Interactive Client Centric Design Management Process for Construction Projects

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ABSTRACT: In construction projects the changes and refinements of client requirements are often seen just as a disturbance causing additional costs. However, today clients' business needs evolve constantly and therefore changes in the project requirements are inevitable. Simultaneously, the increasing competition forces companies to minimise unproductive capital costs. Therefore there is an economical pressure to shorten the construction time and the design and construction will be even more concurrent than today. There is clearly potential value to be created for customer by terms of change management. Customer value creation has been differentiating factor in other industries, especially in the service industry which concentrates to the customer value creation, as prevailing service logic requires a service provider for engaging itself with the clients' practices, learn from the customers and co-create value together with the customers.

Fira is an innovative Finnish company which has developed its interactive and customer centric Verstas-process since 2009. The process helps to identify business critical requirements of the client organisation, develop those to strategic project requirements and further to technical requirements. Fira is using service logic as a guiding principle in the development of Verstas facilitation process and strives for maximising co-created value for customer and uses Building Information Modelling (BIM) in order to visualize the design for end-users as well as for providing near-real time cost information business owners.

Even in the advanced Verstas process, the changes and refinements of client requirements have been a problem when the process is moving to detailed design and production. The traditional project management methods are not efficient in managing late changes in requirements. In this paper we will present new methods for combining Verstas process, requirements management and a new BIM solution, standardised model views in the design and production process. Using these methods Fira can now change its business model, differentiate with more attractive value proposal for customer, create more value than its competitors and capture value for securing its competitiveness in future.

1 INTRODUCTION

In the UK, already in 1998, the Construction Task Force had deep concerns that the construction industry as a whole is under-achieving, even though the industry was believed to match any other construction industry in the world. Among five key drivers of change, the task force named two that are relevant for this paper: 1) focus on customer and 2) integrated processes and teams (Eagan 1998).

Ten years later, Dave et al (2008), took a critical look at construction industry and poor growth of productivity, and pointed out that the sole investment to ICT and technology has been pointless, since it only covers peripheral aspects from the perspective of construction and its processes. If the true benefit, increased productivity and value for customer, is desired the following core aspects, people, process and information systems, must be integrated and addressed as a whole. In the same year, Prahalad (2008) introduced the concept of co-creation for solving the problem of value creation in transformation of business. A year after this, Fira, an innovative Finnish construction company, started to develop Verstas-process to increase co-created value through networks consisting of customer, designers, customer's business analytics and subcontractors.

Since then Fira has continued the development of facilitation skills, organization, Verstas-process itself and ICT-based tools and services, especially the BIM-based design optimisation service where BIM facilitates a fast way to find cost efficient solutions. Finally, in year 2013 Fira introduced construction project oriented applications for Verstas, in which Lean tools, like pull scheduling and Last Planner were introduced for production. Some of these tools

are adopted from Lean Project Delivery Process (LPDS), which is developed by Lean Construction Institute and is based on Lean-principles (Howell 1999) derived from Toyota Lean Management and Toyota Production System (TPS)

The concept of Virtual Design and Construction (VDC) provides modelling tools, which can be used during all stages of LPDS (Khanzode 2006). However, both VDC and LPDS are not emphasizing the customer value co-creation or prioritising customer orientation but focus mainly on production process and tools, even though customer value is first on the list of initial concept of Lean (Womack & Jones 1996). Prahalad (2008) takes the notion of customer value even further, as he states that value is based on unique, personalized experiences of consumers and it is not anymore question of ownership of resources by which the value will be created. Instead, it is a question of access to resources. According to Prahalad, the competitive advantage of a firm will depend on its approach to business processes that can seamlessly connect customer and resources and manage simultaneously the needs for efficiency and flexibility. For construction industry, the concepts of customer value co-creation and service logic are relatively new and they provide opportunity to differentiate in market (Hietala et al 2010). In industrial marketing, there has been an paradigm shift, which took place early '90s and changed product oriented thinking to relationship marketing (Grönroos 1994) and later to service dominant logic (Vargo et al 2008). Today in industrial marketing, customers are considered value creators and companies should urge to get involved with their customers' value-generating processes. By doing this, the supplier can become a co-creator of value with its customers (Grönroos 2008).

From Fira's perspective the value for customer is co-created together in Verstas, where client's processes can be examined and business process requirements for design of the building can be defined in interactive co-working process. Fira's Verstas-process addresses the value creation paradigm shift by taking the client and end-user into the core of construction process. This client centric approach is used to ensure that the focus in process is in whose business the building is built for instead of traditional approach in which client is considered as to whom building is built.

Fira utilises requirements management in Verstas-process to highlight the customer's business requirements throughout the process. Verstas is designed for interaction and consists of pre-planned steps of communication for creating value for the customer.

In this study, a new approach to value creation process is proposed by integrating customer value, people, process and ICT in a common framework.

2 RESEARCH BACKROUND

Both industrial manufacturers and marketing research community have begun to emphasize developing services in addition to traditional product offering. This change has been reasoned by both securing long-term growth and increasing competitiveness (Jacob and Ulaga 2008). As the creation of value is the core purpose of economic exchange, the focus has been traditionally on the supplier's output and price. Service scientists argue that the value is fundamentally derived and determined in-use instead of exchange (Vargo 2008). Furthermore, service as business logic should be implemented as facilitated processes in which supplier gets directly involved with the customer's every day practises. This transition from product focused logic to service and customer centric logic has also become a keen area of interest in research (Grönroos 2008).

2.1 *Value creation for customer*

A company, which is applying service logic, creates opportunities to develop interactions with its clients. It becomes a co-creator of value by directly engaging itself in value fulfilment for the customer (Grönroos 2008). Customer value can be created only by co-creation with the customer and understanding the value creation in customer processes.

2.2 *Challenges in value creation in construction projects*

Construction industry has not provided examples service systems (Hietala 2010). Dave et al (2008) introduce a number of reasons, which prevent construction industry increasing the productivity. Especially the heavily fragmented nature of the industry sector and greatly varying organisational competencies reduce the possibilities to introduce service logic in the construction industry. Also, as Dave mentions, construction industry suffers from the lack of trust between stakeholders and even conflict of interest between client and contractors. Dave proposes a simple framework of people, processes and ICT, and firmly suggests that great significance should be given to integration of these three domains.

2.3 *Verstas*

Fira's Verstas is a multidisciplinary process for co-working and co-creation. It is based on systematic development which begun in 2009 and has so far included over 400 Verstas-sessions both internally and with customers.

Verstas consists of three phases: 1) creation of shared knowledge and experience base, 2) setting requirements, and 3) inventing solutions. Verstas relies heavily on requirements management, as the

process includes documentation, analysing and prioritising the stakeholder requirements. Verstas has been originally developed for project development phase where requirements are seen in a key role in managing the design phase, since ability to trace the links between client requirements and designed constructional solutions provide the necessary tool for profit and cost analysis.

Fira uses BIM-based cost analysis tool in Verstas to provide the customer near real-time cost information of alternative solutions. By doing so, Fira is able to support the client in value co-creation process, in which the client can simulate different processes and e.g. respective floor layouts and evaluate both changes in business profits versus required construction investments and costs for running the business.

3 METHOD OF RESEARCH

The research was conducted by observing and analysing a selected case process in the selected case project Lahden Sairaalaparkki during design and construction phase for six months and piloting Verstas in another case project AVEC-parkki. The data was collected by using interviews and a Lean problem solving tool A3 method (Liker 2012). The analyses were conducted during and after interviews by using a Root Cause Analysis (RCA) as a part of the A3 method,

Simultaneously, a comprehensive literature study was conducted to better understand the nature of findings and also to find innovations how to use Verstas-process in solving the identified problems. The case process and proposed solution was depicted by using business process modelling. The proposed solution was developed by combining the case process analysis and findings in the literature studies. After testing the Verstas-process in AVEC-parkki project, the proposed solution process was improved based on the feedback and observations.

4 CASE PROCESS AND PROJECTS

Access management is a vital functionality in operations and maintenance processes of all customers. In many cases, it also has a significant role in customer's business processes because access management affects directly to the customer's ability of creating value or waste. For example, in the case project, one of the main requirements for the client in selecting the system was flexibility. According to interviews which were conducted in case project, the locking and ironmongery design and production process, which is part of the access management, suffered from severe problems. These defects in the process caused delays in installation phase and also increased the risk that the end result would be something else than client really needs. In addition, the locking and ironmongery is ideal as a case process for this study, because 1) the end result of the process affects directly the building functionality from the users' and client's perspectives, and 2) of its complexity as it involves several different project participants which makes the coordination of information and knowledge among them difficult.

4.1 *Case projects Lahden Sairaalaparkki and AVEC-parkki*

Two Design & Build projects executed by Fira, namely Lahden Sairaalaparkki and Avec-parkki, were selected as the case projects. Lahden Sairaalaparkki was a project containing an office building of 5000 gross-m2 and a car park for 600 cars whereas Avec-parkki was a car park for around 500 cars.
The design in both projects was executed by using BIM and integrated BIM was in daily use on site. The BIM use on site was, however, main contractor-oriented and only few subcontractors were willing and capable to use the models. The BIM use was also limited mainly to the site office due to required skilled use of computer.

4.2 *Case process locking and ironmongery*

In the first case project, Lahden Sairaalaparkki, the locking and ironmongery process was initiated by the architect together with electrical engineer as depicted in Figure 1. The responsibility for initiating the process belongs to architect due to prevailing public sector's contracting principles and national implementation model for project delivery system.

The principles of the safety and access systems of the building were defined together with the design group, main contractor and client. BIM was not utilised to facilitate the definition process instead traditional plans and drawings were used. Based on the principles agreed in the meeting both electrical engineer and architect prepared their designs. Architect consulted external locking specialist to select the ideal locking solutions and to define the coding for them. Although the designs of different disciplines were mainly completed by using BIM, locking and ironmongery design was completed with traditional methods as it is usually done also in BIM projects.

The designs were checked and approved by the client and the main contractor and after that exported to project's database.

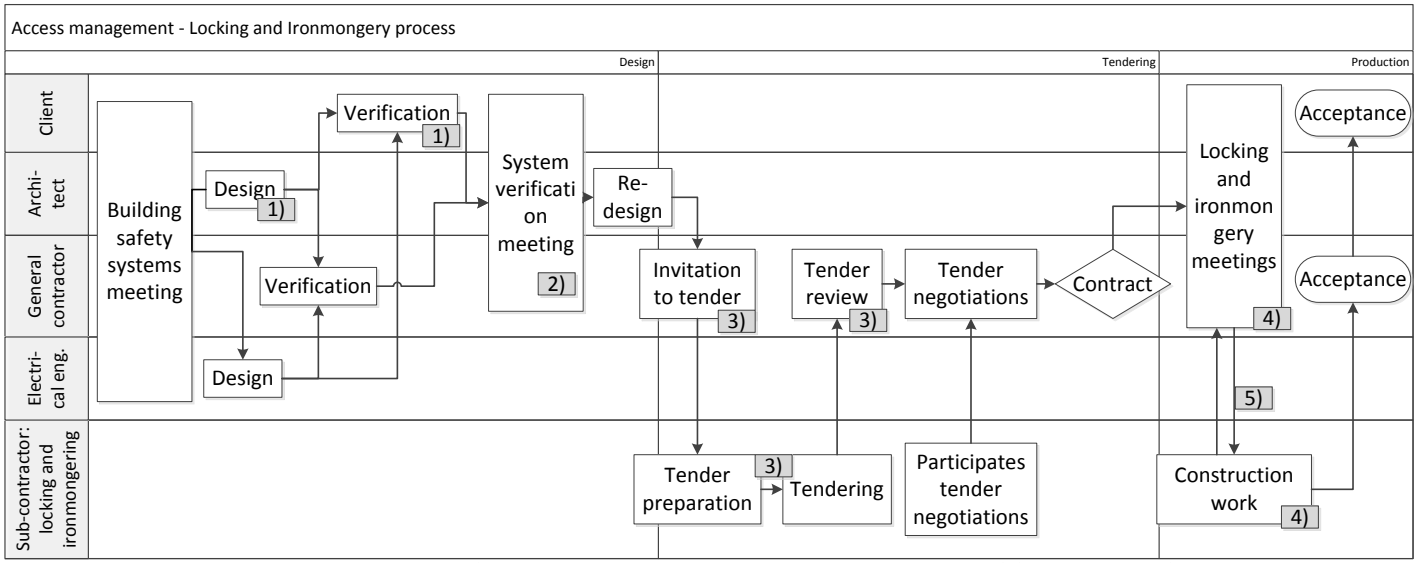

Figure 1. Locking and ironmongery process of the case project Lahti Sairaalaparkki posed number of fallacies and pitfalls. Numbers 1-5 refer to discussion of case process in Chapter 4.3 respectively.

Before starting the tendering phase for installation, a separate system verification meeting was held to ensure the compatibility of locking system solution and design. After consultation the architect updated the design accordingly and main contractor collected all relevant documentation and placed the invitations for installation tender for locking and ironmongery contractors.

In the case process, all four tenderers adhered to their own tendering methods and used the source material very differently when compared to each other. As a result of the tendering process main contractor received four tenders, which were non-comparable and therefore the decision to select the subcontractor was made rather by evaluating the quality and quantity of tenders instead of systematically comparing them with requirements of the customer and each other.

The selected contractor arranged meetings with client, architect and main contractor to go through the proposed solutions to create the final locking and access plans for the project. The discrepancies between the different designs in architectural, electrical and locking as well as smoke extraction plans were solved on site during the installation phase. Simultaneously, as the installation phase made the access management solution more understandable for the end-users, a number of corrections and changes were made to initial locking design. Some critical installation information from the end-users was not included to the design and therefore supplementary information was collected during installation phase.

4.3 *Identified fallacies and pitfalls*

According to interviews and RCA, following six major flaws were identified from implemented locking and ironmongery process in the Lahden Sairaalaparkki case. Numbering is also used to identify occurrences in process chart in Figure 1:

1) Architect had to use consultant to define the locking and ironmongery data into door schedule in design phase. The terms and coding which were used in schedule were so detailed that project participants were not able to verify the results without locking specialist.

2) Access management and locking system provider was selected and system verification was made based on locking solutions. Customer's business requirements for the access management were not properly identified and functionality was not fully defined.

3) Invitations to tender were delivered without functionality description, design contained errors and was partially inadequate. As a result the tenderers didn't have opportunity to provide alternative economical solutions

4) Invitations to tender was provided in a such format that each tenderer needed to interpret the data in order to prepare the tender. As a result tenderers spent varying time and used varying methods to prepare the tenders and thus tenders were not comparable.

5) Subcontractor was not able to detect all the inconsistencies of design and data neither during tendering phase nor in the meetings with the project participants. Therefore subcontractor was not able to finalize the installation as planned and the required design information was completed during the installations. Also, some of the problems were identified too late, which caused non-optimised use of access solutions due to the fact that corrective reinstallations were not financially feasible compared to the potential benefits they would have brought for the client.

6) Client and end-users completed and partially changed their requirements during installation, which caused re-design and re-work.

5 KEY FINDINGS

As discussed in Chapter 4, a lot of waste was produced in the case process in Lahti. Even more challenging was the potential customer value, which was not created, but destroyed. In order to define counter measures, a RCA was used for each fallacy to study each issue in more detail. Resulting root causes were examined further in a framework of value creation, people, processes and ICT and appropriate countermeasures were defined for each root cause to be used in proposed solution process as follows:

1) The case process for designing the access management was in contradiction with the early engagement principle of integrated project delivery (Mossman 2008). Architect, electrical designer and customer alone are not able to identify and define the requirements for the detailed locking solutions. None of the players has sufficient knowledge and skills to fully understand the problems and find best solutions. In terms of value creation, access to resources is not granted for process. Clearly, a preplanned and facilitated process is needed to identify and connect capable resources for value co-creation. The client and the design team will need training and orientation for co-working.

2) Even though BIM was used extensively in the project, the information in each phase was presented solely in prevailing formats and documents. A comprehensive understanding of the defined access management and locking functionality was cumbersome, even impossible, to obtain. Thus errors and discrepancies in the defined plans and details were inevitable and some parts even remained unplanned and recognised only in the installation phase. From the process perspective use of requirements management is essential during the design and construction to make sure that customer's business requirements drive the design. From perspective of value and people, the customer could involve end-users into the development phase if the process would aim to a user-friendly functionality description for access management, which the customer could use internally for sole value creation.

3) The information in the design documentation was scattered and insufficient for verification, tendering and installation purposes. Traditional representation of information caused waste as it prevented architect, client and main contractor from understanding and verifying the design efficiently. In addition, the lack of explicit functionality description for access management prevented subcontractors from understanding and implementing all the required functionalities in their locking solution at once. Process could be efficient only if the information would be targeted and filtered for each process task. Process-wise, the information management should offer just the required information in the most useful format for the people in the process. Information management belongs to ICT domain and efficient information delivery should be implemented by using tailor made standard model views of BIM.

4) Client's business processes evolved during the case project in Lahti. As discussed in 2 and 3, required visualisation of access management solution and requirements management were not present in prevailing process and therefore noteworthy requirements of the customer were not identified along in the locking and ironmongery process. As a result of the low ability to recognize and react to changes in customer's business requirements on time, the late changes disturbed the installation process. From the process and value perspective, the co-creation should be carried out through locking and ironmongery process and co-working should be pre-planned and facilitated to ensure efficiency. Also, from ICT perspective, the use of BIM for visualisation should be mandatory to avoid what happened in the case process, where the client realised designed functionalities only based on observations on site visits. Standardised model views should be used to create more value for customer by enriching the 3D representation and simultaneously for filtering obsolete details from BIM to make it easier for client and end-users to observe and understand the designed access and locking functionalities during the design and implementation process.

Key features in the proposed client centric design management process are

1) Customer's business requirements are always individual and project specific.

2) Customer's abilities to define business requirements and develop them to technical requirements for a construction project are very limited.

3) Customer is not able to understand designed functionalities based on standard documentation of construction process without additional visualisation and personalisation of information.

4) Customer requirements are subject to change during the project due to changes in their business model or their customer business needs.

6 PROPOSED SOLUTION

The design of the proposed client centric solution for the case process is approached by using four design principles, namely customer value, people, process and ICT. Following argumentation is used as guiding principles in designing the proposed solution:

1) Customer value can be maximised by using co-creation with the client and design team for defining functional requirements for access management.

2) Verstas-process is used to facilitate the end-to-end co-creation as it includes requirements management and utilises BIM by definition.

3) System provider selection is made by using formal Request For Information (RFI) and Request For Quotation (RFQ) tendering methods as a part of Verstas process. Criteria are derived from functional requirements.

4) Invitations for tender, which consist of functional requirements, the system design and standardised model views provide best source material for tenderers and hence the tendering process will be efficient.

5) Productivity during installation is increased by using only verified installation data and standardised model views.

6) Adaptivity to changes in client's and end-users' business requirements is ensured by using end-to-end Verstas process and requirements management. Proposed solution is depicted in Figure 2.

6.1 *Detailed process description*

In locking and ironmongery process, the customer value is maximised when the access management solution is aligned with client's processes and business requirements of end-users. Alignment can be obtained by using the three stage Verstas process in design phase, in which the customer processes and use cases are examined interactively by using standard model views for visualisation in order to gain shared understanding for required functionalities of access management. Predefined Verstas facilitation serves both process and people perspectives and produces functional requirements as well as functional descriptions for the access management solution. As an integral part of Verstas facilitation external resources, for example access management solution providers, are connected to Verstas to co-create the solution. The use of tailor-made standardised model views for BIM enhances the co-working of client and design team.

First two Verstas-sessions will provide information required for functional requirements documentation, which Verstas facilitator will produce based on Verstas-sessions. This requirements specification is used also for RFI to initiate a dialog with system providers to acquire necessary system information for the third phase of Verstas, in which access solution for the customer is defined. Based on the solution description, Verstas facilitator prepares RFQ documentation for the access management and locking providers. Customer can then make a fact-based decision about provider based on received information and facilitator's proposal. Both architect and electrical engineer complete the design necessary for subcontractor's tendering phase based on functionality description. BIM will be utilised for visualisation as well as for defining quantities especially for locking. By using BIM for design and information management, it is possible to provide exact material lists together with standardised model views for subcontractors and enhance the tendering process. As a result of improving the quality of invitation for tender, the quality of tenders will be enhanced respectively.

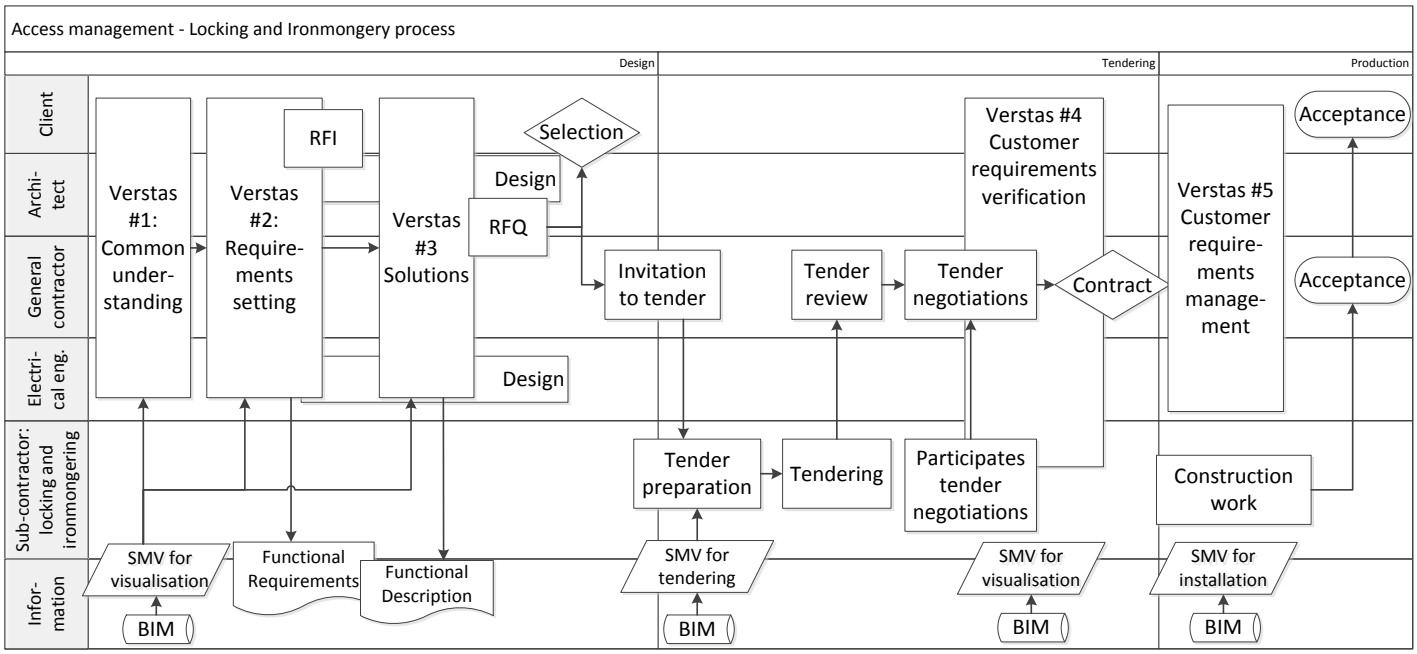

Figure 2. Proposed solution for client centric design management process for locking and ironmongery based on Lahti Sairaalaparkki case project in which Verstas-process, requirements management and BIM-based standardised model views are being used.

Initially, the access management functionality will be defined in the design phase. As the client's requirements may have changed, the second set of Verstas-sessions is held before installations and hardware delivery takes place. In this Verstas-session, the customer use-cases are examined to-

gether to verify the requirements and possible changes and impacts to the access management are identified. If necessary, change requests are made to the design and subsequent changes to the hardware orders are made. In order to reflect possible changes in end-user requirements, the last Verstas-session will be held as a last resort for managing the late changes of client or end-users requirements when installations are on-going. Finally, the construction is enhanced by providing accurate information for subcontractors' technicians using standardised model views.

7 DISCUSSION

Locking and ironmongery process represented in the case project less than one percent of the total budget. It also occurred relatively late in project's infill phase and the production was done parallel with other finalising works with time constraints. From main contractor's perspective, locking and ironmongery process was dealt as an inevitable but not crucial subcontracted part of project. Evidences of loose integration of people, process and information management, which are presented in this study, are matching to findings by Dave et al (2008) in their critical study of construction sector.

Another critical finding of Dave was the marginal productivity improvement for isolated ICT investments. This is in line with the case process, as the main contractor was investing in using BIM in the project and all major design disciplines were utilising BIM as a design tool, but it was not beneficial for customer or subcontractors in case process.

In the case process, the information, knowledge and participants of the process were heavily fragmented due subcontracted work and required expertise. The framework of customer value, people, process and ICT was providing tools to identify the pitfalls and develop interactive client centric design management process. However, there are two obstacles in implementation of proposed solution. Firstly, there will be an initial development cost for standardised model views, facilitation process and training as well as for a new contracting model. Additionally, the Verstas-process implementation and the use of expertise will add costs. Secondly, the currently used contractual agreements maintain the same sub-optimisation and conflict of interest problems that were discussed in Dave et al (2008). Participants will not change their habits without change in the revenue sharing model.

On the other hand, proposed solution provides clearly more value for the customer, since applying Verstas-process into locking and ironmongery process changes the logic of whole delivery system and the end-result is more beneficial for customer. It is also expected that the total cost of installation will decrease due to removal of waste from the process.

The main contractor should take these costs initially as an investment for their service development. Process should be seen as a chargeable service, which needs to be developed into a service concept. Additional value can be also used as an incentive for aligning the contractors by using a shared compensation pool similar to the IPD or alliance model and pain-gain revenue sharing model.

From the service logic perspective, there is a very valuable side effect for the main contractor from using Verstas-process in solving recurring issues of construction management. Main contractor is collecting intangible asset of knowledge in cross-project use of Verstas. Business-model-wise, the value creation for customer is the first objective. Each time the locking and ironmongery Verstas is being held, the customer value increases: 1) access management functionality is designed based on customer requirements, 2) implementation and cost are understood and controlled by the customer and for these reasons the customer satisfaction will be higher than in the case process or cases where prevailing process is implemented. A crucial question is how well the facilitating organisation is able to capture the created value. In other words, main contractor is able to engage it to the customer's practices and first learn from the customer and later provide new customers more variable processes than competitors. Hence, the subsequent Verstas will provide more value for project with less effort and the intellectual capital of main contractor will increase project by project. Proposed use of Verstas-process is actually a co-creative collaboration process with ability to save knowledge for further use and therefore it represents method for value creation for the main contractor's customers and value capturing tool for the main contractor.

8 CONCLUSIONS

The case process of locking and ironmongery was analysed by using the Root Cause Analysis and the results were in accordance with the findings represented by Dave et al (2008). Based on the results of RCA and by utilizing the framework of customer value, people, processes and ICT, a new interactive client centric design management process was developed and proposed. Service logic was used as a guiding principle during development.

Key innovations in the proposed model include value co-creation by using predefined and facilitated Verstas-process as a tool for interaction. Similarly a value capturing method of Verstas for the main contractor was presented, by which the contractor can increase the intangible knowledge in its organization and secure long term competitiveness. Client cen-

tricity is further strengthened by introducing requirements management in the process for documenting, tracking and updating the client requirements as the construction project is proceeding. The utilisation of BIM is expanded from designers to individual workers on site by using standardized model views, which increases the productivity on production phase.

Proposed solution makes it possible to increase customer value even in small scale subcontracts by using an integrated business model. The change in business model and ability to capture value provides company a possibility to differentiate with more attractive value proposal for customer.

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