicate (West et al., 2020).

## 5.19 UNDERSTANDING THE DRIVER OF EVOLVING CONSUMER BEHAVIOURS

As Lupton (2013; 2016) and Lupton & Jutel (2015) described, self-quantification and self-care are naturally occurring phenomena based on the emergence of consumer empowering technologies. Since the pandemic, this has become commonplace, and the Researcher believes these behaviours will remain entrenched. Participants clarified that they want a partnership with their clinicians, not a paternal relationship, as Blandford (2019) argued currently prevalent. They want patient-centric continuous attention to their needs (Emanuel & Emanuel, 1992), not an occasional appointment according to the clinician's availability.

The Researcher believes that he would be remiss in not considering the impact of COVID-19 on patient-centricity and the causal changing consumer-behaviour patterns (Wong et al., 2020; Horgan et al., 2019; Ganguli et al., 2020; Remuzzi & Remuzzi, 2020 & Rosenbaum, 2020) that mainly entrenched new and unpredictable behaviours. Some will revert to pre-COVID-19 status, but others who have experienced digital alternatives highlighted in Kalhori et al., (2021) may default to this modality first. However, the Researcher considers this an opportunity to leverage this behaviour change. The catastrophic event (COVID-19) has rebooted the system. Introducing the clinician in a digital form may be better accepted now that there is a heightened digital consumer-centricity (Blandford, 2019; Yeoman et al., 2017) during the pandemic. The flux caused by these circumstances prompts the time to act and implement, which has resulted in the Artefact having gone into the post-thesis phases as guided by Sein et al., (2011).

The Researcher also considers the remaining research challenge of addressing the need for the personal touch (Heller, 2013). The challenge remains, how do we replicate the hands of the clinician within the Artefacts Avatar?

In considering arguments in (Bailey & Pearson, 1983) that somewhat helps address this challenge, the Researcher proposes that the clinician and consumer address the dynamic changing behaviours by adding a self-tailor function to design their UI. For example, data points, displays, information, and educational links etc., can all be customised to the specific relationship. This acknowledges that encouraging better and personal relationships between the parties, as Arnold and Wilson (2017) argued, is necessary to make clinicians and consumers feel like the Artefact belongs to them. As behaviours change, they can evolve the Artefact to increase the digital intimacy that seeks to replicate a good bedside manner.

### 5.20 GOAL SETTING – NURTURING DIGITAL INTIMACY

Having established that digital personalisation is necessary (Levina, 2017), participants explored the area of compliance and adherence realising, that clinician and consumer should both be notified of pre-set anomalies in conjunction with the treatment plan. As we engage and set up clinical support communities from the App, we may need to incorporate some of the hard-wired UI and UX structures people are used to from Facebook™, Instagram™ etc. (Albert & Tullis, 2013) to capture goals within the treatment plan.

Goal setting coordinated within the treatment plan created strong HCI with the Artefact, and nurtured responses more intimacy with the clinician. It is anticipated that the Artefact will form a contract of targets agreed between the parties that take lifestyle, socio-economic and personal circumstances into account to make achieving the goals realistic as argued necessary by Carroll (2003) and safe as argued by (Barlow, Rada, & Diaper, 1989; Preece et al., 1994). The parties can also decide the appropriate joint calls to action for not reaching goals. If goal failures become serial, the Artefact will prompt the consumer to reach out to the clinician to renegotiate the targets. If severe enough, the Artefact can prompt and help set up appointments with the clinician.

Service feedback is essential to both clinician and consumer, including surveys of how the clinician performs as a service to their consumer. This is a radical departure from the hierarchical and paternal norms (Greenwood & Peeples, 2019; Heifetz & Laurie, 1997; Leape et al., 2009) and forms part of a change management process amongst the clinicians.

## 5.21 DIGITAL CONCIERGE

Participants saw other opportunities in expanding the scope of our DT to include other user needs (Plattner, et al 2009) of the interactive system/artefact (Bevan et al., 2015). This included scoping a concierge feature into the design to address the requirements for ease of use and needs satisfaction (Nielsen, 1994). Findings show that consumers are time poor or just unable to adhere to diets and general wellness habits. Further, there is an underlying lifestyle or environmental issue (Harrison et al., 2007) prohibiting the consumer from sticking to a plan. To address these needs, the Researcher proposes a digital concierge, driven by machine learning, that can assist with simple tasks of finding an appropriate dietician or find a reliable electrician or plumber. These daily functions add to daily stresses and lifestyle disease risks. An AI concierge can evaluate stress levels and other PGHD and intervene with suggestions that help entrench the Artefact further becoming a delicate part of the health consumers daily lives.

## 5.22 CONCLUSION

The Researcher believes that on reflection there may have been merit in conducting the studies in online (COVID-19) focus groups. However, he believes he was able to cognitively mitigate this using each interview as an intimate actionable cycle which made the next interview incorporate reflection on what other participants had offered (Baum et al., 2006). This manifested in the richness of circa 25 hours of recorded data added to pre-thesis findings (Appendix D & E) which he has managed to consolidate into a collection of participant reflections and, tangible design elements. He dedicated the research to finding ways to further enhance the practices warm-body experience through the novel contribution of the Artefact into the practice. However, what remains vexing is that while machines are primarily predictable, the literature and these findings have shown that human nature reliant on intuition is not (Chaudoir et al., 2013; Longoni et al., 2019; Morris et al., 2011). This stretched the Researcher's thinking around HCI paradigms (Rogers, 2012), prompting a notion that an HCI solution should rely more upon as Mandel (2002) and Rogers, (2012) argued, on the user's relationship with the system. The Researcher's background is not in IT systems or programming. He approached the problem seeking to enhance the human value of the relationship between clinician and patient (Brown, 2008; Brown & Katz, 2019) resulting in the Artefact emerging as a platform for human behavioural interactions and not just a functional application to connect data points of interest.

We are at a critical juncture as healthcare delivery faces Health 4.0 (Chute & French, 2019). The fast-paced changes made the Researcher initially feel a heightened anxiety as he saw the increasing disintermediation of his clinicians by machines. This need for urgency to introduce consumer-centric care, as described by Blandford (2019) fortuitously placed this research front and centre for the practice. Now, with a tangible outcome in hand to address the problem, he realises that not all problems are wicked and, that when participative enquiry stretches to include patients helping find solutions for themselves, the rigour and potential of success of the solution goes up exponentially. He believes this study shows that we can find new ways to engage self-quantified, empowered consumers. While the literature is clear that Big-Tech intends to position digital care above the clinician's limited ability to offer services outside of their bricks and mortar practices (Zhang et al., 2015, Zhang et al., 2017 and Zhang et al., 2018). The Researcher believes from this study that there is a sweet spot where they can leverage each other harmoniously. Further, this study shows that we can address the concerns raised by Longoni et al., (2019), who questions the clinician's ability to collaborate with machines by, presenting value adds for all users. The Researcher proposes that the ADR, led by the work of Sein et al., (2011), adds to knowledge when designing new technologies as enhancers of consumer-based care delivery and not a replacement thereof.

The Researcher argues we have a significant gap in practice and literature around the elements of health consumer self-quantified behaviours, delivery of patient education related to online searches using symptoms as a guide, the power of Ambient Intelligent digital tools in clinical care, PGHD and WAT functionality and how it can assist medicine at diagnosis and treatment plan levels. However, what was encouraging for the Researcher was the clinician's spirit and willingness to move from paternalism and to operate on parity with their patients to design a solution. The last chapter concludes on effectiveness of this ADR and the actionable solution that has been presented to the practice for development – named project Treatme.health.

# 6 Conclusions

## 6.1 INTRODUCTION

Conclusions reflect how practical this HCI study was using the ADR approach and methods from DT that addressed the research question and presented Treatme.health as an actionable outcome. The Researcher shows how this research has already benefited the practice. He shows the introduction of a novel way of navigating the dynamic and deliberative consumer PGHD and, inculcating user needs within the clinician's approach to care (Stone, Rousseau & Lai et al., 2016) touching on the science non-fiction of the future.

Highlighting new knowledge from the fusion of all participants ideas into practice thinking has shown changes in approach and culture that presents opportunities for consequent studies. The Researcher presents a notion that supports Mandel (2002) that shows that 60% of systems development in HCI is centred around human behaviour. He argues that his experience in this study, was that human behaviours are what drove the design. When he first conceptualised the Artefact, it was presented to the practice as a single dimensional infographic, now it is a multi-dimensional platform incorporating the clinician as an Avatar, it is the confluence of all data not just PGHD and has become the future home of the treatment plan. On reflection, patients walked out of CDE consults with very little collateral of their visit. Usually it’s with a prescription, a pathology referral and perhaps another referral to an allied clinician. In the future they can look forward to having a treatment plan that houses their data, is the home of their clinician’s Avatar, and using AI, delivers bite sized educational content tailored to their personal plan.

## 6.2 RESEARCH APPROACH & EFFECTIVENESS

The choice of ADR that subscribes to the methods guided by Sein et al., (2011), using two disengaging and disparate participant cohorts, was a risk. So, the Researcher embarked on a sensemaking process to assess if the methodology would be effective in creating a digital-design solution in a complex system (Stacey, 2011; Holland, 2006) dealing with crisis and change (Maitlis & Sonenshein, 2010). The literature helped understand the emergence of self-quantified patients using Dr Google, causing diminishing patient visits (Majmudar et al., 2015). However, there were gaps around why, what, and how the health consumer felt as their WAT's and Dr Google are making the first-line diagnosis (Ip, 2019). Understanding these drivers luring consumers away from our clinicians and making them turn to machines, behaviours shown by this study, to be potentially dangerous has been enlightening but deserves further study.

Finding a digital solution that addresses the deliberative consumer's (Emanuel & Emanuel, 1992) need to command their health (Demiris, 2016), and address the rise above the legacy of paternalism and hierarchy (Greenwood & Peeples, 2019; Heifetz & Laurie, 1997; Leape et al., 2009), required a unique agile methodology. Creating a digital solution for a human behavioural problem (Harrison et al., 2007) that was evolving and multi-dimensional needed cyclic data collection that could build on each interview. ADR using DT emerged as an appropriate methodology to bring human behaviour into agile design. The solution needed to work with fast moving and incremental innovation. This is where the Researcher started using the term "it must be *revovational"* (the radicalisation of incremental innovation). The envisioned process presented by Sein et al., (2011) successfully brought disparate health consumers and clinicians together and gave them equity (Maitlis & Sonenshein, 2010; Weick, 1988; Weick, 1995) in designing an artefact as framed by Orlikowski & Iacono, (2001). This HCI study (Adams & Nash, 2016) was chosen over the alternative of a protracted behavioural change management project that was unlikely to provide an actionable solution. Added, response time to address the problem was critical. Enigmatic PGHD remaining outside the practice domain (Zhu et al., 2016) would be solved by designing and developing an artefact that would practically catalyse and sustainably strengthen the clinician's value proposition. The need to access new HCI knowledge (Rogers, 2012) around PGHD was seen as a business imperative strategy. Accessing the benefits of personal real-time data and adding real-time clinical value fell directly in line with the CDE mission statement of *becoming a gentle part of each health consumers' everyday life.*

The lack of solutions to help halt the machine replacing clinicians (Topol, 2019) were disconcerting. Robust research methodologies ensuring an actionable artefact as an outcome were also not prolific. The Researcher's study of Sein et al., (2011) and the challenges and the subsequent criticisms by Mullarkey and Hevner (2019), and finally, the response in Sein & Rossi (2019), resulted in researcher confidence that ADR would produce the required actionable and tangible outcome. The research objective of co-designing an artefact that can introduce PGHD into the clinician-consumer relationship to enhance the engagement's value and help reunite them was achieved. Consequently, the Researcher can argue and propose to the research community that ADR was a suitable choice however caution is advised that ideation while initiates innovation, also allows fluidity and scope creep. Initially CALC wanted a study on patients indicating fear of allowing patients to dictate the solution but, once engaging in ADR using DT ideation and design we felt a shift in clinicians' minds, embracing Interpretivism and solutionist thinking departing, from positivist paradigms developed in schools of medicine.

The practice has also adopted ADR within other internal workstreams dealing with humans and HCI paradigms (Rogers, 2012). These included a redesign of the CDE Academy training and Annual Forum experiences from face-to-face, to ‘death by webinar’ to what is now a platform providing for multiple stakeholder interactions. ADR using action cycles, also helped unravel micro blind spots in the current clinical thinking. For example, data points like arrhythmic heart rates during sleep, not previously considered are being debated using freeze and unfreeze and sensemaking in Journal clubs. Using AI and Avatars as an extension of the clinician's reach was adopted. Young and old participants were enthusiastic about finding ways to digitally introduce the clinician back into their daily care.

To measure the effectiveness of this research project, the Researcher considered the frame of empowerment evaluation (Wandersman et al., 2015) specifically used in applying objective criteria to this ADR within a healthcare system (Fetterman et al., 2017; Fetterman & Wandersman, 2015) as follows.

The research process saw ADR create a unique shared language to access a new field of knowledge (Simonsen, 2013; Bass et al., 2014) bridging the historic communication gap between the participants (Gatos et al., 2021) to produce an actionable artefact. The transference of this new styled interaction developed a unique research language Bass et al., (2014) that normalised the different activities of each participant (Hamzah & Wahid, 2016). ADR brought the clinicians off the periphery observing their customers (Henriksen et al., 2018; Ruben, 2020) and placed them on the stage of organisational performance. The process was void of hierarchical bias and benefited from the debate around conflicting ideas (FitzGerald & Hurst, 2017). The Researcher was pleasantly surprised because all participants became active researchers (Stephens et al., 2019) from the start (Reis et al., 2011) There was collective ownership of the design of the Artefact, with each participant revealing uniquely different habits (Hamzah & Wahid, 2016). This he argues was also a benefit of one-on-one interviews as each interview reviewed other responses but concentrated on their specific user needs. Further, it was evident that when two disparate parties started to straddle domains (Hamzah & Wahid, 2016) to find a common and mutually beneficial goal, the dynamics changed. The Researcher experienced first-hand the power of qualitative Interpretivist research looking at change while preserving the science of medicine (Atkinson et al., 2003). Clinicians lost their paternal and hierarchical demeanour and embraced consumer-centricity (Blandford, 2019). Health consumers are empowered, enthusiastic and less fearful about changing their paradigm embracing, the potential of the digitised clinician as a primary part of their everyday life. Co-inquiry embraced consumer self-management (Rozenblum et al., 2015) using an artefact as the solution to introduce human clinical management back into the consumer's lives (Lupton, 2013 & Lupton, 2016), circumventing the need for a protracted process of studying the parties and then seeking a solution. Stakeholder empowerment and "organisational citizen behaviours" (Markose & Jayachandran, 2008) had been assessed, adoption of the Artefact as the solution was not challenged, and the design for Treatme.health handed to the practice to develop (Appendix F). The Researcher feels he made more progress than only understanding the research question. It has lifted the business to a level of revolution (*Revovational Transformation)*, which Keesara (2020) suggested was the only way to address a crisis in the practice of this nature. The practice was moving from programmed to new knowledge (Marquardt, 2011) and the study has presented new research questions including but not limited to clinician and consumer WAT behaviour, parochialism around clinical notes, effectiveness of artefacts as a catalyst to reunify clinicians and patients digitally. Perceived threats were proven, and the Researcher now understands why the literature argued that realities that raise problems of this nature are socially constructed (Bryman & Bell, 2014; Creswell & Poth, 2018; Saunders et al., 2012). So, it was correct to approach the study as a social cause.

These findings clarify that diagnosis and management using unstructured and incomplete information is potentially more detrimental to health consumers (Distiller et al., 2010). It was agreed that placing the clinician back into the community using cost-effective digital solutions increases access to quality care at an affordable cost. Presenting a solution to access clinicians out of practice with AI support helps overcome the fear of being treated in a world living with COVID-19 (Pépin et al., 2020) and solves some social inequities that prevent access to care. Besides the identified causes of the problem being the stealthy rise and digital disruption of Health 4.0, paternalism, and hierarchical dominance by the clinicians, the matter of capacity to extend the clinical services beyond the clinician's diary was necessary to affect a viable solution. The introduction of an Avatar of the Clinician, linked to AI and the universe of clinical knowledge, incorporated within the individual patient's treatment plan has also presented some significant annuity revenue opportunities not previously accessible to time-based clinicians. The Researcher however argues that DT adds rigour in creating evidence in ADR (Sein et al., 2011), which allows easy transition of actionable outcomes into the business. The organisation has embraced a culture of reflection, participative thinking, and consultation using the reflexive stages of ADR (Figure 3.2) adapted from Sein et al. (2011). The Researcher now dedicates time to his management meetings using this adaptation to train the teams in freezing, consulting, and unfreezing (Schein, 2010) to facilitate the transition of current projects to actionable outcomes. An example is that a major strategy of acquiring more practices has been turned on its head. Now, the practice has chosen to deploy capital to support chronic diagnostic centres that embrace the Artefact as a platform to integrate the patients and practices. After the data collection phases, most of the ongoing active and valuable participation came from those clinicians who journeyed through the ADR, which helped them appreciate the impacts of Health 4.0 and realise the importance of relinquishing their hierarchical status, creating balance in the social order (Blandford, 2019). While this study concentrated on an outcome that the Researcher believes diluted bias, he appreciates that bias is inordinately powerful and argues that researchers must, before an HCI study, do more than establish a sample. He believes that the success of this study was largely attributable to diligent pre-work and not controlling the sampling process but allowing expansiveness that incorporated a wider variety of participants (Plattner et al., 2009), creating different participant cohort mixes to produce variability. This research was fortunate in that although it had apex opinion leaders, participants were bound to the solution and quickly saw the advantages. However, in the business areas where we bring specialists, general practitioners, pharmacists, and allied professionals together on problems, we still need to promote Interpretivist research methodologies to neutralise embedded hierarchies. The Researcher argues that the research paradigm (Rogers, 2012), if not addressing individual situational needs (Dix et al., 2004), may dilute parity and reintroduce hierarchical mannerisms resulting in voices inevitably being lost.

The Researcher was initially apprehensive about embarking on a process that introduced radical thinking into an organisation resistant to change. However, on reflection, this apprehension entrenched a robust pre-thesis process. He relied on attributes of the Interpretivist paradigm and instituted observation, probing and reflection before and during the primary data collection (Denscombe, 2010). The pre-thesis phases and being published on the subject matter helped establish the Researcher's confidence and conviction in the research question. More importantly, it raised the industry's interest when panic arose around the drastic changes prompted by COVID-19. The preparation and research for the Researcher's Journal article opened his mind to the risks of what he now coins *'Driverless Healthcare'* (Newton, 2020) which made him delve deeper into HCI studies and, more peculiarly, the different paradigms within HCI (Guba & Lincoln, 1994). As Mandel (2002) highlighted, he realised that user behaviour interacts with a system and then grows into a relationship with a tool (the Artefact). As a result, interaction with the system needs to be at parity to create equal research partners (Stephens et al., 2019). So, he had to address clinical, academic, and technical terms translated into linguistics with empathy so that both cohorts of participants could understand to interpret data without ambiguity (Argyris, 1995; Du Toit et al., 2010). It was critical to ensure that no questions would be misconstrued and that findings could extract shared knowledge (Blandford, 2019) and be analysed and compared without being overtly belaboured with misinterpretation or bias. The Researcher initially thought that the interviews would have been compromised by the online fatigue experienced through the lockdown. However, sessions averaged one hour and six minutes and produced rich and diverse data. The Researcher's empathetic probing of the user's needs (Plattner et al., 2009 & Leifer et al., 2013) was welcomed. The participants willingly shared personal experiences and thoughts and presented previously contemplated ideas, allowing human values into the Artefact (Brown & Katz, 2019). For example, using the Artefact as an educational tool for both patient and clinician came out early in the interviews and was immediately adopted as valuable functionality. Open and generous sharing diluted the need for the Researcher to initiate reiterative questioning. The action process was lively and participative. The topic was gleaned as constructive, essential, and ground-breaking and is now considered by the practice as a significant advance in social upliftment (Fairhurst & Grant, 2010).

## 6.3 PROFESSIONAL PRACTICE

Before the DBA journey, the Researcher laboured in single-loop and sometimes double-loop feedback when problems arose, not knowing the answers. He was under the misconception that being a CEO meant being in front of him and that all the ideas needed to be generated in a single-minded process emanating from the top (Murphy et al., 2009). This research has resulted in cathartic moments in his personal development as a leader and a person connected to and understanding society's needs (Tsasis, Evans & Owen, 2012). Passion and purpose were always crucial but seeing the extraction of new knowledge in live real-time (Holzinger, 2013) taught him that passion and purpose without participative execution remain only philosophies. This has resulted in the Researcher having changed his mental mode during the DBA journey (Senge & Sterman, 1992), and he has started living the triple-loop learning process (Raelin, 2009; 2011), listening more (Marquardt, 2011), speaking less.

The journey through this project has meant that consultation, reflection, and inclusiveness are not restricted to the boardroom and strategy meetings. Creating parity between commercial needs and human and environmental factors (Harrison et al., 2007) has brought CDE clinicians into mainstream business strategic thinking. Considering all business and personal life elements has made us socially more conscious, and we are now, as argued by Bevan et al. (2015), trying to find ways of integrating these human elements into our practice systems. Values, ethics, and hierarchical disempowerment have been tested (Halse et al., 2010). Priorities have been recalibrated to look for ways to encourage collaboration between the previously disparate parties. Hamzah & Wahid (2016) observed that the clinician was the centre of the business model as they serviced the patient and generated revenue for the group. By making the health consumer the centre (Rouse & Cortese, 2010) of this HCI study, we moved the clinician's paradigm to consumer-centricity, avoiding the legacy traps of hierarchy (Mantzana et al., 2007). The culture change within the organisation is now apparent (Holland, 2017), and the CEO is being invited to upskill clinicians on the virtues and challenges of PGHD and AI, which culminated in him being asked to present an HCI keynote, a business topic for the first time, at the CDE annual clinical forum in November 2021.

## 6.4 ORGANISATIONAL PRACTICE

The Researcher now considers how the DBA process impacted his organisation's practice and, more specifically, from learnings from applying the ADR process to this research problem.

### 6.4.1 Application of ADR

The Researcher settled on ADR as the methodology merging design science/DT with actionable research (Sein et al., 2011) to bring an actionable solution to an organisational problem. Convinced that this was not a 'wicked problem' (Schein, 2010) but concerned that the solution had a high novelty factor, the Researcher did a pre-mortem (Tetlock & Gardner et al., 2016) that set up the foundation for ADR. The Researcher feels that had he not taken the conservative and more belabouring pre-thesis inquiries, the findings may not have been as robust to allow a conclusive design to be presented to the practice (Figure 4.2). Further, had the ADR interviews begun without prior research, the interviews' probing process may have missed supplementary themes. ADR was powerful in focusing the participants on exposing their feelings, views, and situational needs (Dix et al., 2004); however, the confluence of HCI and DT, the Researcher believes, is what strengthens the ability to offer a valuable and actionable contribution to the practice (Henderson et al., 2013).

Further, another Researchers critique of ADR is that it presumes that the Researcher will have unfettered access to all the participants and that they are domain experts Mandel (1997; 2002). Unfortunately, this is only sometimes possible, and this study proves that we cannot assume participants to be domain experts. To mitigate this, the Researcher made sure that each data element was carefully journaled and documented, avoiding the risk of losing invaluable nuances and subthemes that were collated and added to the previous interview data following each sequential data set. If he were to do this differently in a non-COVID-19 world, he would have complimented the semi-structured individual interviews with intermittent participant focus groups. This was, however, mitigated by continuously using phrases like “other allied clinicians felt that… what are your views?” or “other participant consumers in the study felt that … what are your thoughts?”

The inclusion of disparate participants adds complexity, as Henderson et al. (2013) argued. However, the Researcher overcame this with well-informed and malleable scripts and careful use of language (Gatos et al., 2021).

The Researcher acknowledges that ADR is not perfect (Mullarkey & Hevner, 2019); however, if supported with an empathetic understanding and mitigation of the potential challenges, it is a robust methodology when using HCI and DT methods to create a collaborative design structure.

### 6.4.2 Implications for the CDE

The Researcher built confidence in the people and their ability to position themselves as critical players within the organisation (Rigg & Trehan, 2004; Trehan, 2011). He moved from CEO to the "Chief Insider Agent" (Maitlis & Sonenshein, 2010; Weick, 1988). He is driving the business towards a heterarchy (Crumley, 1995; Kim et al., 2016) with related interdependencies (Greenhalgh, 2009; Greenhalgh et al., 2015; Greenhalgh et al., 2017). Introducing the relationship-centred approach (Safran et al., 2006) supported by a state-of-the-art digital infrastructure that embraced consumers evolving digital needs (Schmidt et al., 2011, Schmidt et al., 2017) has enlightened the practice of consumer self-care. Paradigms shifted to allow self-quantified patients to feel the advantages of feeling secure by having clinicians collaborating for equal control over their health (Homa et al., 2015). There has been a cognitive change in the participant clinicians from positivism to Interpretivism (Creswell & Creswell, 2017). They are promoting the benefits of inclusivity and treating the consumer like a customer, which is finding its way into clinical Journal club meetings. Clinicians are now open to the advantages of shedding their hierarchical and paternal approach to health consumers, favouring partnering for transformation (Grogan et al., 2007) that helps get a collective view of the challenges (Stacey & Mowles, 2016; Stacey, 2011). Clinicians acknowledge that if empowered with more granular knowledge and a partnership with the deliberative consumer (Forlano, 2009; Angrist & Pischke, 2010 & Gordon et al., 2015), the ambient and self-reported data can add value to clinical outcomes.

The Researcher's role as a CEO and leader has also changed. He now understands his degree of ownership and has created a robust emotional framework (Coghlan & Shani, 2017) as he finds himself being invited to more clinical meetings to deliver the attributes of his DBA journey and its research. The dissipation of hierarchies and parochial approaches to problems in the business has naturally empowered the people (Gilmore & Kenny, 2015; Kenny & Gilmore, 2014) and made the task of implementing strategy *with*, instead of *for,* the stakeholders. Management, project managers and teams have stepped up, and delegation, devolution of authority and democratised decision-making (Raelin & Coghlan, 2006) have been warmly received. As a result, the future sustainability of the business is clearer (Wikström, 2010). The digital revolution threat has now been seen as an opportunity fuelled by a new emerging culture of *revovation*. The practice directly addresses health consumer needs of empathy, time, and attention (Meskó & Győrffy, 2019; Meskó et al., 2019), which has resulted in early signs of increasing consultations and, the Researcher is enthusiastic to see once the Artefact is launched what the compound effect will be.

### 6.5 FURTHER RESEARCH

This research specifically sought a solution to bring the health consumer back into the safety of controlled care by arresting the decline in clinical interventions. It used an ensemble of ideas to build an artefact that interprets and brings WAT-generated PGHD into the care pathway (Orlikowski & Iacono, 2001). However, due to the gaps and lack of dominant discourse associated with the topic (Stacey, 2003), the Researcher hopes this study encourages other insider practitioners to stretch the scope of the Interpretivist paradigm and introduce more pre-rigour into research by bringing relevant peripheral pre-thesis data into primary data collection processes.

Comprehensive literature identifies the rise of the self-quantified health consumer (Lupton, 2016). There is sufficient insight into the reasons for diminishing attendance to proper clinical care, including new literature on the impact of COVID-19. However, little in the literature quantifies the risk associated with these phenomena.

There is further scope to explore clinicians' readiness to adopt new consumer-driven digital technologies by reuniting them on mutually beneficial PGHD (Shapiro et al., 2012; Burns et al., 2019 & Lai et al., 2017). The literature is rich regarding care management using clinician or hospi-centric technologies, but little is related to embracing PGHD self-care.

This study's benchmark highlights the move of the positivist clinician to constructivism and an Interpretivist philosophy (Bing-You et al., 2017). Academic medical pedagogy seems to enforce a restrictive positivist focus on clinicians, which they bring into the business of clinical care that demands "clinical independence" (Davies & Harrison, 2003). The Researcher intends to investigate the impact this paradigm has on clinician-consumer relationships.

While this study proved that qualitative co-inquiry between clinicians and consumers could solve practical problems, there is room to expand the Sein et al. (2011) ADR process to lean more on empathetic probing that unpacks domain specificity to mitigate the unknowns associated with studies impacted by revovational influences of the 4th Industrial Revolution. The Researcher intends to follow this research by completing the ADR process within the practice but wants to study the Artefact's impact on the clinical metrics and outcomes compared with its 26 years of historical data derived from care with no use of PGHD. Understanding what other agile technologies are doing to care for management decisions affecting clinical outcomes is imperative.

The disruptive introduction of AI into day-to-day clinical practice has only recently emerged in the literature (Tran et al., 2019). As a result, there needs to be more when trying to understand the impact on care pathways and the role of primary and chronic care clinicians in this new digitised world of medicine. Additionally, harmonising clinicians’ clinical notes with patient data requires deeper investigation.

The Researcher found the actionable outcomes of ADR using HCI and DT powerful, not just for the research, but as an excellent bridge between the study and the consequent adoption of the development and build of the Artefact in practice. Again, he advocates for rigorous post-mortem studies to ensure the scope remains focused on an actionable outcome. The risk, otherwise, is that the survey may require reiterative cycles in practice to retest vague notions and theories.

## 6.6 FINAL REFLECTIONS

The Researcher developed and matured significantly as a scholar-practitioner, manager, and leader and has changed as a person (Badaracco, 1998). He uses introspection as a lifestyle attribute and a phrase to describe himself as he "used to think he knows, but now he knows he thinks." He has instituted a practice programme, "thinking about thinking" (Checkland & Holwell, 2007) so that participative actions and research have become part of his and the organisational DNA.

A watershed moment was when the Researcher realised that while he was researching his clinician paternalism and hierarchies' he reflected and realised that he was suffering from the same effect. He learned that he leverages his business leadership and inadvertently absconds from the personal responsibility of forming inclusive structures that incorporate the people he is dealing with. So, he built on this experience, subsequently personally interviewed patients, and resultantly built confidence in engaging them as stakeholders in creating solutions for them as consumers.

This thesis has remodelled the organisation to embrace the age of digital care and found a way to introduce PGHD to help reunify patients and clinicians. However, it concedes that PGHD cannot be seen in isolation from other critical data points and so Treatme.health will be set up to look at all facets of health consumer and clinician data to strengthen the platforms options for usability in doing so, positions the business the clinician as an active partnership and a delicate part of the health consumer's everyday life. Technology that leverages higher intelligence applied to exponential growth in the functionality of WATs that include but are not limited to electronic skin/mechano-sensation electronics and multi-stimulus sensory detection aligned with rapid innovations in energy harvesting to create seamless diagnostics (Shi et al., 2020) will change the face of healthcare as we know it. The Researcher argues that the impact of highly-intelligent wearables will have on self-monitoring, diagnosis, the automatic delivery of drug molecules into the system, and the control of nanobots dealing with disease mitigation and treatment open this field of study to not just the reunification of clinicians and patients but, how if at all, does the clinician fit into this new era of healthcare provision.

*Grant, your biophysical information says you are having a heart attack - Alexa.*

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# Appendix A: Ethics approval

**Ethics Award Letter**

Dear Grant Newton,

I am pleased to inform you that the DBA Ethics Committee has approved your application for ethical approval for your study. Details and conditions of the approval can be found below:

Committee Name: DBA Ethics Committee

Title of Study: Re-uniting consumers of healthcare services with GP's: Implementation of a digital human computer interface, AI tool.

Student Investigator: Grant Newton
School/Institute: School of Management Approval
Date: 16th April 2020

The application was APPROVED subject to the following conditions:

1. The researchers must obtain ethical approval from a local research ethics committee if this is an international study
2. University of Liverpool approval is subject to compliance with all relevant national legislative requirements if this this is an international study.
3. All serious adverse events must be reported to the Sub-Committee within 24 hours of their occurrence, via the Research Integrity and Governance Officer (ethics@liv.ac.uk)
4. If it is proposed to make an amendment to the research, you should notify the Committee of the amendment.

This approval applies to the duration of the research. If it is proposed to extend the duration of the study as specified in the application form, the Committee should be notified.

Kind regards,

Jim Hanly
DBA Ethics Committee University of Liverpool online Programmes

# Appendix B : Questionnaire

## Phase 2 Emails and Questions

**Email Template**

Subject Line: You Have Been Selected to Further Health Technology based Research

Dear Respondent

Thank you for taking the time to complete my previous survey on digital health. Your indication that you would be willing to participate in further research in this regard is most appreciated.

I am pleased to inform you that you have been selected as one of the respondents for the next phase of my research which involves a **30-minute** virtual interview that I will personally conduct.

This interview will not only provide vital feedback that will further research on the whole, but will allow me to create a solution that will reunite providers and patients in a world disrupted by health technologies. If you participate in this interview discussion you:

1. agree that the anonymised data from this session can be used as part of ongoing research.
2. agree that the anonymised data may be used in articles in scientific or industry journals or publications.
3. don't have any ethical concerns that should be addressed before we continue.
4. you are a willing participant for this session and, are you willing to participate in a short follow up question session should it be deemed necessary.

All information will be treated in the strictest confidence and results will be reported anonymously.

As you will be exposed to confidential information, you are kindly requested to sign the non-disclosure agreement and send the signed copy with confirmation that you are willing to participate in the virtual interviews.

Please look at the schedule of interviews and pick an available time and date. Please respond with confirmation of your participation and confirm that you completely agree to the use of your responses within the interview for research, user-interface and user-experience development purposes.

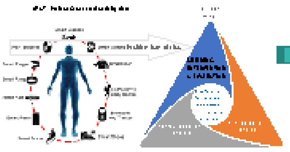
Your cooperation is highly appreciated.

Kind regards,

I REALLY LOOK FORWARD TO OUR SESSION AND AGAIN SINCERELY THANK YOU FOR YOUR PARTICIPATION THUS FAR.

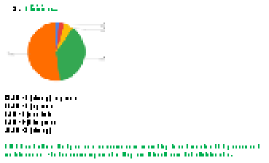
# THIRD PHASE RESEARCH - INFORMATION SHEET
## HEALTH CONSUMERS

(GRANT NEWTON - UNIVERSITY OF LIVERPOOL (UK))



I am conducting research to find out how Personal Health Generated Data (PHGD) from a/your wearable activity tracker (WAT) can be used to improve the interaction between you and your clinician and, manage your health and wellness **both** inside the warm body practice and, remotely through digital interactions that are overseen by your clinician.

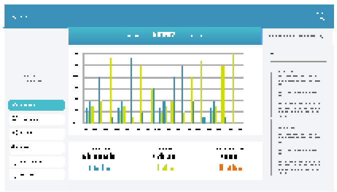
**This is the third phase data collection. Graphs on the left will reference a fraction of the data collected in the first phase of the study in which you kindly participated.**

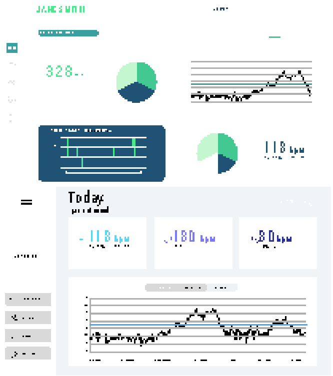


## Summary

This research highlights the phenomenon of patient-generated digital health data (PGHD) from wearable tracker devices (WAT's) fueling the rise of digital self-quantified care. The rise of Artificial Intelligence (AI) and the highly sophisticated rise of digital personal wearable health technologies can be seen as a risk and, an opportunity to healthcare management. A concern for e.g. may be that it disconnects clinician first-line support, potentially placing patient's health at risk. It exposes the problem that clinicians could be disintermediated by consumers exponential adoption of ambient intelligent WAT's. The character of the 'iPatient' is emerging who, through day to day interaction with smart devices, is being drawn into the world of 'driverless', AI-driven healthcare. However, the opportunity and related research hypothesis, is that the axiomatic prevalence of PGHD from Ambient Health Intelligent (AmHI) WAT's can be leveraged by your clinicians. For them to do this, they must digitally position their expertise as a critical and value-added component to the self and, artificial assessment of vital signs and physical data that is freely available. Conceptually, this study presents new thinking that looks at clinicians and their consumers joining forces, to convert AmHI-PHGD to their mutual benefit. The intention is work with clinicians and health consumers to determine ways in which clinicians can harness the power of WAT's, PGHD and AI and, integrate clinician reviewed PGHD to develop more robust consumer-centric models.

*Keywords:* iPatients, iDoctors, Patient-Generated Health Data, Wearable Activity Trackers, Human-Computer Interaction.



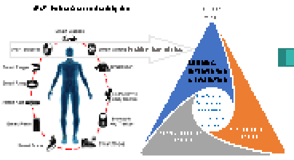


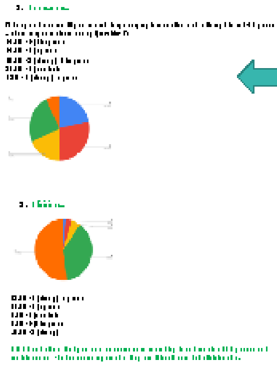
GRANTN@CDEDIABETESCO.ZA

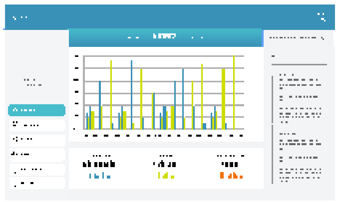
# THIRD PHASE RESEARCH - INFORMATION SHEET
## CLINICIANS

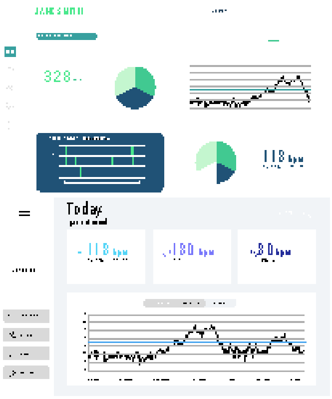
(GRANT NEWTON – UNIVERSITY OF LIVERPOOL (UK))

I REALLY LOOK FORWARD TO OUR SESSION AND AGAIN SINCERELY THANK YOU FOR YOUR PARTICIPATION THUS FAR.









GRANTN@CDEDIABETESCO.ZA

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**Summary**

This research highlights the phenomenon of patient-generated digital health data (PGHD) from wearable tracker devices (WATs) fueling the rise of digital self-quantified care. The rise of Artificial Intelligence (AI) and the highly sophisticated rise of digital personal wearable health technologies can be seen as a risk and, an opportunity to healthcare management. A concern for e.g. may be that it disconnects clinician first-line support, potentially placing patient's health at risk. It exposes the problem that clinicians could be disintermediated by consumers exponential adoption of ambient intelligent WAT's The character of the 'iPatient' is emerging who, through day to day interaction with smart devices, is being drawn into the world of 'driverless', AI-driven healthcare. However, the opportunity and related research hypothesis, is that the axiomatic prevalence of PGHD from Ambient Health Intelligent (AmHI) WAT's can be leveraged by your clinicians For them to do this, they must digitally position their expertise as a critical and value-added component to the self and, artificial assessment of vital signs and physical data that is freely available. Conceptually, this study presents new thinking that looks at clinicians and their consumers joining forces, to convert AmHI-PHGD to their mutual benefit. The intention is work with clinicians and health consumers to determine ways in which clinicians can harness the power of WAT's, PGHD and AI and, integrate clinician reviewed PGHD to develop more robust consumer-centric models

*Keywords:* iPatients, iDoctors, Patient-Generated Health Data, Wearable Activity Trackers, Human-Computer Interaction.

## Semi-Structured Questions - Provider

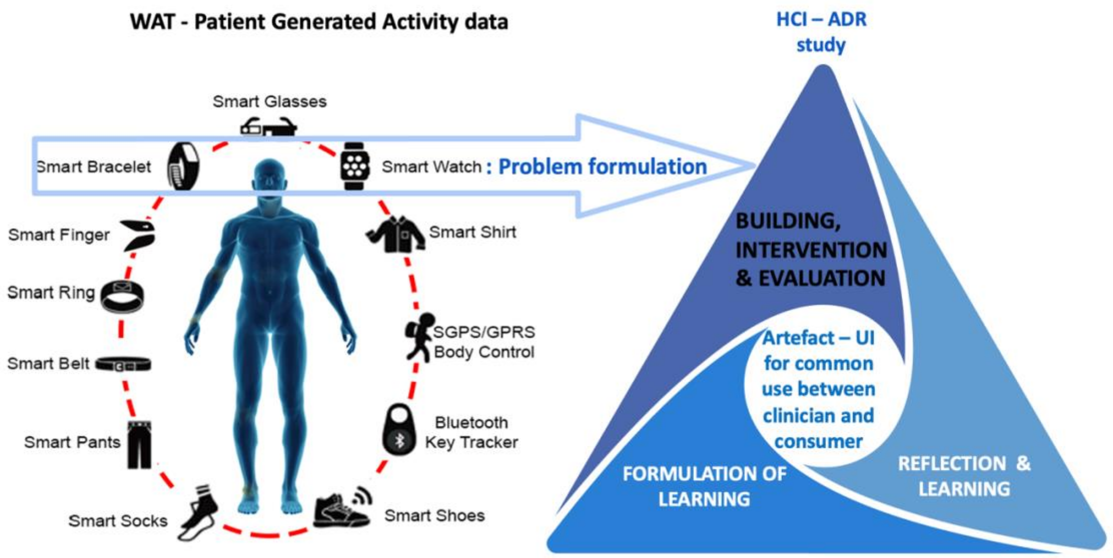
### Introduction

Thank you for meeting with me, I really appreciate your input. As was explained in the initial email, my name is Grant, and I am conducting research to find out how Personal Health Generated Data (PHGD) from your wearable activity tracker (WAT) can help you to improve the interaction with your health consumer and manage their health both inside the warm body practice and remotely through digital interactions.

Just to clarify a few terms when I use them:

When I say **clinician or health care provider,** I mean any caregiver that manages any aspect of health including but not limited to specialist physicians, family doctors, nurses, physiotherapists, podiatrists, pharmacists, dieticians, biokineticists, natural healers and opticians.

***SHOW FIGURE 1***



When I say **wearable activity tracker WAT**, I mean any wearable device that measures aspects of your physical activity or health such as steps, heart rate, sleep, calories etc. I'm not referring to any brand or model in particular. This particular research is looking primarily at those devices worn most often and which is familiar to most people using such devices.

When I say **chronic condition**, I mean a condition that is persistent and lasts longer than 3 months and is often life-long, such as asthma, diabetes, and high blood pressure.

When I say **acute condition**, I mean a condition or illness that starts suddenly and only lasts a short period of time such as a cold or a stomach bug.

## Semi-Structured Questions - Provider

When I say **data** or any derivative thereof, I specifically mean patient generated health data (PGHD). This is primarily collected through ambient intelligent devices and more specifically, WAT devices and those ubiquitous devices that have seen an exponential rise at health consumer level.

When I say iDoctor, I refer to the literature definition – "a machine theoretically capable of replacing the judgement of the clinicians" (Karches, 2018)

When I refer to **Human Computer Interaction** (HCI) I am speaking to the process of studying the interaction between human and computer and in this instance of research using an Action Research Design process that incorporates both Clinicians and Health Consumer views.

As we proceed through the interview, please don't hesitate to ask if you'd like further explanation on any terms that I use or for me to explain a question more fully.

Some questions may sound repetitive but they are gleaned as confirmatory.

Are you clear on the way forward?

Do you have any questions before we start?

### 1) USER BEHAVIOURAL CHARACTERISTICS

1. Considering the increase in patient self-diagnosis using technology - do you think that there is an emerging patient-provider-disconnect and/or health care/consultation value perception problem amongst consumers of healthcare?

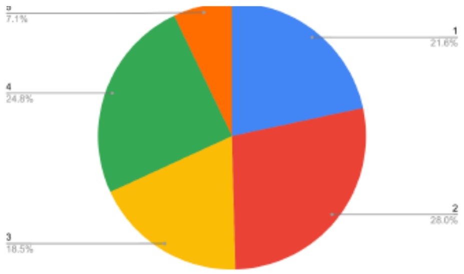
   **Probe:** If so, what do you think this disconnect is and what this is caused by?

   **Show responses from survey Question 2**

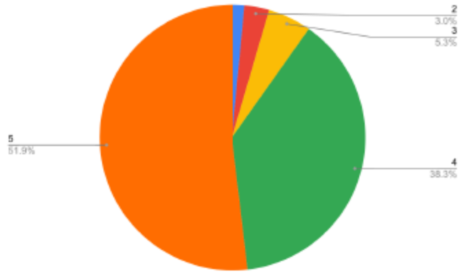
   **Interestingly, these were the responses from the larger survey that showed a difference of opinion between clinicians and health consumers:**

   **1. Consumers**

   When you become ill, you search for your symptoms online and attempt to self-diagnose
   28.0% - 2 (disagree)
   24.8% - 4 (agree)
   21.6% - 1 (strongly disagree)
   18.5% - 3 (neutral)
   7.1% - 5 (strongly agree)



### 1. Clinicians



51.9% - 5 (strongly agree)
38.3% - 4 (agree)
5.3% - 3 (neutral)
3.0% - 2 (disagree)
<1.5% - 1 (strongly

**Clinicians believe that consumers are searching for elements of diagnoses and maintenance - but consumers perceive they use it less than what clinicians do.**

What is your experience of your health consumers interacting with the web for diagnosis or disease information and maintenance?

What do you think is stopping patients, if anything, from attempting to self-diagnose and self-treat their ailments using WAT's and/or the Internet?

What do you think patients are actually using the Internet/Dr Google and their WAT's to try and diagnose and manage on a day-to-day basis?

**Probe:** Do you believe a patient's habits of attempting to self-diagnose using their WAT's and PGHD, is impacted by his or her level of health e.g. chronic etc.?

Focusing on WAT and health apps specifically, besides the app that is directly associated with your WAT – which other WAT associated app's do you use that either link to your device or you use in symbiosis with your WAT?

Which of these do you find could be clinically supportive?

6. Which App's have you seen, or used or heard of that may further assist in diagnosis and/or disease plan maintenance?

7. Which of these do you think could be useful in clinical practice?

Probe: What health WAT App's do you NOT use and why?

Probe: Which specific app do you use, daily, weekly and or periodically and why?

Probe: Do you make use of your WAT App more or less than other associated Apps?

Probe: What specifically do you use your WAT App for (if anything)?

Probe: What influenced your choice of device?

Probe: What WAT Apps do you use for particular functions? (e.g.: for sleep or vital signs or activity)

Probe: Have you tried multiple apps for each function?

Probe: Are there App's that you use to manage and monitor your health that are not associated with your WAT? If so, what are they?

Probe: (if yes) What have you found more user-friendly or functionally better than what is provided for on your WAT App?

8. In focusing on the WAT specifically, which features on your wearable fitness WAT do you use the most and why?
Probe: Given your experience in using your WAT device, what features would you like to see your health consumers use more often?

Probe: What would prompt you to use the same features more often?

Probe: What would make you promote the use of these apps to your health consumers?

9. What are some of the things that irritate you about your WAT device?

Probe: What would you prefer WAT devices NOT to do?

10. Describe your current WAT routine?
Probe: How often per day do you check your tracker?

Probe: At what time of the day do usually check it?

Probe: When else or what else prompts you to look at the information from your WAT?

Probe: Do you check information at the end of day/end of week in completing goals?

## 1) INFORMATION SYSTEM CHARACTERISTICS

1. As a clinician, what other information do you wish your WAT detected? What do wish the health App reflected?

2. What visual format do you personally prefer your personal health data to display in?

   **Probe:** In which other visual formats would you want the information conveyed, firstly as a consumer yourself and secondly as a clinician working with PGHD from your health consumers WAT's?

   **SHOW MOCK UP's**

   **DIRECT USER TO THE PROVIDED DISPLAY OPTIONS (3)-**

3. Of these examples, which of these visual displays do you prefer and find more user-friendly? A – B – or C.

   **Probe:** How do you prefer to have health data displayed? For example, are you more comfortable with graphs, iconology, 3D illustration of the body, or statistical percentages?

   **Probe:** if they say graphs for example, why graphs? What is it about the way in which the information is displayed that you like?

   **Probe:** Do you find this interface easy to use?

   **Probe:** Do you understand the icons and language?

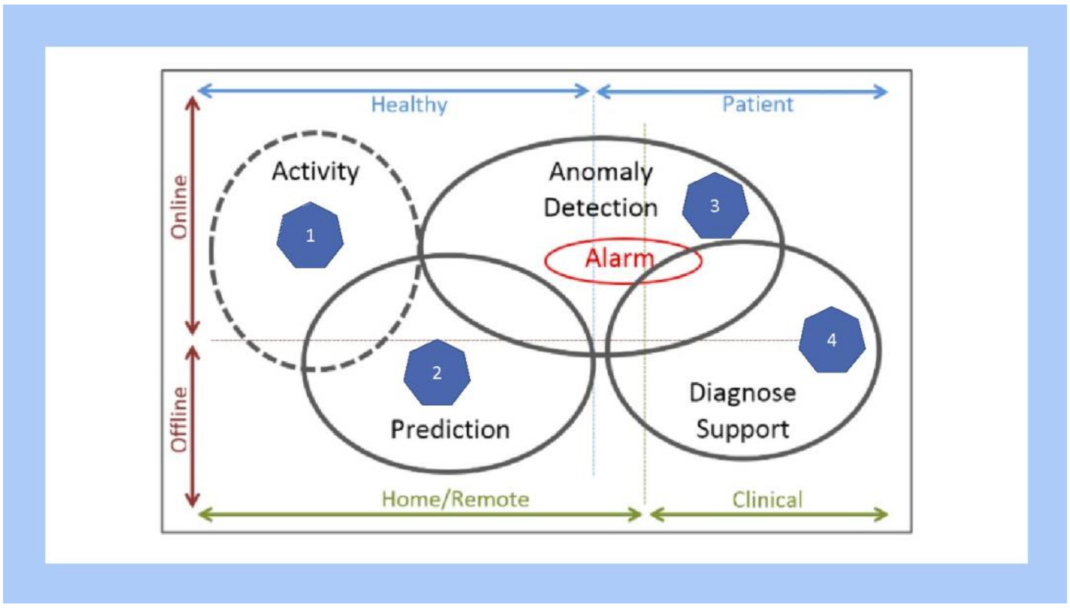
   **Probe:** Are any parts of the interface particularly useful or helpful?

   **Probe:** Is there a different way of displaying the data that has not been covered in these examples that you would prefer?

   Let's now assume that we could display the data in an easy and acceptable way, that all clinical areas can in some way be addressed by Ambient Artificial Intelligence from WAT's, and that the data is accurate and dependable.

   **As it pertains to the continuous wellness interaction with your health consumer as depicted in broken circle 1 & oval marked 2 and the area in oval 3 depicted left of the broken green line:**

**SHOW DIAGRAM:**



Schematic overview of the four main data mining processes (activity, prediction, anomaly detection and diagnose/decision support) in relation to different aspects of wearable sensing in wearable health devices. Filled line- Medical purposes; Traced line: Activity purposes. Adapted from Banaee H., Ahmed M.U., Loutfi A. Data mining for wearable sensors in health monitoring systems: A review of recent trends and challenges. Sensors. 2013;13:17472–17500. doi: 10.3390/s131217472.[PMC free article] [PubMed] [CrossRef] [Google Scholar]
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1. What data do you think the health consumer should be measuring continuously?

2. What wellness data aggregated over a period would you like to receive as part of the health consumers briefing to you in a consultation?
   An example of this may be:
   - Levels of activity (steps or time in exercise – heart rate during exercise and related recovery rates) as well as heart/pulse rates or periods of being sedentary over a period
   - Time in deep sleep, time in REM and time in light sleep – sleep interruptions
   - Calorie counts
   - Daily pulse or beats per minute – resting heart rate, recovery rates out of excursion or exercise.

   **Probe: What other data points around daily wellness and lifestyle from these points would be valuable to you as a clinician that can be presented in an aggregate view covering a past week or two period – in anticipation of a clinician/patient interaction?**

   ---

Now we look at **circles 3 & 4** which pertain to data support during and directly related to your treatment plan of your health consumers. Here we are looking at ways that WAT and Patient Health generated data to support **adherence and compliance of a treatment plan that you may already have formulated for the consumer.**

It is important to appreciate that the newest WAT devices are able to measure BP and most vital signs. In addition, new devices are being launched that will allow for FDA approved 12 lead ECG's. With this in mind:

6. What anomaly from the health consumers/patient data would be useful to you to help manage the patient to stay adherent, compliant and more specifically to manage anomalies both in and out of practice.

7. What alarms, if potentially detected by AI or data analytics would you be interested to know about a) in consultation and b) out of consultation?

8. What is your view of and, would you utilise a diagnosis supported by AI/machines (under your control) for health consumers that are engaged with WATs that are able to deliver PGHD to you digitally?

9. Assuming you found the AI interventions that are overseen by clinicians credible, what diagnosis support do you think may be beneficial to your overall health consumer management as a clinician?

10. What is your view on your expertise, digitally aligning with AI assistance as opposed to the health consumer reverting to AI (the iDoctor like Google, Amazon and IBM) directly?

11. What is you view of the future of the relationship between the consumer and the likes of Google AI and, what is the impact going to be on your treatment plans for your consumers?

12. Would you find it useful if an interface was able to capture your health consumers clinical care plan and report to you and your health consumer when they are out of treatment plan that was measured by the ambient intelligence of the WAT?

Probe: What vital alerts would assist in your management of the patient?

Probe: How do you see these plugging into the consultation process?

Probe: Looking at efficiencies and importantly taking the necessity for compensation aside for a moment, what value would these data points add in helping you to manage your patient out of the confines of the bricks and mortar of your practice?

13. What do you think about a platform includes push notifications that prompts the health care consumer to manage compliance and adherence to your treatment plan using the WAT device?

Probe: Would you want to be alerted if there was a compliance and adherence failure?

Probe: What other notifications outside of normal clinical metrics do you think should be relevant e.g. pulse rates during activity/exercise?

Probe: Assuming that there was fair remuneration to you and there was absolute system integrity, would you be comfortable that a machine governed in some way by you, was interacting with your patient rather than another commercial App or Big Data entity?

14. What are your thoughts on the iDoctors targeted to your health consumers by the likes of Google, Amazon, IBM and Facebook?

Probe: Would you be prepared to work with these technology giants or would you prefer to govern your own relationship with your health consumer assuming there was a system available to do so?

Probe: If the interface was able to capture your clinical care plan and report to you and your health consumer out of treatment plan alerts would this assist in your management of the patient? (see above)

15. Do you have concerns about protecting personal information when interacting with an application?

Probe: What is your view on security features that need to be built into a platform that bring WAT PGHD into your relationship with the patient?

Probe: Which security features would you want to be built into the app to make you feel more comfortable in using the platform to interact with the consumer/patient ?

Probe: How do you feel about elements such as integrity, POPI and secure data warehousing?

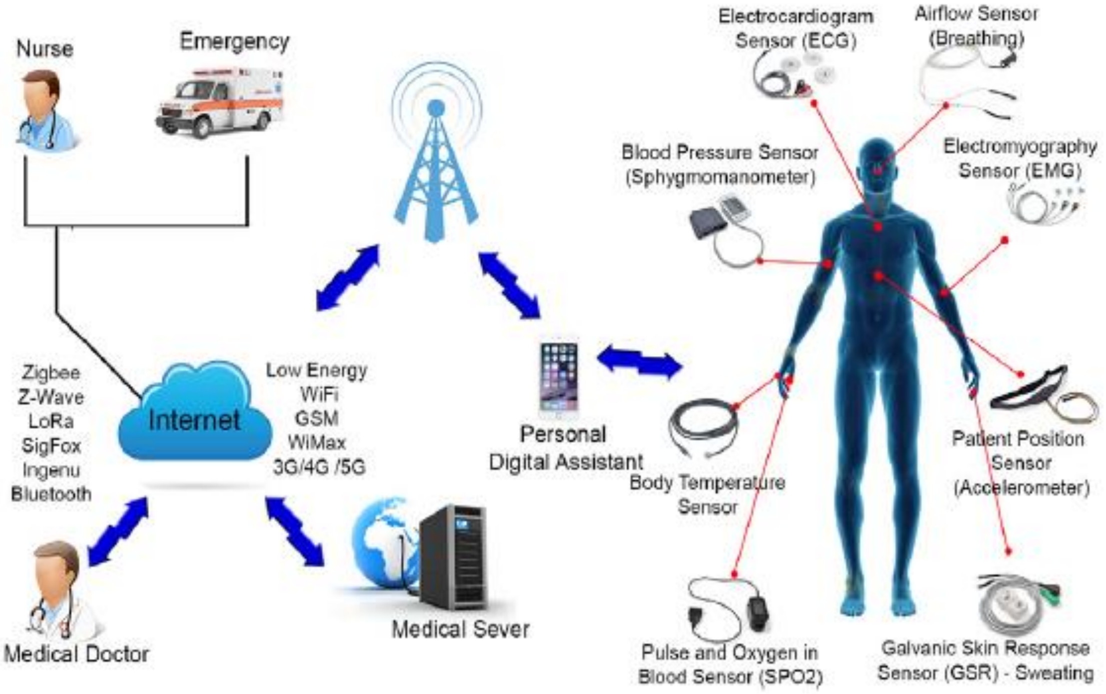
16. Do you think that you as a clinician should have 24/7 access to your health consumers important clinical/vital signs data from a WAT or, only during a consultation?

Probe: Most apps have a feature which dictates when the app can pull information i.e. perpetually in the background or on request, which would you prefer?

17. Would you want the information from the platform to be readily available across all WAT devices?

Probe: Would you want the dashboard to be website and mobile compatible?

## 1) CONTEXT OF USE AND ENVIRONMENT CHARACTERISTICS



1. What are your thoughts on the benefit/value of new non-WAT diagnostic versus AI-WAT technology?

   **Probe:** Which elements of new wearable diagnostic technology would be beneficial to diagnosis?

2. Have you encountered other platforms that display information using patient generated data from WAT devices?

   **Probe:** Which platforms?

   **Probe:** What did you enjoy about the interface of those platforms?

   **Probe:** What are some of the interface features that irritated you?

## 2) DEVELOPMENT PROCESS CHARACTERISTICS

1. Do you think it is important to personalise the use of the platform to each individual user?

   **Probe:** What type of personalisation would be important to you?

2. Can you give me an idea of what type of information you would want to be displayed in relation to each other on your fitness tracker?

Probe: What features would you want to “overlap” – sleep cycle and pulse rates as an example?

Probe: How would you like it displayed?

4. (if either) What level do you want this data, for example, in analysing sleep patterns?

Probe: What period would you like the sleep assessment data to cover?

Probe: Would you want aggregated or daily compared data?

Probe: Would you want to see how many times a night the patient woke up?

Probe: Would you like to see how long the patient was awake on average due to interrupted sleep?

Probe: Would you like to see how many hours on average the patient sleeps per night?

Probe: Would you like to see how many of these hours are in deep sleep, rem and light sleep respectively?

4) IMPACT OR OUTCOME OF COMPUTERISATION

1. Have any of your patients presented insights from their WAT to you during a consultation?

Probe: How did you feel when these insights were presented?

Probe: Did you try to integrate these insights into your consultation?

2. (If no) Why do you think patients have not yet presented insights from their WAT’s to you during a consultation?

3. In what ways would the platform add the most value to a consultation?
(How do you see it adding value for example: time saving, confidence diagnosis and post consultation measurement and service?)

4. Do you have confidence in your own ability to interpret information from a patient’s data as provided by a fitness tracker/smartwatch?

Probe: Why do you feel this way?

Probe: What support would you like in having the confidence to include this data in consultations?

KARCHES, K. 2018. Against the iDoctor: why artificial intelligence should not replace physician judgment. Theoretical Medicine and Bioethics, 39.

# Health Consumer Phase Questions

**Semi-Structured Questions – Health Consumer**

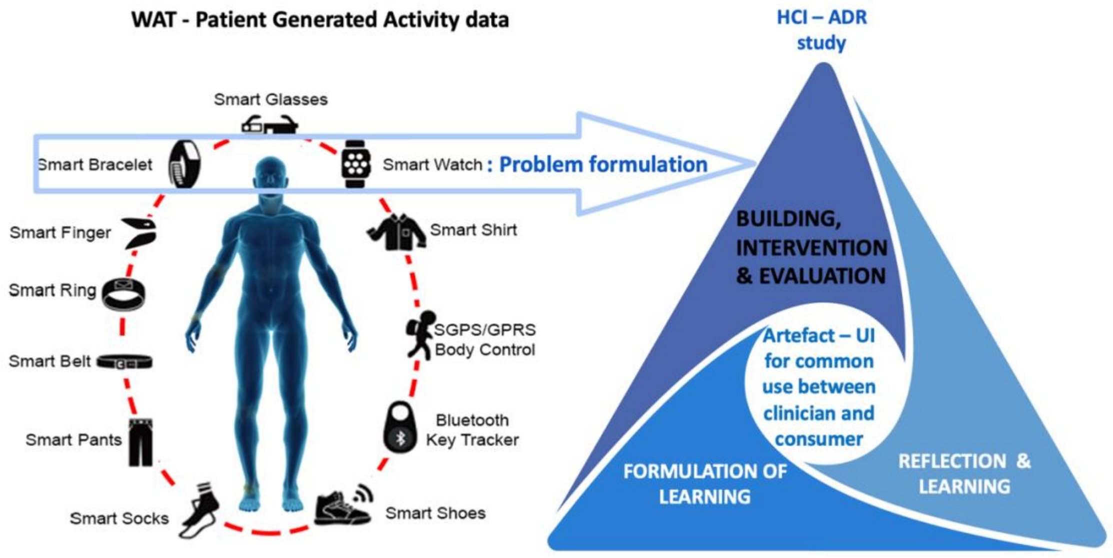
**Introduction**

I am conducting research to find out how Personal Health Generated Data (PHGD) from a/your wearable activity tracker (WAT) can be used to improve the interaction between you and your clinician and, manage your health and wellness both inside the warm body practice and remotely through digital interactions that are overseen by your clinician.

Just to clarify a few terms when I use them:

When I say **clinician or health care provider,** I mean any caregiver or professional that manages any aspect of your health including but not limited to specialist physicians, family doctors, nurses, physiotherapists, podiatrists, pharmacists, dieticians, biokineticists, natural healers and opticians.

***SHOW FIGURE 1***



When I say **wearable activity fitness tracker (WAT)/smartwatch**, I mean any wearable device that measures aspects of your physical activity or health such as steps, heart rate, sleep, calories etc. I am not referring to any brand or model in particular.

When I say **chronic condition**, I mean a condition that is persistent and lasts longer than 3 months and is often life-long, such as asthma, diabetes, and high blood pressure.

When I say **acute condition**, I mean a condition or illness that starts suddenly and only lasts a short period of time such as a cold or a stomach bug.

When I say **data** or any derivative thereof, I specifically mean patient generated health data or PGHD. This is primarily collected through ambient Intelligent devices, more specifically WAT devices as well as those ubiquitous devices that have seen an exponential rise at health consumer level.

When I say iDoctor, I refer to the literature definition – "a machine theoretically capable of replacing the judgement of the clinicians" (Karches, 2018)

When I refer to **Human Computer Interaction** or HCI, I am speaking to the process of studying the interaction between human and computer and in this instance of research, using an Action Research Design process that incorporates both Clinicians and Health Consumer views.

As we proceed through the interview, please don't hesitate to ask if you'd like further explanation on any terms that I use or for me to explain a question more fully.

Some questions may sound repetitive, but they are used for confirmation.

Are you clear on the way forward?

Do you have any questions before we start?

## 1) USER BEHAVIOURAL CHARACTERISTICS

1. Literature shows that there has been an exponential growth in patient self-diagnosis using technology.,
    - Do you think that the expansion of the web and wearable technologies has encouraged patients to turn to the web and artificial intelligence more often?
    - Do you think this has affected or added to the a clinician-patient/health consumer growing disconnect?

    What value do you get from a clinical consultation that you can't get from the web associated with the smart tech?

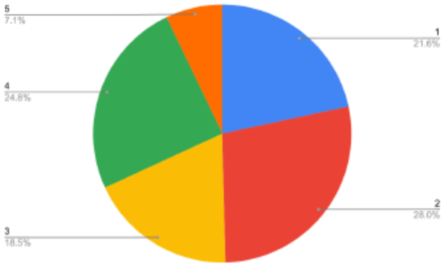
**Show responses from survey Question 2**

**Interestingly, these were the responses from the larger survey that showed a difference of opinion between clinicians and health consumers:**

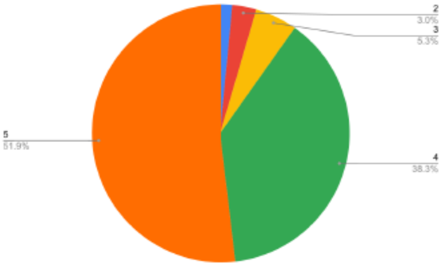
### 1. Consumers

When you become ill, you search for your symptoms online and attempt to self-diagnose – show responses from survey *Question 2:*

28.0% - 2 (disagree)
24.8% - 4 (agree)
21.6% - 1 (strongly disagree)
18.5% - 3 (neutral)
7.1% - 5 (strongly agree)



## 1. Clinicians



51.9% - 5 (strongly agree)
38.3% - 4 (agree)
5.3% - 3 (neutral)
3.0% - 2 (disagree)
<1.5% - 1 (strongly

Clinicians believe that you as a consumer are searching for elements of diagnoses and maintenance - but consumers perceive they use it less than what clinicians do.

1. What is your experience when interacting with the web for diagnosis or information on diseases?

2. What do you think is stopping consumers, if anything, from attempting to self-diagnose and self-treat their ailments using WAT's and/or the Internet?

3. What do you use the Internet/Dr Google and their WAT's for?

4. Do you try and diagnose and manage your health on a day-to-day basis when not interacting with a clinician?

   **Probe:** Do your habits of attempting to self-diagnose using WAT, WEB or PGHD, is impacted by your level of health e.g. chronic etc.?

5. Do you wear your WAT as often as possible if so why and if not why not?

   **Probe:** what would make you more comfortable in wearing the device?

6. Which tracker/smartwatch app do you use in conjunction with your WAT?

7. Do you use other Apps that either link to your device or that you use in combination with your WAT?

8. Which WAT do you own (e.g. Samsung Health/FitBit) and are you happy with its performance?

9. Which WAT would you like to own and why?

1. In your experience, which tracker/smartwatch App would you think would be more effective for diagnosis and/or disease plan maintenance if it had the oversight of your clinician?

2. Would any of these be useful in clinical consultations?

   **Probe:** What health WAT App's do you NOT use and why?

   **Probe:** Narrowing it down, which specific App for which vital measurement do you use, daily, weekly and or periodically and why?

   **Probe:** (If not bespoke WAT App) what have you found more user-friendly or functionally better than what is provided for on your WAT App?

   **Probe:** Did price, looks/aesthetic design or, functionality of the WAT device influence your choice of device?

   **Probe:** Which WAT Apps do you use for these functions a)sleep, b)vital signs c)activity?

   **Probe:** Have you tried multiple apps for each function?

3. Which features on your WAT do you use the **most** and why?

   **Probe:** Given your experience in using your WAT device, what features would you like to see as added functionality to your WAT?

   **Probe:** Would value added by your clinicians to the data you derive from your WAT and associated App's prompt you to use the features more often?

4. What are some of the things that irritate you about your specific WAT device?

   **Probe:** What would you prefer WAT devices NOT to do?

5. Do you feel that the information from your WAT is accurate?

   (If not) What measurements concern you?

   **Probe:** Do you think your WAT and associated App provides you with sufficient information to help you interpret your health?

6. (If not) What should be added?

7. What do you think about a clinician and consumer-friendly platform that you and your clinician can use to assist in completing goals interpretation of your vital health data over

   **Probe:** Would it be useful if a platform existed that brought you, your clinician and all of your personal daily/weekly PGHD data together?

## 1) INFORMATION SYSTEM CHARACTERISTICS

1. What other Ambient personal information like brain activity, sugar levels or skin quality as examples do you wish your WAT detected?

**Probe:** Which elements from your WAT APP do you find confusing or difficult to interpret?

2. What visual format do you personally prefer your personal health data to display in?

**SHOW MOCK UP's**

**DIRECT USER TO THE PROVIDED DISPLAY OPTIONS (3)**-

3. Of these examples, which of these visual displays do you prefer and find more user-friendly? (A – B – or C)

**Probe:** if you had a choice - How do you prefer to have health data displayed, for example, are you more comfortable with graphs, iconology, 3D Avatar illustrations of your body, or statistical percentages?

**TAKE USER THROUGH EACH OPTION**

**Probe:** Do you find this interface easy to use?

**Probe:** Do you understand the icons and language?

**Probe:** Are any parts of the interface particularly useful or helpful?

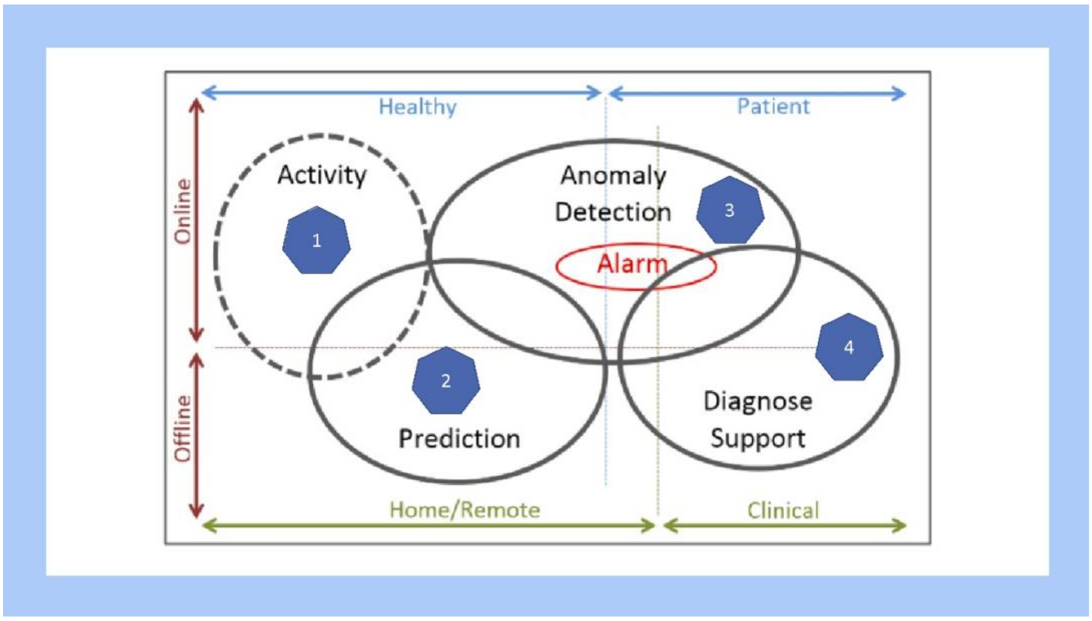
**Probe:** Which of these 3 options displayed do you prefer and why?

**Let's now assume that we could display the data in an easy and acceptable way, that all clinical areas can in some way be addressed by Ambient Artificial Intelligence from WAT's and that the data is accurate and dependable (for the purposes of the following questions).**

**[please concentrate on the circles/ovals within the diagram]**

**As it pertains to the continuous wellness interaction with your health provider as depicted in the broken line circle marked 1, oval marked 2 and the area in oval marked 3 that displays left of the vertical dotted green line:**

**SHOW DIAGRAM :**



Schematic overview of the four main data mining processes (activity, prediction, anomaly detection and diagnose/decision support) in relation to different aspects of wearable sensing in wearable health devices. Filled line- Medical purposes; Traced line: Activity purposes. Adapted from Banaee H., Ahmed M.U., Loutfi A. Data mining for wearable sensors in health monitoring systems: A review of recent trends and challenges. Sensors. 2013;13:17472–17500. doi: 10.3390/s131217472. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
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1. What would your view be if there were an AI chatbot platform built by consumers and clinicians that was partnering your clinician that made regular use of your data from your WAT device?

**Probe:** What data do you think you should be measuring continuously?

2. What wellness data aggregated and explained from a clinical point of view - over a period - would you like to receive as part of empowering you as a health consumer when briefing or updating your clinician in a consultation?

An example of this may be:

- Levels of activity (steps or time in exercise – heart rate during exercise and related recovery rates) as well as heart/pulse rates or periods of being sedentary over a period
- Time in deep sleep, time in REM and time in light sleep
- Calorie counts
- Daily pulse or beats per minute – resting heart rate, recovery rates out of exertion or exercise.

**Probe:** What other data points around daily wellness and lifestyle from these points would be valuable to you?

**Now if we look at ovals 3 & 4 which pertain to data support during and directly related to your treatment plan created by your clinician.** Here we are looking at ways that WAT and Patient Generated Health Data support adherence and compliance to treatment plans.

It is important to keep in mind that the newest WAT devices are able to measure blood pressure and most vital signs. In addition, new devices are being launched that will allow for FDA approved 12- lead ECG's (electrocardiogram – heart monitor usually used to measure the electrical activity of the heart. With this in mind:

1. What alarm measuring anomaly's from your patient data would be useful to you to help manage your illness These may or may not include sleep deficit alarms, raised pulse levels at rest and during activity, excessive calorie counts etc.?

2. How would you feel if your clinician started to use AI in conjunction with your WAT to help manage your care.?

3. Assuming you found the clinically overseen AI interventions credible, what out of consultation support do you think may be beneficial?

Ensure that the respondent has a clear understanding of what out of practise support entails.

4. What are your thoughts of an interface that is able to capture your clinical care plan and report to you and your clinician when you are struggling with your treatment plan?

**Probe:** What alerts would assist in management of your condition?

**Probe:** How do you think could alerts can plug into clinical visits or consultation processes?

**Probe:** Would you be encouraged or happy that your clinician was more involved in your out-of-consultation care?

**Probe:** What do you think about push notifications that prompts the respondent to, manage compliance and adherence to take their medication, sleep, activity or exercise prescribed by your clinician?

**Probe:** What other features would you want notifications for? (e.g. take your medication, drink water)

5. What is your view of "congratulations features" (or incentive) in terms of goal completion (points, badges) that is linked to the tracking of your habits?

6. What are your thoughts on the iDoctors launched by the likes of Google, Amazon, IBM and Facebook?

**Probe:** Would you be prepared to work with technology giants or would you prefer to govern your own relationship with your clinician (assuming there was a system available to do so)or, both?

1. Do you have concerns about protecting personal information when interacting with an application?

**Probe:** How do you feel about elements such as integrity, POPI and secure data warehousing?

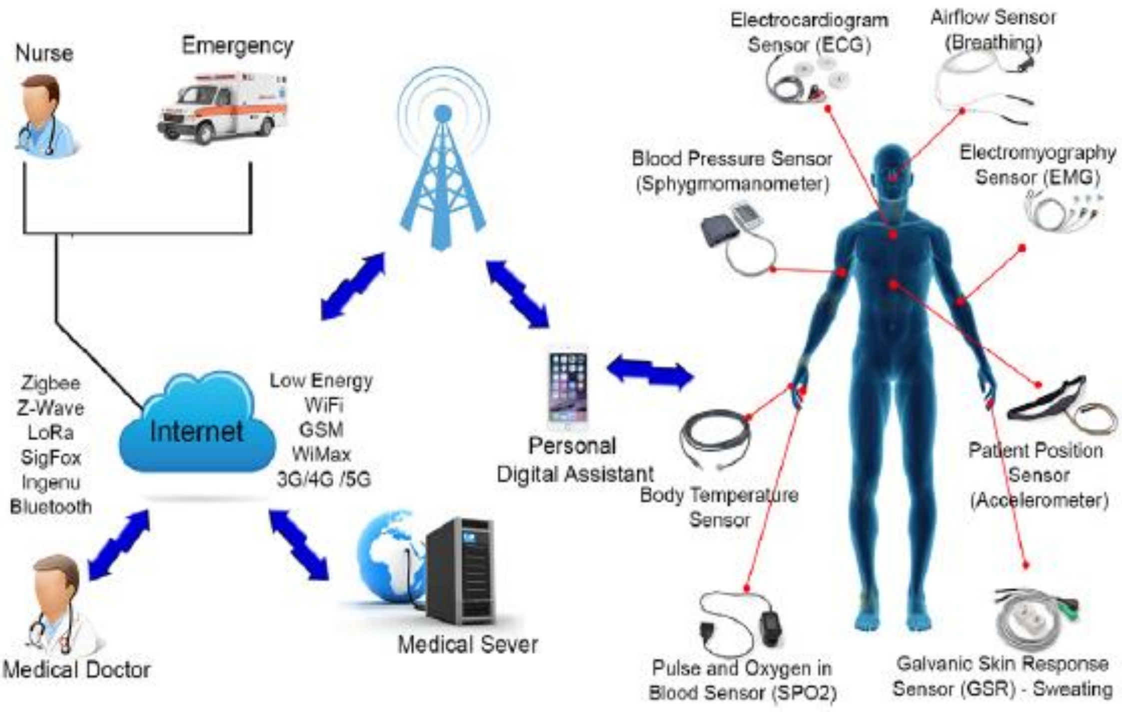
**Probe:** What is your view on security features that needs to be built into a platform?

2. Do you think that you should have 24/7 access to your clinical health records and data.

**Probe:** Most apps have a feature which dictates when the app can pull information i.e. perpetually in the background or on request. Which would you prefer?

**Probe:** Would you want the dashboard to be website and/or mobile compatible?

## 1) CONTEXT OF USE AND ENVIRONMENT CHARACTERISTICS



1. WAT routine?

   **Probe:** How often per day do you check your tracker?

   **Probe:** At what time of the day do you usually check it?

2. Have encounter other platforms that display information using patient generated data that may be useful to you and you clinician in partnership?

   **Probe:** Which platforms?

3. Do you search for your symptoms online and attempt to self-diagnose when you become ill?

   **Probe:** Does searching for the symptoms online increase or decrease your desire for a consultation?

### 1) DEVELOPMENT PROCESS CHARACTERISTICS

1. Does data from your fitness tracker influence your perception of the interface features?
   **Probe**: Does the data captured from your wearable fitness tracker/smartwatch influence the frequency of your consultations with your health care provider?

   **Probe:** If you received added-value information on your specific data from your health care provider and, it prompted you to a call to action which may include you coming in to see your health care provider how would you respond?

2. Do you think it is important to personalise your specific data on a per user basis?

   **Probe:** What type of personalisation would be important to you?

   **Probe:** What features would you want to see together in a dashboard sleep cycle and pulse rates while on meds as an example?

### 3. IMPACT OR OUTCOME OF COMPUTERISATION

1. Have you ever presented any information from your WAT or PGHD during a consultation with your clinician?

2. In our survey, consumers indicated that they have confidence in their own ability to interpret information from a patient's understanding, yet they do not change their habits/decisions based on this data as provided by a fitness tracker/smartwatch. Do you think if clinicians were more involved with the data this might change actions?

   **Probe:** What daily habits or health-related decisions (such as diet, supplementation, exercise) have you changed as a direct result of your device's feedback?

   **Probe:** Why have you changed these habits and not others?

3. Do you usually adhere to your treatment plan from your clinician strictly?

4. In your experience, has your WAT in any way helped or hindered your adherence to your treatment plan from your clinician?

Probe: If you were involved with your health care provider in collaborating the design and output of the platform, would you feel more included and thus inclined to use it?

# Appendix C: Consent Form

**Re-uniting consumers of healthcare services with GP's: Implementation of a digital human-computer interface, AI tool.**

- I, ..................................................... voluntary agree to participate in the online research study.
- I understand that even if I agree to participate now, I can withdraw at any time or refuse to answer any question without consequences of any kind.
- I understand that I can withdraw permission to use data from my online interview within two weeks after the interview, in which case the material will be deleted.
- I have had the purpose and nature of the study explained to me in writing and I have had the opportunity to ask questions about the study.
- I understand that participation involves participating in online focus groups with the core focus of designing a digital tool that may be used in the future as a commercially viable AI-driven software platform used by clinicians and their consumers of health care.
- I hereby acknowledge that I have no claim whatsoever to the intellectual property, commercial rights or, any benefits accruing from the development of any product or service rising from this research whatsoever.
- I understand and agree that this Action Research may result in a commercial advantage to the researcher, his practice and associated commercial partners and will I have no claim against them using any input I may have given whatsoever.
- I agree and understand that my rights as a consumer will be respected and protected as I am involved in the design, development and testing of any product that may arise from this research.
- I understand that I will not benefit directly from participating in this research.
- I agree to my interview being auto-recorded and documented for research purposes and the development of new knowledge in the health business and management sectors.
- I understand that all information I provide for this study will be treated confidentially.
- I understand that in any report on the results of this research my identity will remain anonymous. This will be done by changing my name and disguising any details of my interview which may reveal my identity or the identity of the people I speak about.
- I understand that disguised extracts from my interview may be quoted in the thesis, conference presentations and published papers.
- I understand that if I inform the researcher that myself or someone else is at risk of harm, they may have to report this to the relevant authorities - they will discuss this with me first but may be required to report with or without my permission.

I understand that signed consent forms and original audio recordings will be retained in a pre-specify location, under strict security arrangements as prescribed by the

- I understand that a transcript of my interview/s in which all my identifying information has been removed will be retained for at least 5 years after the exam board confirms my thesis results.
- I understand that under the freedom of information legalisation and personal protection of information act, I am entitled to access the information I have provided at any time while it is in storage as specified above.
- I understand that I am free to contact any of the people involved in the research or the University of Liverpool directly to seek further classification and information.

NAMES, DEGREES, AFFILIATIONS and CONTACT details of researcher and academic supervisor will be available on-demand.

*Signature of research participant*

....................................................... ...............................

Signature of participant Date

---------------------------------------------------------------------------------------------------

*Signature of researcher*

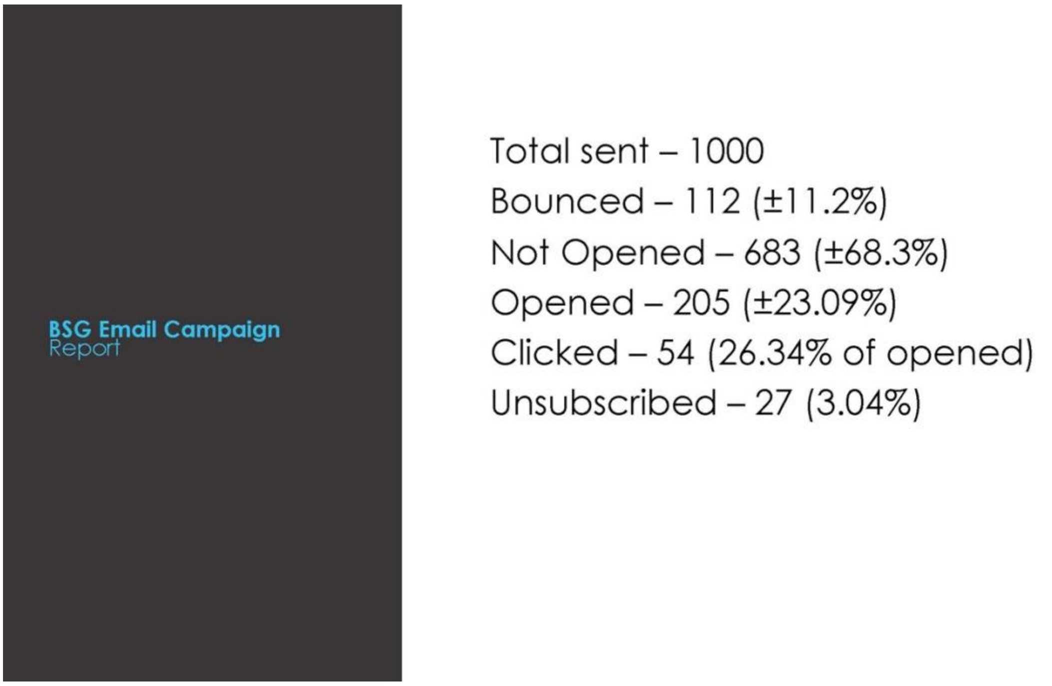
I believe the participant is giving informed consent to participate in this study

.................................................... ...................................

Signature of researcher Date

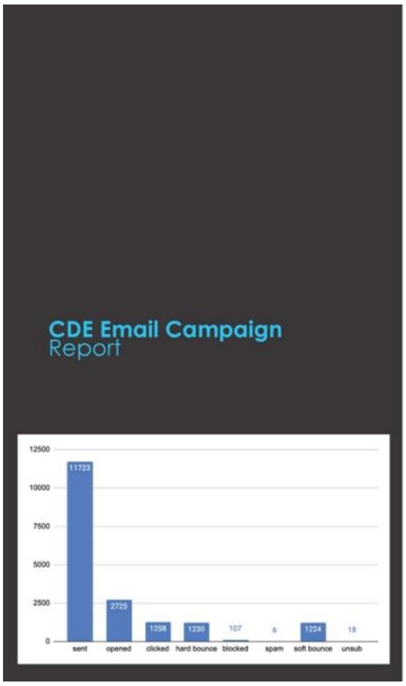
# Appendix D: Consumer (Public) Survey Analytics Report Findings

**Public** Phase 1
Survey Analytics
Report



**BSG Email Campaign**
Report

Total sent – 1000
Bounced – 112 (±11.2%)
Not Opened – 683 (±68.3%)
Opened – 205 (±23.09%)
Clicked – 54 (26.34% of opened)
Unsubscribed – 27 (3.04%)



**CDE Email Campaign**
Report

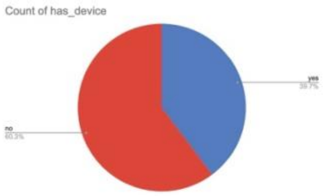
Total sent – 18 291
Bounced – 2 561 (±14.0%)
Not Opened – 11 723 (±64.0%)
Opened – 2 725 (±15.0%)
Clicked – 1 258 (46.0% of opened)
Unsubscribed – 18 (<0.09%)
Spam – 6 (<0.03%)

**Combined Email Campaign**
Report

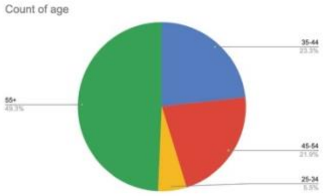
Total sent – 19 291
Bounced – 2 673 (±14.0%)
Not Opened – 12 406 (±64.0%)
Opened – 2 930 (±15.0%)
Clicked – 1 312 (45.0% of opened)
Unsubscribed – 45 (0.2%)
Spam – 6 (<0.03%)

# **Public Survey** Insights

## **Public** Demographics



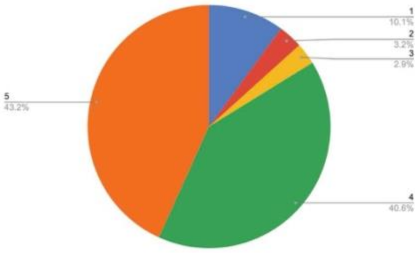
39.7% have a device
60.3% do not have a device



5.5% 25 – 34
21.9% 45 – 54
23.3% 35 – 44
49.3% 55+

## Question 1:

**You have one or more chronic conditions (diabetes, high blood pressure, high cholesterol, asthma, etc.)**



43.2% - 5 (strongly agree)
40.6% - 4 (agree)
10.1% - 1 (strongly disagree)
3.2% - 2 (disagree)
2.9% - 3 (neutral)

## Question 1: Insights

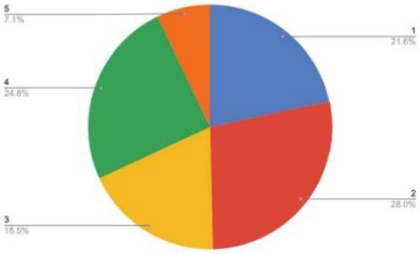
The majority of respondents have one or more chronic conditions (diabetes, high blood pressure, high cholesterol, asthma, etc.)

**Probe further: No**

The results are clear in that 83.8% strongly agree or agree. No further probing is needed.

## Question 2:

**When you become ill, you search for your symptoms online and attempt to self-diagnose**



28.0% - 2 (disagree)
24.8% - 4 (agree)
21.6% - 1 (strongly disagree)
18.5% - 3 (neutral)
7.1% - 5 (strongly agree)

## Question 2: Insights

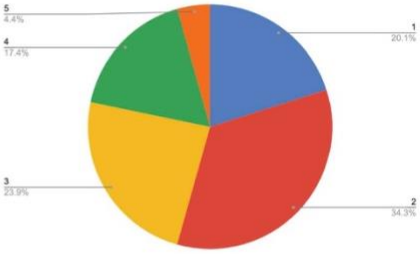
The majority of respondents do not search for their symptoms online and attempt to self-diagnose.

**Probe further: Yes**

The results are clear in that (49.6%) strongly disagree or disagree.

This information went against the researcher's assumptions as the researcher thought that there would be a larger majority of people who search for symptoms online. This could be linked to the nature of the patients who have pre-existing conditions and so may be more hesitant to take general advice off of the internet. This assumption would need to be probed further.

## Question 3:



**You trust your own intuition and online resources to treat your ailments**

34.3% - 2 (disagree)
23.9 - 3 (neutral)
20.1% - 1 (strongly disagree)
17.4% - 4 (agree)
4.4% - 5 (strongly agree)

## Question 3: Insights

The majority of respondents do not trust their own intuition and online resources to treat their ailments.

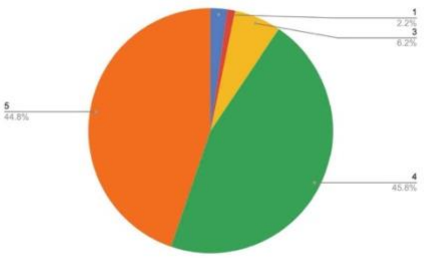
**Probe further: Yes**

The results are clear in that the majority of respondents do not trust their own intuition and online resources to treat their ailments.

This information again went against the researcher's assumptions as the researcher thought that the majority would be people who search for symptoms online. This could however be linked to the nature of the patients who have pre-existing conditions and so may be more hesitant to take general advice off of the internet. This assumption would need to be probed further.

## Question 4:

**You trust your doctor to treat your ailments**



45.8% - 4 (agree)
44.8% - 5 (strongly agree)
6.2% - 3 (neutral)
2.2% - 1 (strongly disagree)
<1% - 2 (disagree)

---

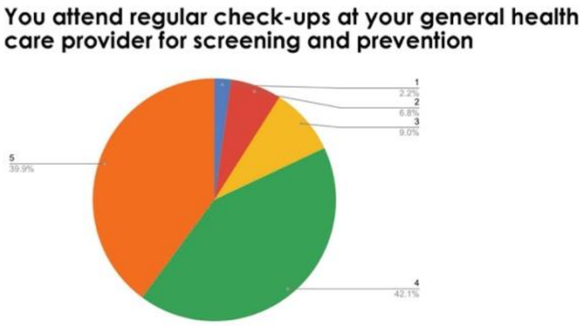
## Question 4: Insights

The majority of respondents trust their healthcare provider and to treat their ailments.

**Probe further: No**

The results are clear in that 90% strongly agree or agree. No further probing is needed.

## Question 5:


You attend regular check-ups at your general health care provider for screening and prevention

42.1% - 4 (agree)
39.9% - 5 (strongly agree)
9.0% - 3 (neutral)
6.8% - 2 (disagree)
2.2% - 1 (strongly disagree)

## Question 5: Insights

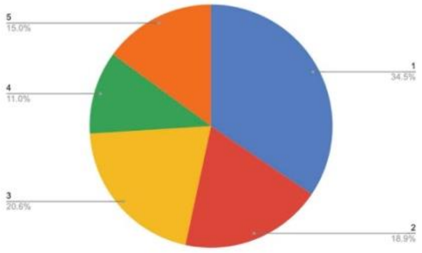
The majority of respondents attend regular check-ups at their general health care provider for screening and prevention.

**Probe further: No**

The results are clear in that the majority of respondents (82%) attend regular check-ups at their general health care provider for screening and prevention. No further insights required here.

## Question 6:

**You wear your wearable fitness tracker and/or smartwatch as often as possible**



34.5% - 1 (strongly disagree)
20.6% - 3 (neutral)
18.9% - 2 (disagree)
15.0% - 5 (strongly agree)
11.0% - 4 (agree)

## Question 6: Insights

The majority of respondents do not wear their wearable fitness tracker and/or smartwatch as often as possible

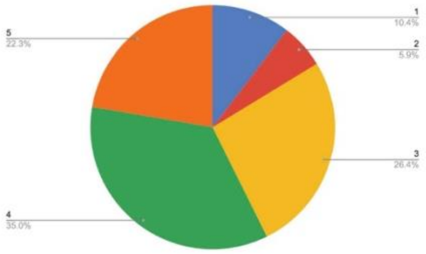
**Probe further: Yes**

The majority of participants (49,5%) indicated that they do not wear their fitness tracker as much as possible.

The strength of the platform to be developed is only as strong as the patient-generated data and so understanding obstacles to patient wearing habits is crucial. This will be probed further in the next research phase.

## Question 7:

**You would be willing to share the information from your wearable fitness tracker and/or smartwatch with a GP**



35.0% - 4 (agree)
26.4% - 3 (neutral)
22.3% - 5 (strongly agree)
10.4% - 1 (strongly disagree)
5.9% - 2 (disagree)

## Question 7: Insights

The majority of respondents would be willing to share the information from their wearable fitness tracker and/or smartwatch with their GP.

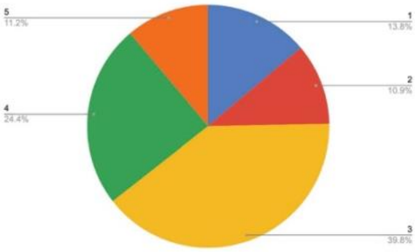
**Probe further: No**

The majority of participants agree, are neutral or strongly agree.

The researcher initially anticipated this response to be more wide spread. The fact that the answers were majority in being willing to share this information with their provider meant that no further analysis of this was needed.

## Question 8:

**You feel that you are able to accurately interpret the information from your wearable fitness tracker and/or smartwatch device**



39.8% - 3 (neutral)
24.4% - 4 (agree)
13.8% - 1 (strongly disagree)
11.2% - 5 (strongly agree)
10.9% - 2 (disagree)

## Question 8: Insights

The majority of respondents are able to accurately interpret the information from their wearable fitness tracker and/or smartwatch device.

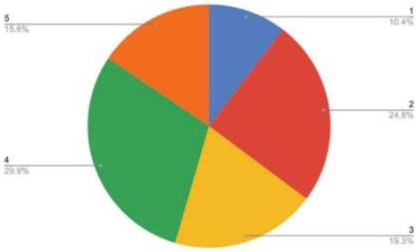
**Probe further: Yes**

There are mixed results in neutral (39.8%), agree (35,3%) and disagree (24,7%).

Since most respondents gave a neutral answer. More probing is needed in the semi-structured interview session. The researcher needs to understand what the user found confusing/limiting about the way in which data was presented on the device so to ensure that these user experience insights are included in the development of the platform.

## Question 9:

**Due to the COVID-19 pandemic, you have considered doctor's practices and healthcare facilities as unsafe and vulnerable environments and have stayed away**



29.9% - 4 (agree)
24.8% - 2 (disagree)
19.3% - 3 (neutral)
15.6% - 5 (strongly agree)
10.4% - 1 (strongly disagree)

---

## Question 9: Insights

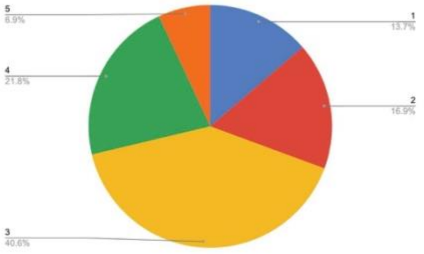
The majority of patients considered doctor's practices and healthcare facilities as unsafe and vulnerable environments and have stayed away due to COVID-19

**Probe further: No**

The majority of patients (45,5%) agree or strongly agree. Although this was a majority, it was not by a large ratio. This was interesting as the researcher assumed that COVID-19 would have played a higher factor in patients' fear of consultation attendance. No further probing is required.

## Question 10:

**You have changed daily habits or health-related decisions (such as diet, supplementation, exercise) as a direct result of your device's feedback**



40.6% - 3 (neutral)
21.8% - 4 (agree)
16.9% - 2 (disagree)
13.7% - 1 (strongly disagree)
6.9% - 5 (strongly agree)

## Question 10: Insights

The majority of patients have not changed daily habits or health-related decisions (such as diet, supplementation, exercise) as a direct result of their device's feedback

**Probe further: Yes**

The majority of patients (30,6%) disagree or strongly disagree. Although this was a majority, it was not by a large ratio. It is very important to understand the user motivations behind this.

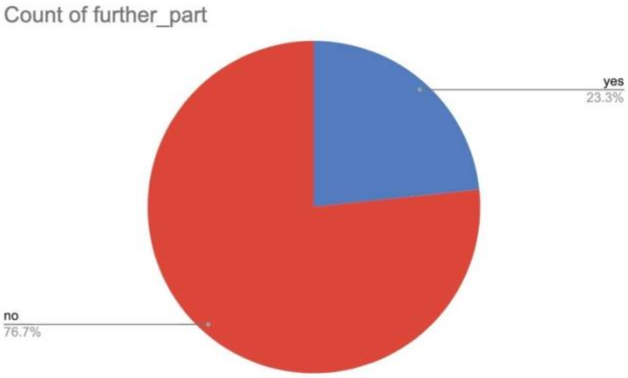
This is much lower than the responses from providers (where 62,1% agree or strongly agree) on the same question. The researcher needs to understand why this willingness to change habits is higher in providers than patients. Key questions to answer include: What different user motivations are there? Why do providers see value when patients do not and how can providers communicate this value to patients?

Could it be that patients do not understand the value that this data holds and need a platform that is able to show them how this information can be used? The second phase of the research will seek to answer this.

**Further Participation:**

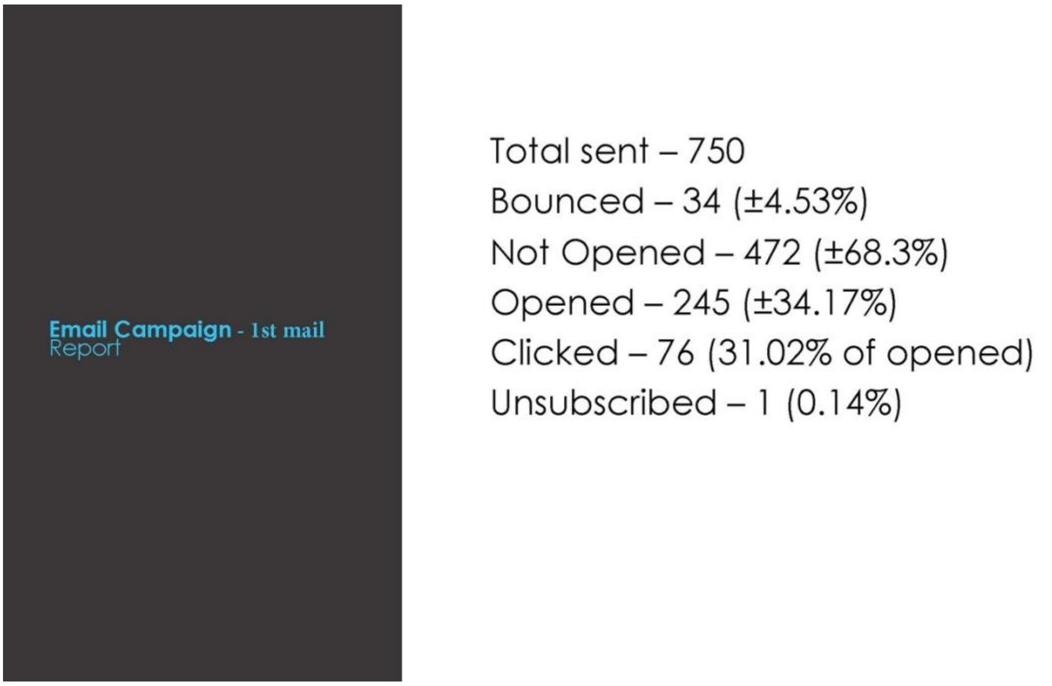
Yes – 23.3%

No – 76.7%



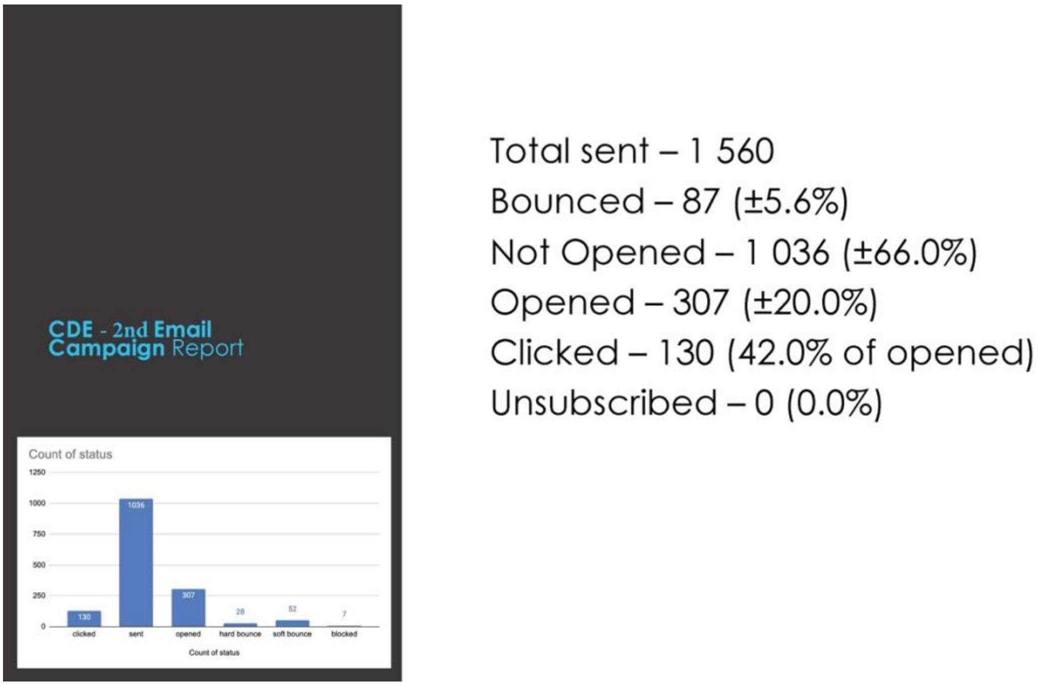
# Appendix E: Clinician (Provider) Survey Analytics Report Findings

**Provider** Phase 1 Survey
Analytics Report



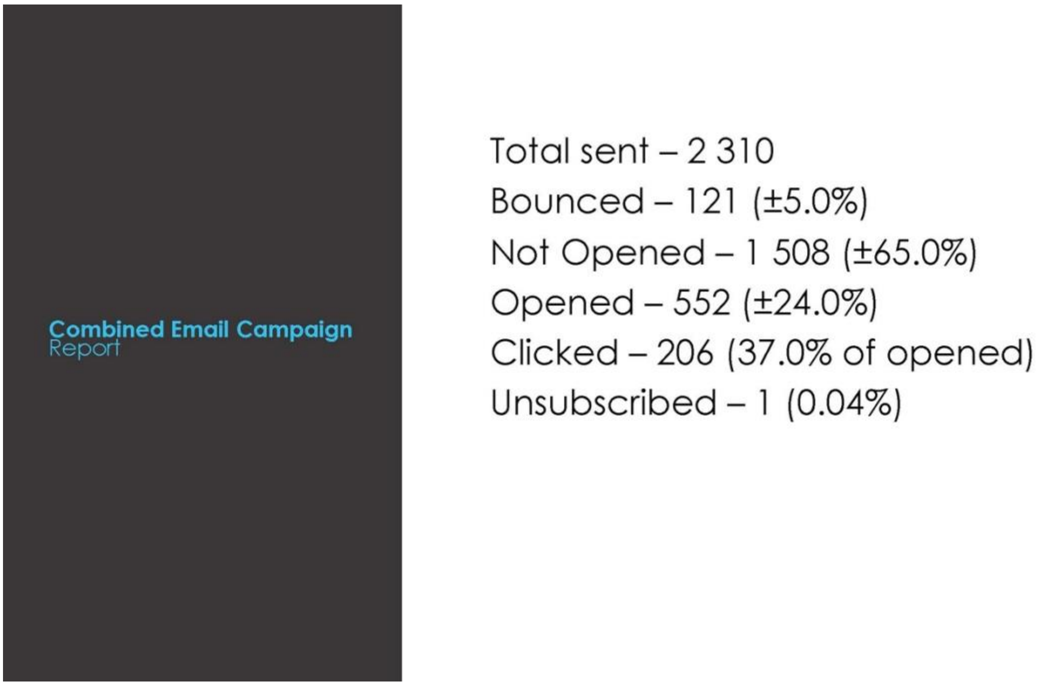
**Email Campaign** - 1st mail
Report

Total sent – 750
Bounced – 34 (±4.53%)
Not Opened – 472 (±68.3%)
Opened – 245 (±34.17%)
Clicked – 76 (31.02% of opened)
Unsubscribed – 1 (0.14%)



## CDE - 2nd Email Campaign Report

Total sent – 1 560
Bounced – 87 (±5.6%)
Not Opened – 1 036 (±66.0%)
Opened – 307 (±20.0%)
Clicked – 130 (42.0% of opened)
Unsubscribed – 0 (0.0%)



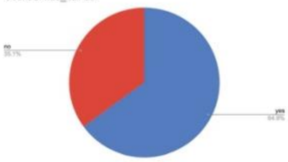
## Combined Email Campaign Report

Total sent – 2 310
Bounced – 121 (±5.0%)
Not Opened – 1 508 (±65.0%)
Opened – 552 (±24.0%)
Clicked – 206 (37.0% of opened)
Unsubscribed – 1 (0.04%)

# Provider **Survey** Insights

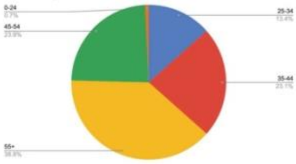
## **Provider** Demographics

Count of has_device



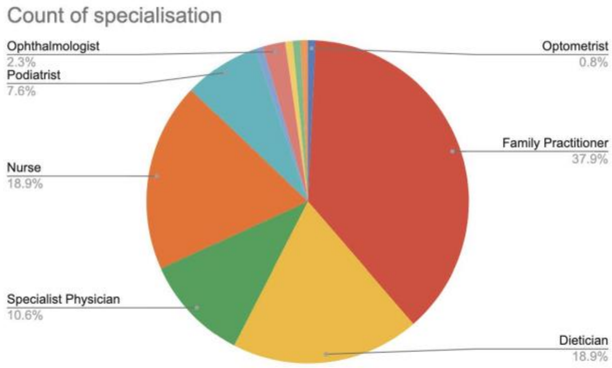
64.9% have a device
35.1% do not have a device

Count of age



38.8%   55+
23.9% 45 – 54
23.1% 35 – 44
13.4% 25 - 34

**Provider Demographics**
Specialisation



37.9% Family Practitioner
18.9% Dietician
18.9% Nurse
10.6% Specialist Physician
7.6% Podiatrist
2.3% Ophthalmologist
0.8% Optometrist

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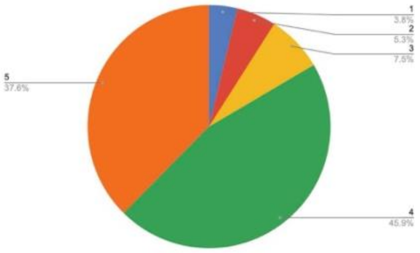
## Question 1:

**You are aware of what health and wellness data is available from a fitness tracker and/or smartwatch device**



45.9% - 4 (agree)
37.6% -5 (strongly agree)
7.5% - 3 (neutral)
5.3% - 2 (disagree)
3.8% - 1 (strongly disagree)

## Question 1: Insights

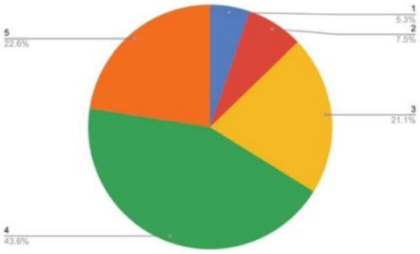
There is a strong understanding of the type of data available from a fitness tracker and/or smartwatch device.

**Probe further: No**

This is not necessary. The results are clear (83,5%) strongly agree or agree. This result is similar with patients. Both parties have a strong degree of knowledge about the data available. This is further supported by question 7. No new information is needed here.

## Question 2:

**You feel that you are able to accurately interpret the information from a fitness tracker and/or smartwatch device**



43.6% - 4 (agree)
22.6% - 5 (strongly agree)
21.1% -3 (neutral)
7.5% - 2 (disagree)
5.3% - 1 (strongly disagree)

## Question 2: Insights

The Providers feel confident in their ability to accurately interpret the information from a fitness tracker and/or smartwatch device.

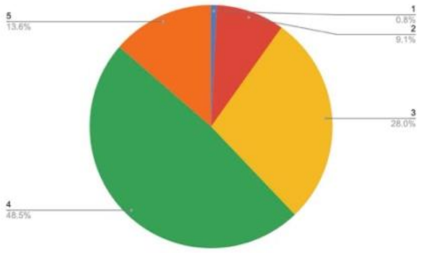
**Probe further: Yes**

The results are clear in that 66,2% strongly agree or agree that they feel confident in their ability to accurately interpret the information from a fitness tracker.

This is similar with patients as both parties feel confident in their ability to interpret the data. What is prevalent from Question 7 however, is that providers have less awareness about *what* data their patients are monitoring. The link between these two information points needs to be investigated further.

## Question 3:

**You would change your daily habits or health-related decisions (such as diet, supplementation, exercise) as a direct result of a fitness tracker and/or smartwatch device's feedback**



48.5% - 4 (agree)
28.0 - 3 (neutral)
13.6% - 5 (strongly agree)
9.1% - 2 (disagree)
0.8% - 1 (strongly disagree)

## Question 3: Insights

The majority of respondents would change their daily habits or health-related decisions as a direct result of a fitness tracker and/or smartwatch device's feedback.

**Probe further: No**

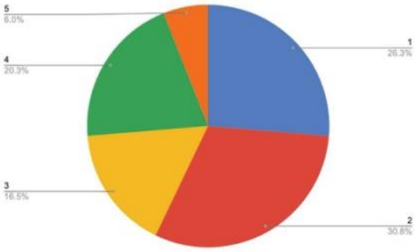
The majority of respondents (62%) agree or strongly agree that they would change their daily habits or health-related decisions as a direct result of a fitness tracker and/or smartwatch device's feedback.

This is higher than the responses from patients (where 35,5% indicated agreement or strong agreement) on the same question. The researcher needs to understand why this willingness to change habits is higher in providers than patients. Key questions to answer include: What different user motivations exist here? Why do providers see value when patients do not and how can providers communicate this value to patients?

Is it that patients do not understand the value that this data holds and therefore need a platform that can show them how this information can be used? The second phase of the research will seek to answer this.

## Question 4:

**Due to the COVID-19 pandemic you are hesitant to conduct face-to-face consultations with patients**



30.8% - 2 (disagree)
26.3% - 1 (strongly disagree)
20.3% - 4 (agree)
16.5% - 3 (neutral)
6.0% - 5 (strongly agree)

## Question 4: Insights

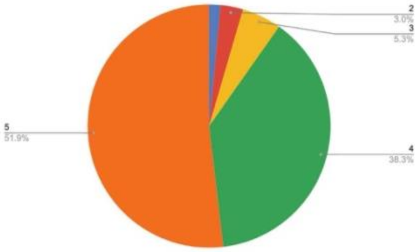
The majority of respondents are not more hesitant to conduct face-to-face consultations with patients due to COVD-19.

**Probe further: No**

The results are very clear. The majority of respondents (57,1%) strongly disagree or disagree. This information went against the researcher's original assumptions as the researcher expected to see a higher degree of hesitation in attending face-to-face consultations. This did not however justify further probing as the focus of the research did not warrant this. This information did however unearth new findings around patient's perceived fear (or lack thereof) during a pandemic.

## Question 5:

**You believe that patients searching online for their symptoms and attempting to self-diagnose without clinical oversight is a dangerous exercise and has a detrimental effect on health outcomes**



51.9% - 5 (strongly agree)
38.3% - 4 (agree)
5.3% - 3 (neutral)
3.0% - 2 (disagree)
<1.5% - 1 (strongly disagree)

## Question 5:Insights

The majority of respondents indicated that they see patientssearching online for their symptoms and attempting to self- diagnose without clinical oversight as a dangerous exercise.

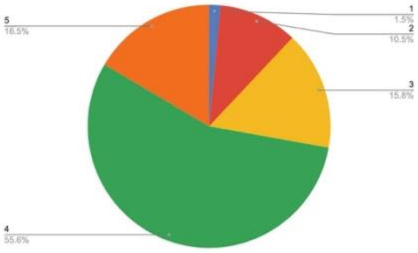
**Probe further: No**

The results are very clear. The majority of respondents (90,2%)strongly agree or agree.

Questions 5,6, and 10 combined clearly indicate that providersfind many patients attempting to self-diagnose and that in theiropinion, there is a risk/danger involved in this. This shows the need to insert the provider back into this process as the intermediary between health information and actionable advice. This data is clear and no further probing is required.

## Question 6:

**You find more of your patients attempting to self-diagnose and self-treat their ailments using technology and/or the internet instead of booking a clinical consultation**



55.6% - 4 (agree)
16.5% - 5 (strongly agree)
15.8% - 3 (neutral)
10.5% - 2 (disagree)
1.5% - 1 (strongly disagree)

## Question 6: Insights

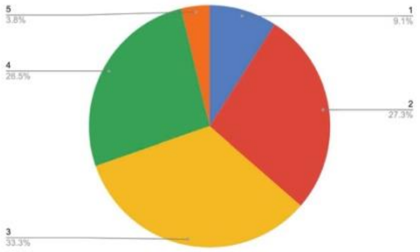
The majority of respondents indicate that they are finding more patients attempting to self-diagnose.

**Probe further: No**

The results are very clear. The majority of respondents (72,1%) strongly agree or agree.

Questions 5,6, and 10 combined clearly indicate that providers find many patients attempting to self-diagnose and that in their opinion, there is a risk/danger involved in this. This shows the need to insert the provider back into this process as the intermediary between health information and actionable advice. This data is clear and no further probing is required.

## Question 7:


**You are fully aware of what data patients are tracking on their fitness tracker and/or smartwatch device**

33.3% - 3 (neutral)
27.3% - 2 (disagree)
26.5% - 4 (agree)
9.1% - 1 (strongly disagree)
3.8% - 5 (strongly agree)

## Question 7: Insights

The majority of respondents indicated that they are not aware of what data their patients are tracking on their fitness tracker and/or smartwatch device.

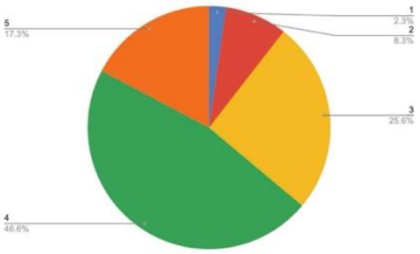
**Probe further: Yes**

The majority of respondents (36,4%) strongly disagree or disagree with (33,3%) neutral and (30,3%) agreeing or strongly agreeing.

Further probing is needed towards the patient in uncovering what data they are tracking. Although the majority of respondents indicated disagreement, this was not by a very large majority. This data is clear and no further probing is required.

## Question 8:

**You believe new wearable diagnostic technology is beneficial to diagnosis**



46.6% - 4 (agree)
25.6% - 3 (neutral)
17.3% - 5 (strongly agree)
8.3% - 2 (disagree)
2.3% - 2 (strongly disagree)

## Question 8: Insights

The majority of respondents believe that new wearable diagnostic technology is beneficial to diagnosis.

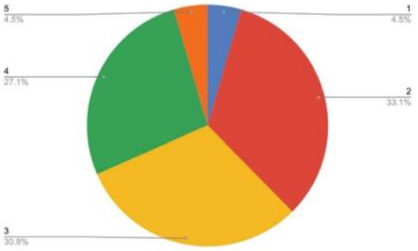
**Probe further: Yes**

There is a very clear indication as the majority of respondents (63.9%) strongly agree or agree.

What is not yet clear are what features and/or information the provider would find most useful and beneficial to diagnosis. This needs to be probed further in phase 2 of the research.

## Question 9:

**You are sceptical of the accuracy of new diagnostic technology and believe tried and tested manual methods to be superior**



33.1% - 2 (disagree)
30.8% - 3 (neutral)
27.1% - 4 (agree)
4.5% - 5 (strongly agree)
4.5% - 1 (strongly disagree)

## Question 9: Insights

There are mixed results regarding the respondents perceived accuracy of new diagnostic technology.

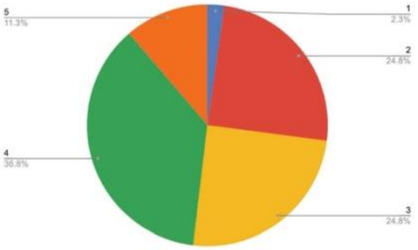
**Probe further: Yes**

There is not a strong enough difference between the agree/disagree viewpoints. (disagreement 37,6%, agreement 31,6%, 30,% neutral).

Having faith in the data pulled from fitness trackers and/or smartwatch devices is key because having confidence in the accuracy of that data would lead to confidence in the accuracy of the outputs on the platform. Understanding what elements are the biggest barriers to confidence is key in ensuring successful adoption of the platform. This will be further probed in research phase 2.

## Question 10:

**You are sceptical of patients' self-reported symptoms when they cannot be clinically confirmed**



36.8% - 4 (agree)
24.8% - 3 (neutral)
24,8% - 2 (disagree)
11.3% - 5 (strongly agree)
2.3% - 1 (strongly disagree)

## Question 10: Insights

The majority of respondents are sceptical of patients' self-reported symptoms when they cannot be clinically confirmed.

**Probe further: No**

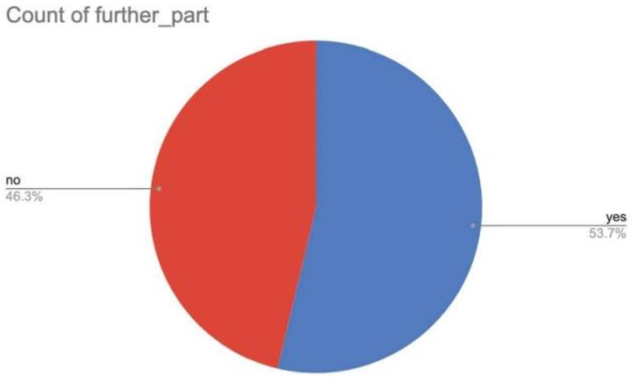
The majority of respondents (48.1%) strongly agree or agree that they feel sceptical of patients' self-reported symptoms when they cannot be clinically confirmed.

Questions 5,6, and 10 combined clearly indicate that providers find many patients attempting to self-diagnose and that in their opinion, there is a risk involved in this. This shows the need to insert the provider back into this process as the intermediary between health information and actionable advice. This data is clear and no further probing is required.

**Further Participation:**

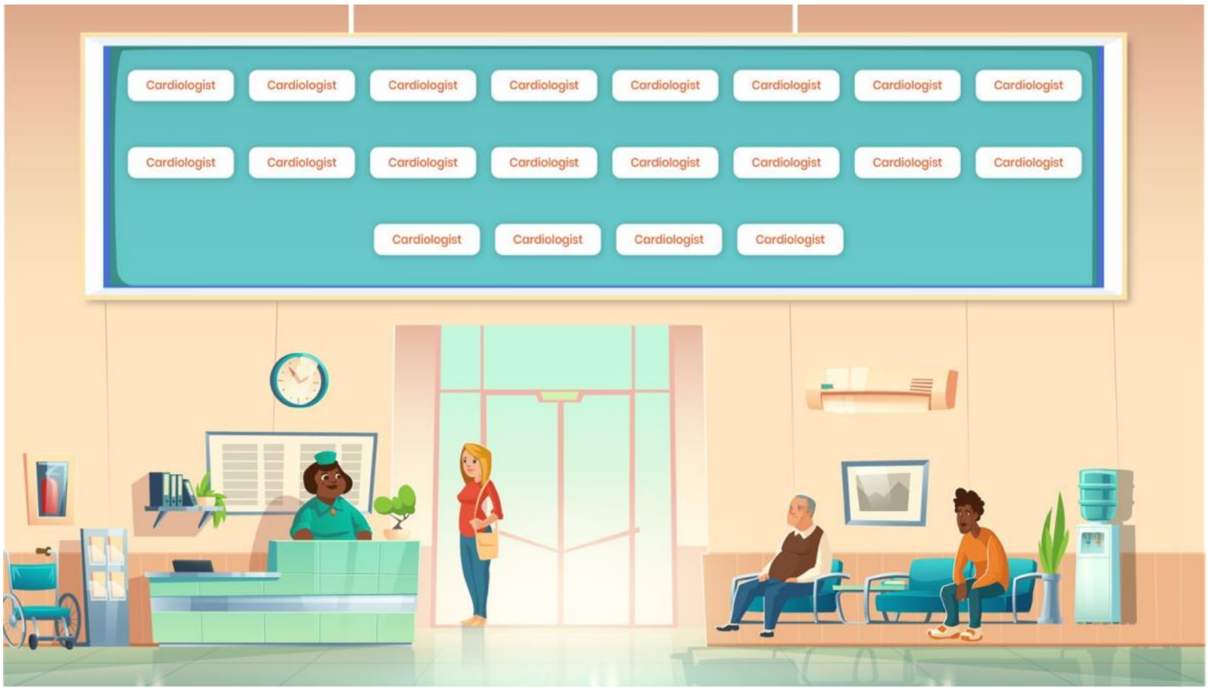
Yes – 53.7%

No – 46.3%



## Appendix F: First Screens – Treatme.health


My Achievments
My Education
My Messages
My Profile
My Treatment Plan
My Shop


Cardiologist
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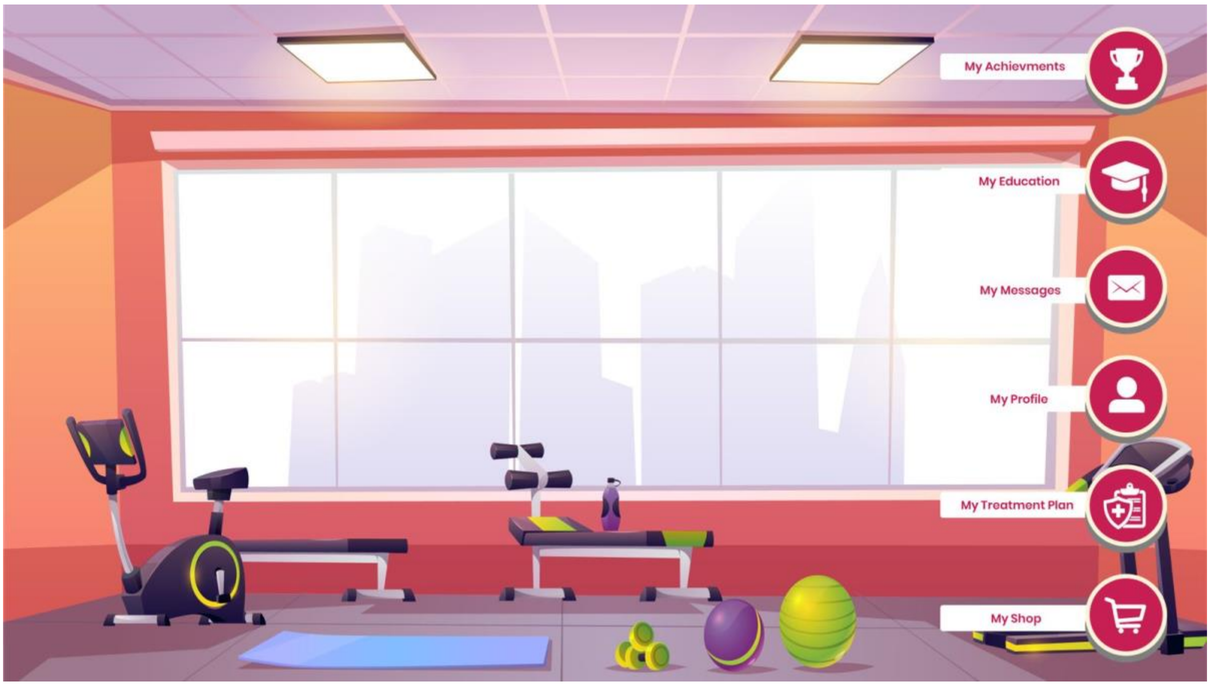
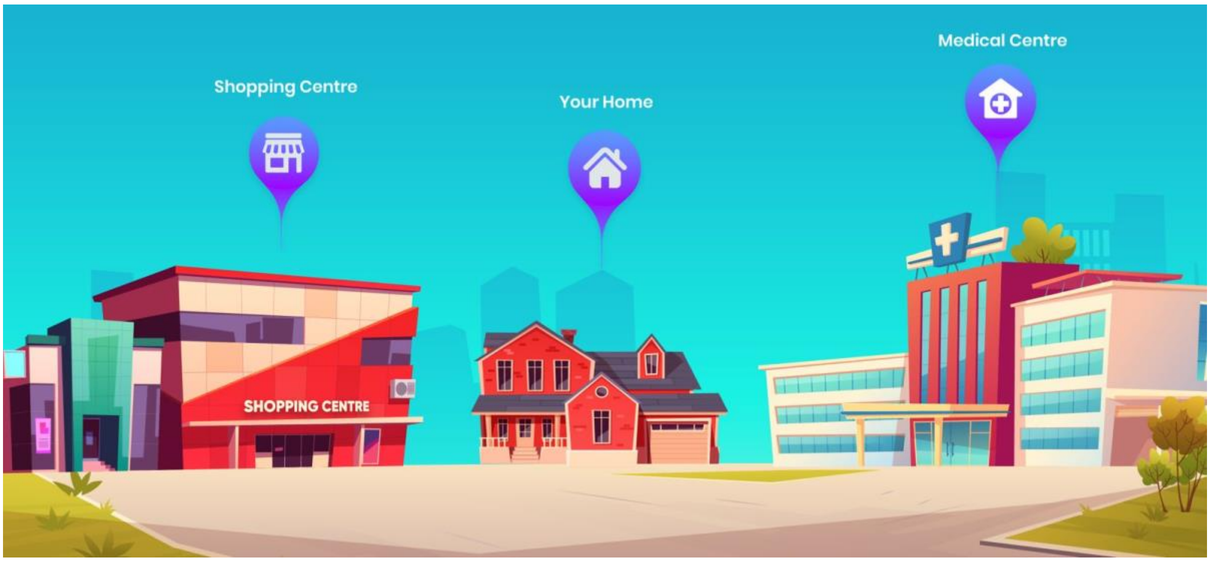
Cardiologist
Cardiologist
Cardiologist


My Achievments
My Education
My Messages
My Profile
My Treatment Plan
My Shop


SUPERMARKET
CAFE
BREAD
ALCOHOL
FRUIT VEGETABLES
MILK
BIG SALE 50%
PHARMACY
WC
DEVICES

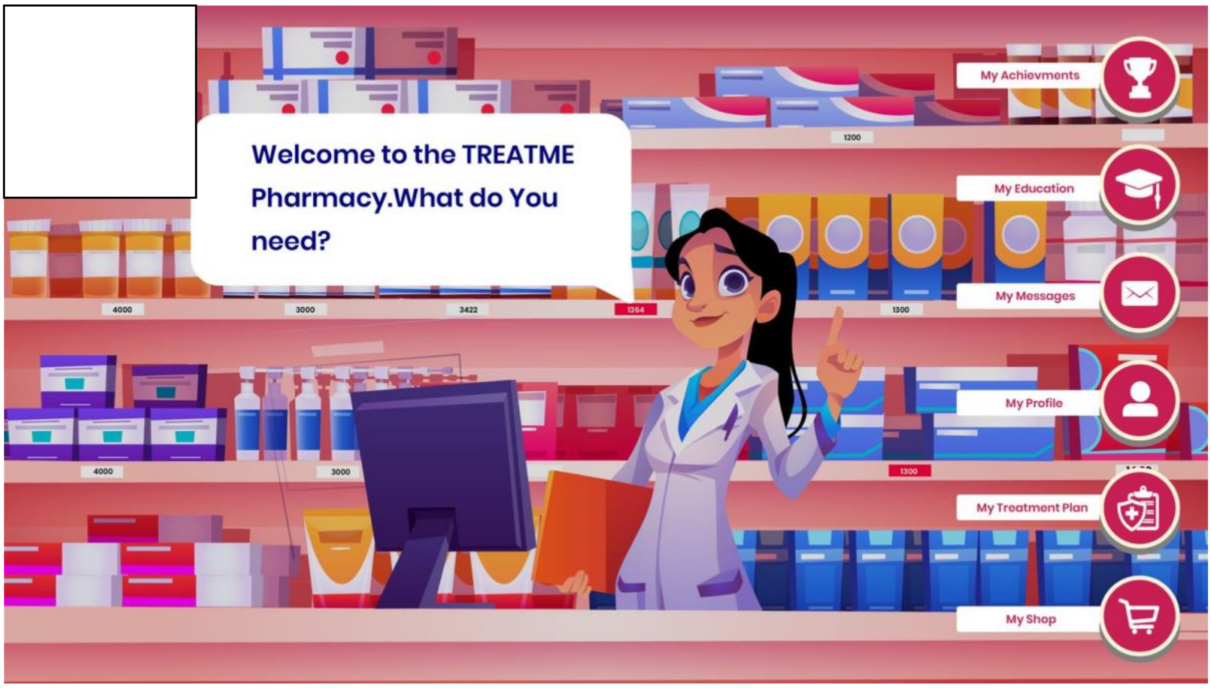

My Achievments
My Education
My Messages
My Profile
My Treatment Plan
My Shop


My Achievments
My Education
My Messages
My Profile
My Treatment Plan
My Shop


Shopping Centre
Your Home
Medical Centre
SHOPPING CENTRE


BEDROOM


My Achievments
My Education
My Messages
My Profile
My Treatment Plan
My Shop
DIET PLAN
DIET PLAN
09:00
13:00
18:00



Welcome to the TREATME Pharmacy.What do You need?