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CUSTOMER INVOLVEMENT IN CONSTRUCTION PRODUCT SUPPLIER'S NEW PRODUCT DEVELOPMENT

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ABSTRACT

Jaakko Karppinen: Customer Involvement in Construction Product Supplier's New Product Development

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Construction industry is generally viewed to suffer from low rate of innovation, which is at least in part due to the project-based nature of the industry. Carefully resourced projects do not provide the best platform to innovate, and efficient project management is often prioritized over creating solutions that are transferrable from project to another. Construction product suppliers, however, are usually not project-oriented and can thus better maintain research and development (R&D) programs beyond the project-level. Suppliers have even been argued to be a key source for innovation within construction.

Developing new products according to market requirements is central for long-term success of a business. Accessing this necessary market input is seen particularly challenging for construction product suppliers when considering their non-central position in project networks and the whole industry. The objective of this research is thus to build a comprehensive framework for involving a variety of customers into supplier's new product development (NPD), and then adapting this framework to the NPD process model utilized in a target company of this research. To achieve this objective, this research considers (1) how different customers perceive innovation and involvement in the supplier's NPD, (2) what knowledge they can contribute, and (3) when and by what practices the involvement is to happen.

This thesis is conducted as an explorative design science research commissioned by a Finnish supplier of construction products. 15 semi-structured interviews are conducted with variety of customers from construction project networks, including contractors, architects, project clients, and construction consultants with varying backgrounds and expertise. Participatory observation was used to provide complementary knowledge throughout the research.

Qualitative data from the interviews reveal tangible business- and project-level practices for attaining valuable market input from all customer stakeholders in construction project networks during all stages of supplier's new product development process. The findings further imply how innovating is seen challenging within projects, but also how project-level innovation can be promoted with more collaborative project implementations. Customer involvement at the business-level of supplier's NPD is however highlighted the most, with emphasis on, among others, identifying the lead users, building and leveraging trustworthy relationships, and exploiting every possible opportunity for informal involvement.

The findings create strong support for existing literature on promoting construction innovation, but also complement greatly on the unfortunately constricted research from suppliers' point of view. In addition to the theoretical value and originality, the research offers managerial implications by establishing a generalized yet comprehensive framework as a baseline tool for NPD managers in firms supplying all types of construction products.

Further research is needed to validate some of the findings based on qualitative data, such as how different levels and breadth of customer involvement affect construction product supplier's NPD performance. Some unanswered questions and unexpected findings should also be further explored, such as how construction product suppliers could better promote the adoption of new products and services within the industry, or how collaborative project implementations such as alliances promote project-level innovation in practice.

Keywords: construction industry, innovation, new product development, supplier, stakeholder, customer, involvement, project network, project-level, business-level

The originality of this thesis has been checked using the Turnitin OriginalityCheck service.

TIIVISTELMÄ

Jaakko Karppinen: Asiakkaiden osallistaminen rakennustuotteiden toimittajan tuotekehityksessä

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Rakennusalan nähdään yleisesti kärsivän heikosta innovaatiotoiminnasta, mikä aiheutuu ainakin osittain toimialan projektiluonteesta. Huolellisesti resursoidut projektit eivät tarjoa parasta alustaa innovoinnille, ja tehokas projektinhallinta asetetaan usein etusijalle hankkeesta toiseen monistettavien ratkaisujen kehittämisen sijaan. Sen sijaan rakennustuotteiden toimittajat eivät useimmiten toimi projektitasolla ja pystyvät siten paremmin ylläpitämään tutkimus- ja kehitysohjelmia projektitason ulkopuolella. Toimittajien on jopa väitetty olevan keskeinen innovaation lähde rakennusteollisuudessa.

Uusien tuotteiden kehittäminen markkinoiden tarpeisiin on keskeistä liiketoiminnan pitkän aikavälin menestykselle. Näiden välttämättömien markkinaviestien saavuttaminen nähdään erityisen haastavana rakennustuotteiden toimittajille ottaen huomioon niiden asema projektiverkostoissa ja koko toimialalla. Tämän tutkimuksen tavoitteena on siten rakentaa kokonaisvaltainen viitekehys erilaisten asiakkaiden osallistamiseksi toimittajan uustuotekehitykseen, ja sen jälkeen sovittaa tämä viitekehys kohdeyrityksen uustuoteprosessiin. Tämän tavoitteen saavuttamiseksi tutkimuksessa selvitetään, (1) kuinka eri asiakkaat kokevat innovaation ja osallistumisen toimittajan tuotekehitykseen, (2) mitä tietoa asiakkaat voivat tarjota, ja (3) milloin ja millaisilla käytänteillä osallistamista tulee tehdä.

Tämä opinnäytetyö on tutkimusotteeltaan kartoittava suunnittelututkimus, joka on toteutettu suomalaisen rakennustuotetoimittajan toimeksiannosta. Ensisijaisena tutkimusaineistona toimi 15 puolistrukturoitua haastattelua, jotka toteutettiin erilaisten rakennusprojektin asiakassidosryhmien kanssa, mukaan lukien urakoitsijat, arkkitehdit, rakennuttaja-asiakkaat ja -konsultit. Osallistuvaa havainnointia hyödynnettiin koko tutkimuksen ajan tarjoamaan täydentävää tietoa.

Haastatteluista kerätty laadullinen data paljastaa konkreettisia liiketoiminta- ja projektitason käytäntöjä arvokkaan markkinapanoksen saamiseksi kaikilta rakennusprojektien asiakassidosryhmiltä tuotekehitysprosessin kaikissa vaiheissa. Tulokset osoittavat edelleen, kuinka innovointi nähdään haastavana projektien aikana, mutta myös kuinka projektitason innovaatioita voidaan edistää yhteistoiminnallisemmilla projektitoteutuksilla. Eniten kuitenkin korostuu asiakassidosryhmien osallistaminen toimittajan liiketoimintatason tuotekehityksessä, jossa painottuvat muun muassa varhaisten omaksujien tunnistaminen, luotettavien suhteiden rakentaminen ja hyödyntäminen sekä jokaisen eteen tulevan osallistamismahdollisuuden hyödyntäminen.

Tulokset antavat vahvaa tukea aiemmille tutkimustuloksille rakennusteollisuuden innovaation edistämisestä, mutta myös täydentävät merkittävästi rakennustuotteiden toimittajien näkökulmasta tehtyä, joskin valitettavan rajallista tutkimusta. Teoreettisen kontribuution lisäksi tutkimus tarjoaa arvokkaita käytännön implikaatioita johdon tueksi esittämällä yleistettävän mutta kattavan viitekehysten rakennustuotteita toimittavien yritysten tuotekehityspäälliköiden työkaluksi.

Lisätutkimusta kuitenkin tarvitaan vielä joidenkin laadulliseen aineistoon perustuvien tulosten verifioimiseksi, kuten esimerkiksi koskien sitä, kuinka asiakassidosryhmien osallistaminen eri tasoilla ja laajuudella vaikuttaa rakennustuotteiden toimittajan tuotekehityksen onnistumiseen. Joitain vaille vastausta jääneitä kysymyksiä ja myös odottamattomia löydöksiä tulisi myös tutkia tarkemmin, kuten kuinka rakennustuotteiden toimittajat voisivat paremmin edistää uusien tuotteiden ja palveluiden käyttöönottoa toimialalla tai miten yhteistoiminnalliset projektitoteutukset kuten alianssit edistävät projektitason innovaatioita käytännössä.

Avainsanat: rakennusteollisuus, innovaatio, uustuotekehitys, toimittaja, sidosryhmä, asiakas, osallistaminen, projektiverkosto, projektitaso, liiketoimintataso

Tämän julkaisun alkuperäisyys on tarkastettu Turnitin OriginalityCheck –ohjelmalla.

PREFACE

This thesis marks the end of a very long, almost 20-year journey for me as a student. I am very thankful for the target company and its management who commissioned and financed my thesis. It has been an extremely deep dive to the vast industry of construction with practically no previous experience from the industry altogether. In addition, I'm very thankful for my co-worker Harri who had no formal role in making of this thesis, but who still managed to act as a major mental support and distraction factor when chatting about stuff related to music and guitars.

Although I probably will not pursue a career within this industry, I am still very thankful for the experience and all the countless new things I learnt along the way. In my opinion, there is no such a thing to be learnt that would be in vain. Everything you learn along the way takes you a step forward to somewhere – whether foreseeable or unknown. And for me, these steps to the new and unknown are especially what makes life interesting.

- Jaakko Karppinen

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ABBREVIATIONS

| | |
|-----|--|
| CIC | Customer Involvement as Co-creators |
| CIN | Customer Involvement as Innovators |
| CIS | Customer Involvement as Information Source |
| NPD | New Product Development |
| R&D | Research and Development |
| UDI | User-driven Innovation |
| VoC | Voice-of-Customer |

1. INTRODUCTION

1.1 Research background

Low performance of innovation is an important issue in project-based industries (Winch 1998). Especially construction industry is often cited as conservative in terms of innovation (Lassen et al. 2010). This is at least partly because unique, one-time projects do not provide the most supportive platform for innovation. Indeed, construction projects often prioritize efficient project management over finding transferrable solutions from project to another (Blayse & Manley 2004; Keegan & Turner 2002).

There is a vast amount of research discussing innovation in construction industry from the project-oriented perspective of contractors, designers, and project clients. However, the suppliers of construction products epitomize one of the most neglected areas in construction research (Larsson et al. 2006), despite project schedules are dependent on material and component deliveries that usually account for up to 50-60 percent of total project costs (Ibn-Homaid 2002). In addition, construction product suppliers do often have the best technological knowledge within their field and are regarded as key sources of innovation in the industry (Bygballe & Ingemansson 2014; Gambatese & Hallowell 2011; Hemström et al. 2017).

Research and development (R&D) and new product development (NPD) are central to the long-term success and growth of a business (Brown & Eisenhardt 1995). As construction product suppliers are usually more product-oriented than project-oriented, they can maintain these development programs beyond project-level better than other actors in the industry (Blayse & Manley 2004). Despite this, there is only a limited amount of research on the role of suppliers for promoting construction innovation (Manley 2008).

The management of a Finnish company supplying variety of construction products has identified a problem regarding the inclusion of market input into the process of new product development. Indeed, the use of market input and especially information on such customer needs, wants, and problems has been shown as one of the strongest discriminators between the worst and the best performing NPD practices across multiple industries (Cooper et al. 2004). But what makes this especially difficult for construction product suppliers is their non-central position in construction project networks, which hinders direct communication and relationships with project clients and end users, and thus also hinders their contribution to construction innovation in general (Sariola 2018).

1.2 Research context, purpose, and objective

The target company of this research is a medium-sized supplier of large variety of construction products. The company operates mostly on Finnish markets with a mixture of vertically integrated and outsourced manufacturing of products and services. The majority of products the target company supplies could be best described as low- or mid-tech products, although during the recent years the company has pursued expansions to some more advanced product categories. All the products are used for interior construction and have both operational and aesthetical functions for end users.

Most of the target company's products are supplied for public construction projects and construction of business premises, but some products are also being supplied for residential construction and even retail. Apart from retail, there is rarely no single customer or customer organization for any products supplied for construction projects, but rather the whole network of stakeholders within a construction project acts as the customer. In practice, product requirements (and sometimes even specific products from specific suppliers) are first specified by *designers* according to the needs and specifications defined by project *clients* and *end users*, and then finally procured by a head *contractor* through formal bidding process. In addition to these stakeholders, construction project clients often utilize *consultants* to coordinate and manage the project and to act as client's representative.

Supplier's position in construction project networks has been recently studied in Tampere University of Technology by Rami Sariola & Miia Martinsuo (2013, 2015, 2016, 2018). These studies shown, however, focused mostly on developing construction project network relationships when supplying and buying products and services within projects, and largely do not consider the relationships and opportunities for cooperation in new product development out of project boundaries from the supplier's perspective.

Sariola (2018) answered on *how can contractors leverage the knowledge of suppliers for construction innovation?* Need for further research was identified to broaden this perspective on other stakeholders such as designers, clients, and end users. In addition, a viewpoint focusing on supplier's innovation was recognized as another potential topic. The purpose of this thesis is to take on both topics by exploring ways to involve different stakeholders of construction project networks (aka. supplier's customers) into supplier's new product development, and therefore to also answer on the problem recognized within the target company of this research. In comparison to the research by Sariola (2018), the objective of this research is therefore to answer on *how can suppliers leverage the knowledge of their customers, i.e., contractors, designers, construction project clients, and end users for construction innovation?* From the perspective of the

target company, this objective is achieved by first constructing a generalized framework on customer involvement in construction product supplier's NPD, which is then adapted to the specific NPD process model utilized by the target company.

Research by Wandahl et al. (2011) is based on a similar type of case study within Danish construction material industry, with a purpose to develop a user-driven innovation (UDI) framework from a supply network perspective. By reviewing the UDI literature, they concluded the following variables to address in this type of innovation network:

- the different roles of the users
- type of information/knowledge required from the users
- deciding when a user should become involved within the innovation process, and
- different methods and tools to conduct UDI in a network. (Wandahl et al. 2011, p.407)

This research, however, takes more of a supplier-driven perspective to innovation and new product development, but considers similar aspects as listed above. In addition, the relationships between suppliers and their customers are viewed only from a dyadic perspective instead of triadic or even more complex network perspectives. Thus, the research questions for this research are formulated as follows:

RQ1: How do different customers of construction products perceive construction innovation and involvement in supplier's new product development?

RQ2: What type of knowledge can these customers contribute to supplier's new product development?

RQ3: At what stages and by what practices can supplier involve these customers into its new product development?

The focus of this research is on material, product, and product system supply, and service supply is thus excluded and recommended as a topic for further research. When discussing construction products, the scope of this research is on all types of products where the market input from contractors, designers, clients, and/or end users can be seen beneficial for the supplier. These products can include, for example, all types of interior construction products and product systems such as doors, flooring, and tiling, but also structural products and product systems such as HVAC or even insulation materials. Although the scope of products is very broad, this research only focuses on products used in building construction, and thus infrastructure is out of the scope excluding the use of literature examples from infrastructure.

1.3 Research process

Figure 1 shows a rough depiction of the research process. Unstructured participant observation was used primarily in the early stages of the research to define the research topic and research proposal (Saunders et al. 2019, p.380-382). In addition, continuous observation was carried out throughout the research project to provide complementary knowledge to the semi-structured interviews. All relevant discussions and observations were recorded systematically in a single notebook in the moment of an event. All target company workers subject to observation were aware of the researcher's presence and the goals of the research process in all their activities. Therefore, researcher's role as an observer could be described as *active participation* or *participant-as-observer* (Spradley 2016, Saunders et al. 2019, p.384).

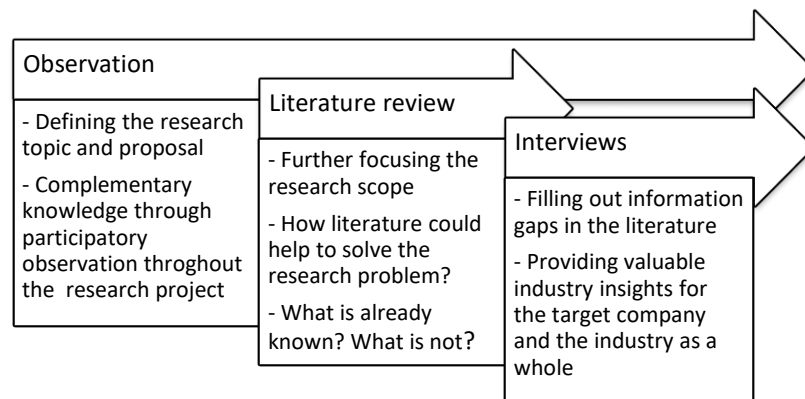


Figure 1: depiction of the research process

The research begins by reviewing relevant literature in chapter 2. First, both generalized and construction-specific concepts and research findings on new product development and customer involvement in new product development are discussed. Second, the stakeholders in construction project networks and their interdependencies and roles in construction industry and innovation are discussed. A theoretical justification for this research is then formed by synthesizing findings from these two streams of literature.

The primary data-acquisition method of this research consists of 15 semi-structured interviews carried out during the fall 2021. The methodology used for the interviews is further described in chapter 3, and the findings from these interviews are presented and discussed in chapter 4. These findings reveal tangible business- and project-level practices for attaining valuable market input from all customer stakeholders in construction project network during all stages of supplier's new product development process. Finally, the contributions of the research, possible limitations, and subjects for further research are concluded in chapter 5.

2. LITERATURE REVIEW

2.1 New product development

New product development (NPD) can be defined as “collection of activities of a firm that lead to a stream of new or changed market offerings over time” (Loch & Kavadis 2007, p.3). This includes the generation of new ideas, the selection of the most feasible ideas, and finally the transformation of ideas these into manufactured products and/or services offered to customers. This research, however, is limited only to studying NPD of manufactured products, and thus the creation of new service offering is excluded.

Literature recognizes myriads of NPD process models that divide the process in distinctive stages. Many of these models also include distinctive decision-making gates between the stages, thus often called stage-gate models. The earliest process models with multiple stages with decision-making gates were developed during the mid-1900's, but arguably the most well-known model has been developed and popularized by Robert Cooper (2001). Table 1 showcases some of the most well-known NPD process models.

Table 1: excerpt of NPD process models found in literature

| Scholar(s) | NPD process stages |
|----------------------------|--|
| Andreasen & Hein (1987) | Recognition of need → investigation of need → product principle → product design → product preparation → execution |
| Barclay et al. (2000) | Idea generation → preliminary investigation → detailed investigation (business case) → development → testing and validation → production and market launch |
| Blanchard (2004) | Conceptual design → preliminary system design → detailed design and development → construction → production |
| Cooper (2001, orig. 1986) | Discovery → scoping → building business case → development → testing and validation → launch |
| Fox (1993) | Pre-concept → concept → design → demonstration → production |
| Herbert (1969) | Design thinking: define → research → ideation → prototype → choose → implement → learn |
| IEC 60300-1 (2003) | Concept and definition → design and development → manufacturing installation |
| Pahl & Beitz (1996) | Clarification of task → conceptual design → embodiment design → detail design |
| Pugh & Hollins (1990) | Market → specification → concept design → detail design → manufacture |
| Roozenburg & Eekels (1995) | Analysis → concept → materialization |
| Tidd et al. (1998) | Search → select → implement → capture |

It is evident that all the models shown in Table 1 are based around a similar idea, where the whole process is divided in smaller sections starting from the generation of ideas to eventual launch of the product. This research adapts to the process model developed in 1986 by Robert Cooper (2001), as it is arguably one of the most widespread models used in variety of industries, and it is well suited for the needs of the target company and its business model. In addition, despite many of the similar models use terms *phase* and *phase-gate* to describe the NPD process, this research adapts to terms *stage* and *stage-gate* according to definition by Cooper (2001).

Figure 2 depicts the distinctive stages and their descriptions of the NPD process model by Cooper (2001). Although the inter-organizational management of innovation is not in the focal point of this research, this framework has a very central role in understanding customer involvement in NPD and especially what type of knowledge, if any, each customer group could contribute to each of these distinctive stages of the NPD process.

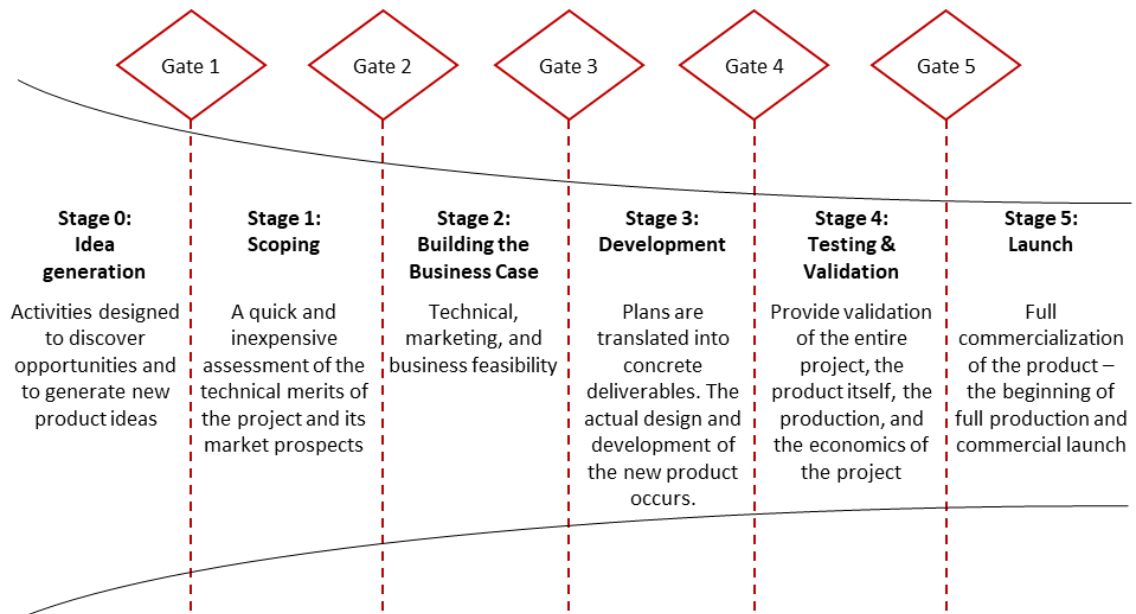


Figure 2: stage-gate NPD process model. Adapted from Cooper (2001)

According to industry findings, 71 % of the best performing NPD practices do include both explicit deliverables and designated gatekeepers for Go/Kill decisions in each stage (Cooper et al. 2004). Although literature recognizes some practical examples for these so-called *gate-deliverables*, these deliverables are usually very much context-dependent and are not thus further discussed in this research. It is not however excluded that this research could not result practical recommendations for such gate-deliverables that would be dependent on customer input or even require approval from certain customer groups.

2.2 Customer involvement in new product development

From an inter-organizational perspective, new product development programs are notorious for their uncertainty. But if the adopters of new products and innovations are also facing uncertainty in their own business operations, the developer of an innovation must also understand the problems of these various other stakeholders who will be the eventual adopters of an innovation. (Rogers 2003, p.140) These individuals and organizations are referred in this research as *customers*. The concept of customer should not be confused with the concept of construction project *clients* (see chapter 3.1.), although construction project clients are an important customer group for construction products.

There can be many drivers for companies to involve their customers to their NPD processes, such as understanding basic user needs, complying with regulations and standards, improving product quality, and improving commercial success of an innovation (Vaquero Martín et al. 2016). This research, however, does not focus on the question of *why*, but rather on questions of *how*, *when*, *who*, and *what (information)*. To answer these questions, Melander (2020) has constructed a set of questions an organization should ask itself when considering customer involvement in NPD. Although these questions presented in Table 2 were constructed in the context of a company manufacturing tools for automotive industry, the objective was to build a practical tool for manufacturing firms across industries. This set of questions was thus utilized throughout this thesis as a general guideline and checklist.

Table 2: summarized list of questions a firm should consider when planning for customer involvement in NPD (Melander 2020)

| Aspects of customer involvement | Questions to consider |
|--|--|
| Number of customers involved | How many customers should be involved in NPD? |
| Relationships with customers | What type of relationships do we have or should have with customers? |
| Communication with customers | Should we use indirect or direct communication with customers? |
| Timing of customer involvement | When should customers be involved? |
| Role of customers | What role should the customers have? |
| Customers' knowledge contribution | In what area do we want the customer to contribute knowledge? |
| Inter-organizational collaboration | Which internal functions need to collaborate? |
| Complementing customer involvement methods | How can different customer involvement methods be combined? |

Customer involvement in new product development has been studied extensively in the past, but research from the perspective of construction product suppliers is very limited. Therefore, in addition to literature specific to construction industry, this chapter looks at

generalized results of customer involvement in NPD that could also have implications in construction industry. As the concept of customer involvement is very broad, this research only focuses on managing customer interactions and gathering information from customers. Thus, the aspect of internal collaboration (Melander 2020) is excluded, including inter-organizational management of innovation, internal information sharing, and involvement of different internal groups. These areas of customer involvement should however never be neglected by NPD managers. Indeed, involving customers and gathering external knowledge is no use if a firm does not have the internal capabilities to process and absorb the gathered knowledge (see e.g., Cohen & Levinthal 1990; Spithoven et al. 2010).

2.2.1 Levels of customer involvement

Cui & Wu (2016) propose three levels of customer involvement in supplier's new product development: (1) customer involvement as an information source (CIS), (2) customer involvement as co-developers (CIC), and (3) customer involvement as innovators (CIN). Merit & Nielsen (2006) recognize similar concepts as the first two forms with customer roles spanning from "informants" to "co-creators". Brockhoff (2003) uses concepts such as "involvement by advice", "involvement by doing" and "involvement by strong control" to describe similar activities as Cui & Wu (2016). In the context of developing construction products, Wandahl et al. (2011) adopts the concept of user-driven innovation (UDI) similar to the concept of customer involvement as innovators (CIN).

Kaulio (1998) defines a framework for customer involvement practices with two dimensions. *The longitudinal dimension* includes the points in time during the NPD process when customer interaction and involvement happens, whereas *the lateral dimension* considers the level, depth, and breadth of customer involvement. The lateral dimension is further divided to three forms of customer involvement similar to definitions by Cui & Wu (2016), Merit & Nielsen (2006), and Brockhoff (2003).

Finally, Cooper (2011 & 2014) adopts a bit more ambiguous concept called *Voice-of-Customer* (VoC) originally established by Griffin & Hauser (1993) to discuss various practices on customer involvement in various stages of an NPD process. Thus, it is not such a multi-level conceptualization as the others mentioned above, although Cooper (2011) does include similar multi-level methods within this one concept such as ethnography, customer visits, lead user analysis, and even the design-by-customer approach.

Different conceptualizations of customer involvement in NPD are presented in Table 3. As most of these conceptualizations include similar characteristics, this research could

very well adopt any of these. The conceptualization by Cui & Wu (2016) is however chosen due to its overall good suitability and acclaim in high level publications.

Table 3: conceptualizations on levels of customer involvement, i.e., the lateral dimension

| Scholar(s) | Customer as an information source | Customer as a co-creator | Customer as an innovator |
|---|--|---|--|
| Cui & Wu (2016) | Customer involvement as information sources (CIS) | Customer involvement as co-developers (CIC) | Customer involvement as innovators (CIN) |
| Merit & Nielsen (2006) | Customers as informants or evaluators | Customers as co-creators | - |
| Brockhoff (2003) | Involvement by advice, involvement by weak control | Involvement by doing | Involvement by strong control |
| Wandahl (2011) | - | - | User-driven innovation |
| Kaulio (1998) | Design for customer | Design with customer | Design by customer |
| Griffin & Hauser (1993); Cooper et al. (2011) | Voice of Customer (VoC) | - | - |

The third level of utilizing customers as the innovators (CIN) in focal firms NPD is not as unambiguous nor cited as frequently in the literature as utilizing customers as information sources or co-creators, although von Hippel (1982) emphasized the implications of user innovation and user-developed products already in 1982. In essence it involves situations where customers are design products to their own needs, but which are then adopted and commercialized by a supplier (Nambisan 2002; von Hippel & Katz 2002). Despite its specialty, the method could be well suitable in the environment of developing construction products as there is a significant amount of designing capabilities within customer stakeholders, as for example noted by Wandahl et al. (2011). The target company of this thesis in fact has recognized the possibilities of this method, but also some challenges. As an example, there had been a case where a customer had approached with a completely new product idea to be developed. The challenge and eventual doom of the idea, however, came as the customer had underestimated the technical development costs and risks. The target company did not want to carry these costs and risks alone as there was no evidence for a wider adoption of this innovation, so the project was abandoned at an early stage. Nevertheless, the idea was well documented and preserved for possible future development, and thus contributing to the learning of the organization.

Cui & Wu (2017) studied the effects of CIS and CIC approaches to NPD performance in the regard of how much firm utilizes experimentation in the NPD process. They found that the more s firm utilizes experimentation and trial-and-error strategies in NPD, the

more they should adopt the CIS approach. Contrarily if less experimentation is utilized, the more they should adopt the CIC approach. (Cui & Wu 2017)

Lin et al. (2013) studied 196 high-tech NPD projects in Taiwan and found that the greater the customer involvement as information sources (CIS) in radical NPD projects, the lower the NPD outcome. This logic was also recognized in a research by Lagrosen (2005) by a company producing dishwashers, who claimed that customers usually provide information by comparing current product offerings from different suppliers, and thus hindering radical innovation by contributing ideas only for incremental changes. In addition, it was thought in the company that customers usually lack the competence to suggest valuable ideas, which could be very true in high-tech industries. There is however no evidence if these findings hold true with radical innovations occurring in low-tech industries such as construction.

Lin et al. (2013) also found that the customer involvement as co-developers (CIC) was positively associated with high-tech NPD outcome. This finding is supported by Chatterji & Fabrizio (2014), who claim that inventive collaborations with diverse user groups are most beneficial practices in the development of radical innovations.

When discussing the longitudinal dimension of customer involvement, industry benchmark studies by Cooper et al. (2004) show how the use of market input in various stages of NPD is one of the strongest discriminators between the worst and the best performing NPD practices. This observation is supported in the context of construction industry by Larsson et al. (2006), who show that the most innovative companies in Swedish construction industry engage in regular communication with their customers with well-established information-sharing practices. Sivunen et al. (2013) also suggest how sustainability innovations in construction fail commercially, because they lack active customer involvement and aim for incremental improvements rather than creating new and radical innovations. Furthermore, according to Cooper (2014), the best performers involve customers in every stage and iteration during the NPD process, and even include specific decision gate deliverables to ensure that the product indeed creates value to its potential customers.

Lagrosen (2005) explored the best practices in customer involvement in NPD through a qualitative case study targeting three small companies and three large multinational enterprises. Through his findings he suggests CIS type of approaches in the early stages of development, and CIC type of involvement in the later stages such as testing and piloting. Furthermore, integrative relationships where customer is able to contribute to the design (CIN) were seen to include involvement in every stage of the development. These findings have been compressed in Table 4.

Table 4: customer involvement with different levels of relationship (Lagrosen 2005, p.433)

| Level of a relationship | Longitudinal customer involvement | Lateral customer involvement | Suitable involvement methods |
|-------------------------|---|--|---|
| Transactional | <ul style="list-style-type: none"> Only in the early stages | <ul style="list-style-type: none"> Customer involvement as information source (CIS) | <ul style="list-style-type: none"> Surveys, focus group interviews, observation |
| Facilitative | <ul style="list-style-type: none"> In the early stages, in the testing stage, and occasionally in other stages | <ul style="list-style-type: none"> Customer involvement as co-developers (CIC) | <ul style="list-style-type: none"> Prototype testing, beta testing, conjoint analysis, team customer visits |
| Integrative | <ul style="list-style-type: none"> In all stages | <ul style="list-style-type: none"> Customer involvement as innovators (CIN) | <ul style="list-style-type: none"> Integrated NPD teams with representatives from both the supplier and the customer |

Lagrosen (2005) also found that company size does not correlate with the level of customer involvement, and the involvement breadth seems to vary wildly between companies regardless of the size. For the case companies in his research, the most common practice was to first gather ideas from customers through various channels, such as complaints and suggestions, but then not to involve customers again into the project until the first prototype of the new product was developed. Cost factor was recognized as the main reason for not using additional involvement. (Lagrosen 2005) Gruner & Homburg (2000) similarly suggest how involving customers in the early and late stages of NPD is beneficial for NPD performance, but that there are no benefits in involving customers in the intermediate stages such as technological development. These findings are further supported in the statement by Cooper (2001, p.52), that “competence in the technological tasks in the project” is the main success factor in NPD. However, according to best NPD practices observed across multiple industries, customers should be involved in every iteration of technological development through testing and trialing, albeit not in the actual technological development (Cooper et al. 2004) – unless it is the customer who acts as the innovator.

In most studies, customer involvement breadth is seen to positively affect NPD financial performance (Gruner & Homburg 2000; Lin et al. 2013; Vaquero Martín et al. 2021). In other words, the more different stakeholders, including users, buyers, payers, and regulators are involved in NPD processes in various stages, the more likely the project is to succeed. However, too intensive stakeholder involvement has been shown to decrease NPD outcome in some situations, with the most obvious reason being due to increased costs (Vaquero Martín et al. 2021). And as it was suggested by Lagrosen (2005) and Lin et al. (2013), intensive stakeholder involvement can be harmful to NPD performance if the chosen form of involvement is not the most suitable for the type of innovation at hand.

2.2.2 Choosing customers to involve

The innovativeness of the customers involved is seen as an important factor for NPD performance (Cooper et al. 2004; Gruner & Homburg 2000). Von Hippel (1988) was one of the first scholars to argue how lead users can recognize product attributes that become valuable for the greater audience only later in time. Therefore, the recognition of innovative lead users should be considered as an important criteria in customer involvement.

Gruner & Homburg (2000) found that involving technologically advanced customers is negatively associated with NPD performance. They propose two possible reasons for this somewhat unintuitive result: (1) technologically advanced customers have different needs from those of the market in general, and/or (2) firms involve technologically advanced customers when they have difficulties solving technological problems on their own. The latter reasoning would therefore imply that poor NPD performance is rather caused by technological incapability of the focal firm (as supported by Cooper (2001)) than because of involving technologically advanced customers. But obviously this does not eliminate the possibility that technologically advanced customers can have different needs from the wider market and should thus be addressed when choosing customers to involve.

Bosch-Sijtsema & Postma (2009) studied the capabilities and governance methods of the CIC approach in the Dutch construction industry and concluded that successful co-development requires careful selection of familiar, innovative, trustworthy, and competent partners with good reputations and intentions. Furthermore, both parties should perceive two-way benefits in cooperating, and the project should receive sufficient support from higher management. (Bosch-Sijtsema & Postma 2009)

Lawson et al. (2009) investigated the effects of formal and informal knowledge sharing on NPD performance within manufacturing industry in the UK and found strong evidence to support informal knowledge sharing practices over formal practices, although formal mechanisms were seen as important precursors for informal mechanisms. Sariola & Martinsuo (2016) also support the importance of informal knowledge sharing through non-contractual relationships within Finnish construction industry between product suppliers and designers.

When choosing customers to involve, it is obviously worthwhile to also consider the perspective of customers, i.e., what motivates customers to get involved in suppliers NPD. As the literature in integrative NPD is scarce from the point of view of construction product suppliers (Manley 2008), it is quite understandable that there is practically no literature discussing the perspective of designers, contractors, or clients when pursuing

involvement in construction product supplier's NPD. However, Vaquero Martín et al. (2016) carried out a comprehensive literature review in the context of medical device industry to determine drivers for customers to participate in a focal firm's NPD. They chose to examine this industry specifically because of its multiple downstream market stakeholders; a setting of which is very similar to the one in this research. The findings of their research are presented in Table 5.

Table 5: drivers for customers to participate in supplier's NPD (Vaquero Martín et al. 2016, p.1104)

| Stakeholder | Intrinsic drivers | Extrinsic drivers | |
|--|--|--|---|
| | | Non-material | Material |
| End consumers | <ul style="list-style-type: none"> • Interest in and enjoyment of innovation and invention (extrapolated from professional users) | <ul style="list-style-type: none"> • Finding solutions to their own challenges • Recognizing the value of their experience | <ul style="list-style-type: none"> • [Only marginally mentioned] |
| Customer organization – professional users | <ul style="list-style-type: none"> • Interest in innovation, technologies, and new knowledge • Improving end user satisfaction | <ul style="list-style-type: none"> • Overcoming unsuitability of existing technologies | <ul style="list-style-type: none"> • Monetary compensations • Prestige (significance not established) |
| Customer organization – decision makers | <ul style="list-style-type: none"> • [Low (individual intrinsic motivation likely subordinated to organizational objectives)] | <ul style="list-style-type: none"> • Improving quality of services | <ul style="list-style-type: none"> • Reduced costs of products and services |

Vaquero Martín et al. (2016) divide downstream market stakeholders in three distinctive customer groups that are (1) end consumers, (2) professional users, and (3) decision makers. Though it is discussed more thoroughly in the following chapter, it is already worth noting how this division is reasonably well suited for categorizing stakeholders in construction project networks too, as the listed drivers do match some industry findings and observations made within the target company. For example, the designers in construction project networks can be seen as the professional user group for construction products with an interest to improve end-consumer well-being, whereas contractors are usually the most dominant decision makers with an intensive to reduce cost of service delivery. However, the matching of construction project clients as the end consumers is not as straightforward, and neither it is clear whether any results in Table 5 describe the behavior of construction project clients and/or end users.

Vaquero Martín et al. (2016) continue by describing possible drivers for a focal firm to involve their customers to their NPD processes. Although this thesis does not focus on the question of *why* to involve customers in the first place, the findings presented in Table 6 do give some insight on *what* type of information could be expected from different customer groups.

Table 6: drivers for involving customers in supplier's NPD (Vaquero Martín et al. 2016, p. 1103)

| Driver (expected firm benefits) | Description | Main stakeholders that contribute to the driver |
|---|--|---|
| Understanding user needs | <ul style="list-style-type: none"> • Uncovering unmet needs • Understanding user' preferences and the product use conditions made known to firm through users' integration | <ul style="list-style-type: none"> • Professional users • End users |
| Improving product quality | <ul style="list-style-type: none"> • Obtaining specific technical skills needed to achieve product quality (effectiveness, usability, etc.) • Accessing the radically new ideas of innovative users | <ul style="list-style-type: none"> • Professional users |
| Improving commercial success | <ul style="list-style-type: none"> • Reducing post-launch costs • Increasing adoption of the final product • Reducing development costs • Designing successful business models • Meeting the needs of decision-makers | <ul style="list-style-type: none"> • Professional users • End users • Decision-makers • Financial mediators |
| Complying with regulation and standards | <ul style="list-style-type: none"> • Meeting the requirements of regulatory bodies • Meeting additional requirements of e.g., standardization and funding organizations | <ul style="list-style-type: none"> • Professional users • End consumers |
| Strategic benefits | <ul style="list-style-type: none"> • Developing strategic capabilities • Informing strategic decisions related to approval processes • Informing strategic decisions related to market trends and competitive landscape | <ul style="list-style-type: none"> • Professional users • End consumers • Regulators |

To conclude this chapter, Vaquero Martín et al. (2016) also present a framework on the barriers and success factors when both choosing the customers to involve and when interacting with these chosen customers. Though the points presented in Table 7 are quite comprehensive, they are at same time very open-ended, i.e., they leave many aspects to be considered separately from project to project. For example, what is the sufficient involvement breadth if greater breadth constitutes to a greater NPD performance, but requires more resources spent on the involvement? However, the listings of barriers and success factors also include some interesting points, that will be interesting to explore in this research in the context of construction. For example, how much possible conflicts of interest, different objectives, or different jargon act as barriers when involving customers in construction innovation? Or how much are there access barriers to the "right" customers in general?

Table 7: barriers and success factors in customer involvement (Vaquero Martín et al. 2016, p.1106)

| | Barriers in customer involvement | Success factors in customer involvement |
|-----------------------------|--|---|
| Identification of customers | <ul style="list-style-type: none"> • Interference of commercial and budget pressures of the focal firm • Difficulties in identifying range of customers or foreseeing potential future customers • Accessing vulnerable customers • Accessing customers with potential conflicts of interest • Biased customer selection to avoid negative feedback | <ul style="list-style-type: none"> • Identifying the right customers in a timely fashion • Determining the breadth of customers most adequate for each project • Identifying a range of customer groups, sub-groups or individuals who will be in contact with the product • Avoiding a biased selection to ignore possible sources of negative feedback • Integrating lead users with specific cognitive characteristics for each phase of the NPD process • Overcoming access barriers to customers through the identification of adequate proxies or representatives |
| Interaction with customers | <ul style="list-style-type: none"> • Barriers of individuals' 'not knowing' or 'not wanting' • For customer organizations: rigid hierarchies and the fear of losing IP rights • Different objectives, norms, and jargon • Use of inadequate methods | <ul style="list-style-type: none"> • Interacting with customers from the beginning of the NPD process • Designing adequate interaction patterns in terms of the number and mix of participants, duration and range of methods used • Ensuring an open environment for knowledge sharing • Using a common language, supported by the use of prototypes |

2.3 Construction innovation

The construction product industry – and also the construction industry in general – have for long been known to suffer from low rate of innovation and conservatism, which has led these industries to fall behind others. (Lassen et al. 2010). Furthermore, the innovation-oriented activities are heavily orientated towards incremental product enhancement rather than broader improvements on processes and operating models (Winch 1998).

The characteristics of the construction industry can largely be defined as a low-tech with below 2 percent investments in R&D (Reichstein et al. 2005; Seaden & Manseau 2001). Furthermore, the industry structure creates a strong interdependence between different parties in supply network (suppliers, manufacturers, retail, architects, and contractors) which often becomes a barrier to innovation (Lassen et al. 2010).

In this chapter, acknowledged perceptions and practices for innovation in construction industry are discussed separately from the point of view of each major stakeholder in construction project network. Figure 3 depicts the basic structure of a construction project network and its stakeholders, where solid arrows represent contractual relationships in projects, and dashed arrows represent informal relationships.

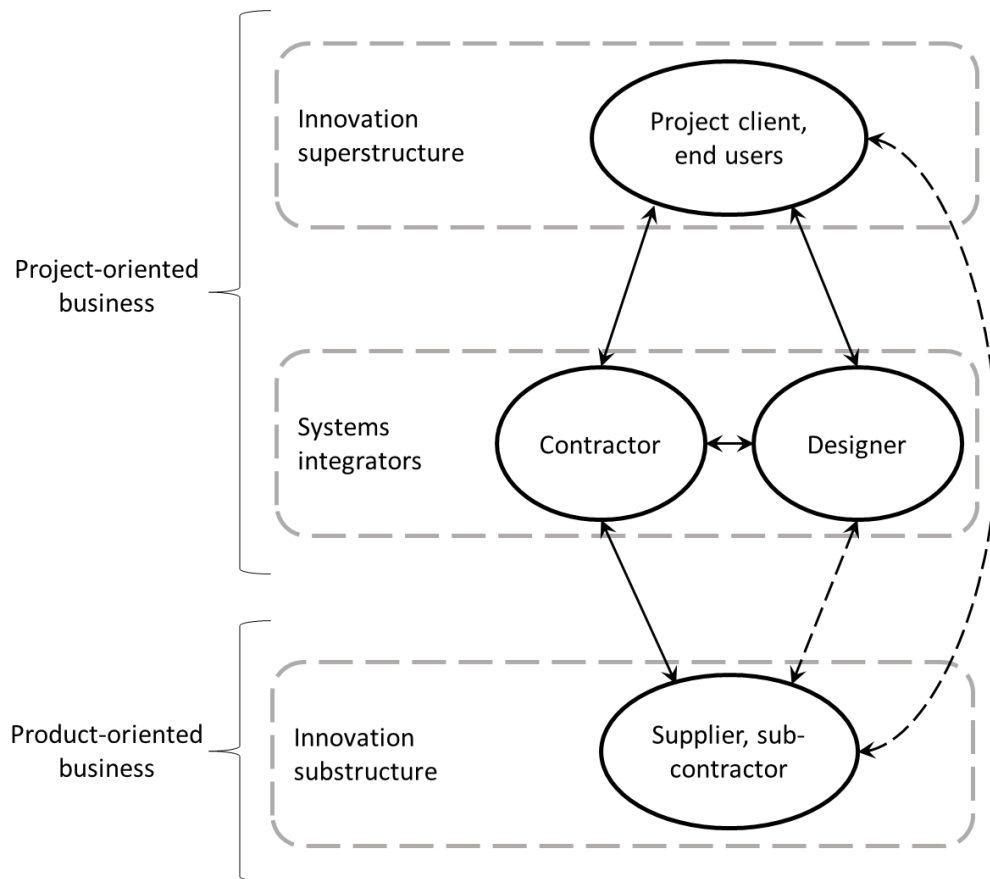


Figure 3: construction project network. Adapted from Winch (1998) and Sariola (2018)

2.3.1 Supplier's perspective

Suppliers stand out from other actors in construction project networks because their business models are usually more product-oriented than project-oriented (Larsson et al. 2006). Suppliers have even been argued as key sources of innovation within the industry (Bygballe & Ingemansson 2014; Gambatese & Hallowell 2011), because this product-orientation allows suppliers to maintain long-term R&D programs beyond project boundaries better than actors with mostly project-based operations (Blayse & Manley 2004). However, as it is also recognized by the target company, construction product suppliers can have difficulties in identifying relevant market needs for new product development as they usually do not have a direct link to the eventual adopters of their products (Larsson et al. 2006). In addition to completely new products, this applies also into how existing products could be developed further.

Atkin (1999) argued how traditional construction project implementations and contracting make insufficient use of suppliers' expertise, although Gil et al. (2001) found that trends in lean construction have increased early project involvement of supplier's and specialty contractors compared to that of 20th century. But nevertheless, Sariola (2018) found that

supplier's non-central position in project networks hinders their contribution to construction innovation still today in Finnish construction industry.

In addition to having a non-central position in construction project networks, earlier research has recognized other factors that limit the suppliers' innovation potential in the construction industry. The project-based nature of construction is limiting innovation in general as these projects and project organizations are often unique and temporal (Gann & Salter 2000). This non-recurring nature of construction projects hinders the possibilities for developing innovations that can be transferred from a project to another, thus reducing initiatives to innovate within projects (Blayse & Manley 2004). Suppliers also view restrictive and cost-centric tendering criteria, insufficient involvement in early design stages, and difficulty of trialing new products as the barriers to construction innovation (Rose et al. 2019). There is, however, some evidence that non-traditional and more collaborative contracts could lower these barriers and provide better platforms for suppliers to implement innovations; as for example partly shown in research by Manley (2008).

Manley (2008) reviewed four Australian construction projects in which product suppliers were implementing new innovations. Because of the advanced nature of all implemented innovations, the suppliers' primary relationships were with the project client, with head contractors being of secondary importance. In all reviewed projects, suppliers had developed relationships with the project networks several months or even years before the projects were finalized. It was thus concluded that the success of suppliers' innovations in these projects were mostly influenced by the exceptional strength of their relationships within project organizations and end users, driven by the advanced nature of implemented innovations. (Manley 2008) It is important to note that building such high-quality relationships might be much harder with low-tech and incremental innovations more typical for construction. In addition, even with high-quality relationships driven by advanced innovations, the suppliers in Manley's (2008) research did not have direct relationships with end users. Lack of end-user involvement is acknowledged as a constant problem in the industry, despite the increased acknowledgement of its costs (Larsson et al. 2006).

Larsson et al. (2006) interviewed 10 construction product suppliers and manufacturers with operations in northern European countries to benchmark practices and perceptions on managing innovation. The interviews revealed significant variations on how different suppliers view their position in the innovation process, their approach and processes for new product development, and also the interaction with their customers. Although they were not able to pinpoint which of these practices had worked out the best, they

concluded that any proactive approach towards contractors would be beneficial to promote product and process innovation (Larsson et al. 2006). Mapping out opportunities for improved collaborations between construction companies and product suppliers to promote innovation was thus recognized as a topic for future research.

Supplier's technical capabilities and problem-solving abilities have been shown to be important antecedents of trust in contractual relationships by many authors (see e.g., Khalfan et al. 2007; Meng 2012). This would imply that stakeholders in construction project networks value supplier's technical capabilities at the project-level, and in case the business-level co-development is based around contractual relationships. But regarding non-contractual relationships, such evident does not exist.

2.3.2 Contractor's perspective

According to McCoy et al. (2009), contractors are the most dominant decision-makers within the construction industry with a power to affect the commercial success of a construction innovation. Contractors do also have a central role in every construction innovation, as they ultimately deliver these innovations to clients through projects. The role of contractors in construction innovation can be described as a *system integrator* (Sariola 2018), which is defined by Winch (1998) as the "mediating role in the interface between the innovation superstructure and the innovation substructure". For these reasons alone, it is vital for suppliers to understand the contractors' perspective in successful new product development.

Sariola (2018) interviewed 18 contractors and their representatives from Finland to find out practices for enhanced supplier-contractor relationships. The results were divided in relationship-oriented practices and innovation-oriented practices at both business and project-levels and are presented in Table 8. In terms of supplier's NPD, especially interesting are the mentioned innovation-oriented practices at the business-level, as these results imply that contractors could provide resources and knowledge especially for technical product development and piloting. Regarding recommended practices for suppliers, one interviewed contractor even mentioned how "contractors are the only source of feedback and development ideas for suppliers" (Sariola 2018, p.176), as they use the products at construction sites and know the development needs. However, contractors will not usually give feedback to suppliers by their own initiative, but rather suppliers need to ask for development ideas and for feedback proactively from contractors. (Sariola 2018) But accessing this knowledge can be difficult even for contractors themselves. As observed by Rundquist et al. (2013) the main challenges in involving contractor's knowledge in construction innovation is how to first get hold of

ideas appearing among staff at the construction site, and then storing the collective knowledge developed at a site for future projects.

Table 8: practices for enhanced relationship and innovation from contractor's perspective
(Sariola 2018, p.173-175)

| Relationship oriented practices | Contractor's practice | Supplier's practice |
|---------------------------------|---|--|
| Business-level | <ul style="list-style-type: none"> • Framework agreements • Partnering • Product category management | <ul style="list-style-type: none"> • Specific contact person • Reliable operation of business • High-quality products |
| Project-level | <ul style="list-style-type: none"> • Reasonable tendering • Giving positive and negative feedback | <ul style="list-style-type: none"> • Quick reactions to questions and problems • Ensuring deliveries |
| Innovation oriented practices | | |
| Business-level | <ul style="list-style-type: none"> • Resources for development • Piloting new products and solutions from supplier's initiative • Guiding supplier in new product implementation | <ul style="list-style-type: none"> • Presenting new products and solutions • Proposing new product pilots • Asking feedback and development ideas |
| Project-level | <ul style="list-style-type: none"> • Requesting alternative solutions • Tendering with incomplete designs • Cooperation in project network | <ul style="list-style-type: none"> • Checking design in detail • Proposing alternative solutions |

As the research setting of this research is very similar to that of Sariola (2018), it will be interesting to see if the contractors interviewed in this research have similar perceptions. Although it is important to distinguish how this research takes a deeper dive to the supplier's perspective, and specifically NPD of a firm. This could thus yield more specific thoughts and ideas from interviewees due to a more specific context.

Despite the suppliers are seen as key sources for innovation in construction industry (Bygballe & Ingemansson 2014; Gambatese & Hallowell 2011), a survey research by Håkansson & Ingemansson (2013) showed how Swedish contractors perceived opinions and ideas of their clients and co-workers as more important drivers for innovation than the opinions and ideas of their suppliers. However according to Sariola (2018), contractors in Finland do acknowledge the innovation potential of suppliers' too, but leveraging this potential requires better enhanced contractor-supplier relationships and overcoming barriers that are limiting suppliers' innovation potential. But nevertheless, it seems clear that the incentives for contractors to initiate enhanced relationships with supplier's and to leverage supplier's knowledge for innovation is relatively low.

Frödell (2011) conducted participatory observation and interviews with strategic procurement of Skanska Sweden to develop criteria for achieving efficient contractor-supplier relationships. Most of the criteria demand for contractors to develop long-term relationships with suppliers, but it seemed that contractors were unwilling to do this (Frödell 2011). Bygballe & Ingemansson (2014) support this observation by indicating

that contractors are not motivated enough to develop their long-term relationships with suppliers. They found that contractors have only little incentive to collaborate with raw material suppliers, while in comparison, subcontractors are given more attention. However, even if suppliers' importance for innovation is recognized, the short-term focus on ongoing projects means that long-term relationships are generally not pursued. (Bygballe & Ingemansson 2014) These results also support the risk aversion of contractors observed by Blayse & Manley (2004).

Contractors are usually the first-hand paying customers for suppliers in construction project networks with strong initiatives to minimize total costs (Frödell 2011). This would imply that suppliers should ensure the paying intent of new product innovations primarily from contractors. Indeed, the research by Akintoye & Main (2007) suggests that contractors play a crucial role in the development of the value proposition of construction innovation. The challenge here, however, seems to be in getting contractors involved in the first place. Akintoye & Main (2007) show that contractors in United Kingdom would enter collaboration with the hopes of financial gains by reducing project development costs and risks. Their findings also suggest how contractors do not enter collaboration because of what their competitors are doing, but only if it is a viable business proposition for them (Akintoye & Main 2007). In addition, it is a recognized phenomenon in the target company of this research that contractors usually require extended warranties and considerably lower prices when piloting new products. This behavior was also mentioned by one contractor interviewed by Sariola (2018).

2.3.3 Designer's perspective

Construction projects employ many different types of designers in every stage of a project. As this research is focused on the supplier's perspective, we are mostly interested in designers who work in close proximity to suppliers and are held responsible for specifying products to be used in projects. These designers are sometimes referred in literature as *specifiers* (Emmit 2006). This research however adopts the concept of *designer*, as the possibility of involving other designer's than specifiers to supplier's NPD should not be excluded. This is especially true when involving designers in supplier's business-level NPD, as in this context, a designer would not have the role of a specifier.

Designers are recognized to hold a rather central position within the construction project network similar to that of contractor's (Sariola 2018; Yang et al. 2011). Indeed, designers are involved in construction projects from early on and usually participate through the project from early planning all the way to creating the final touch (Hemström et al. 2017; Jalkala et al. 2010). To illustrate this central position in construction project networks,

clients and contractors often utilize designer's specifications as a guideline in their tendering and purchasing decisions (Errasti et al. 2009; Peat 2009, Sariola 2018). However, there is lack of research on designer's role especially at the business-level of construction industry, and specifically the development and adoption of suppliers' new innovations (Emmitt 1997; Larsson et al. 2006; Sariola & Martinsuo 2016).

Bygballe et al. (2010) & Hemström et al. (2017) argue that most of the new innovations in the construction industry are found to come from architects, structural designers, suppliers, and from the collaboration between these parties. In addition, cooperation between product suppliers and designers has been shown very important specifically in terms of new innovations and new product development (Ozorhon 2013; Rutten et al. 2009). Indeed, as designers are engaged with both customers and contractors in construction project networks, they could contribute knowledge with a wide perspective for supplier's new product development. However, most of these prior studies have been carried out only from the perspective of project-level cooperation, and thus leaving in questions about cooperation at the business-level. To answer this, Sariola & Martinsuo (2016) studied the non-contractual relationships between suppliers and designers in Finnish construction project networks and showed that only 38 percent of designers had at least once cooperated with suppliers beyond project boundaries. The result implies that designers and product suppliers do not cooperate actively within the construction industry beyond project-level. (Sariola & Martinsuo 2016)

However, according to a prior research by Martinsuo & Sariola (2015) some designers in Finland had been found to have an interest in supplier's development projects beyond project-level. They were especially interested in possibility of bringing in their perspectives rather early in a new product development process (Martinsuo & Sariola 2015). Also, the findings by Vaquero Martín et al. (2016) presented in chapter 2 showed how professional users such as designers are intrinsically motivated by technologies, innovation, and sources of new knowledge. Combined with designers' central position in project networks and their potential to also convey the needs of contractors and clients, these findings seem quite promising in terms of involving designers in supplier's new product development. A comprehensive web-based survey by Hemström et al. (2017) also showed how architects find construction to lack innovation but at the same time they thought suppliers to have a key role in construction innovation. These results could also imply interest to participate in supplier's innovation efforts. But however, there are also findings that could imply lower levels of interest towards suppliers, such as Emmitt & Yeomans (2008, p.153) showing how the selection and specification of construction products is seen as the least glamorous, most tedious, and a very time-consuming task, which is often delegated to lower paid employees in the architect's office.

Regarding the selection of construction products in projects, designers are known to stick down to known products, and thus creating a barrier to innovation (Emmitt 1997; Sariola 2018). They have even been shown to utilize lists of known and favorable products (Emmitt & Yeomans 2018, p.153); a practice also recognized in the target company. Getting new products on these lists should naturally be in every supplier's interest, but also keeping the existing products on these lists. This is because architects have been shown to easily discard and even blacklist products that have not performed as stated or completely failed (Emmitt & Yeomans 2018, p.153). But nevertheless, these findings imply, that developing trust in a relationship and engaging designers also during the launch stage of NPD process would be important in order to make designers aware of and to accept the new innovation.

Emmitt (2006) suggests that designers need suppliers' technical help in problem-solving situations, which may further increase trust in relationships between designers and suppliers. Indeed, it's also noted in the target company, how designer's might call and ask for help with technical issues. Thus, it is no surprise that designer's do view supplier's technical capabilities and problem-solving skills as important antecedents to trust in non-contractual relationships (Sariola & Martinsuo 2016), whether the non-contractual cooperation happens at project or business-level. However, there is no clear evidence on how these results would translate to a situation where supplier is asking for help from a designer for new product development. For example, would designers be more willing to participate in a non-contractual co-development initiated by a supplier if they perceive supplier's technical capabilities and problem-solving skills to be particularly high? And conversely, would low technical capabilities lower designers' interests to participate?

Rogers (2003, p. 377) suggests that the greater the empathy is between possible client and a supplier, the greater the trust will be in a relationship and thus greater chance for ensuring adoption. Indeed, some construction product suppliers have employed designers as trade representatives in the pursuit to reduce this so-called heterophily gap (Emmitt & Yeomans 2008, p. 168). Ibstock, a brick manufacturer from UK was allegedly the first product supplier to do so, and since then this marketing strategy has been adopted by their competitors (Cassell 1990). Although these studies have focused on the adoption of new and existing innovations, the results could also be applicable when developing trustworthy, non-contractual relationships with designers. In addition, these results could imply that it is not particularly the level of technical capability that matters, but rather the similarity of capabilities with designers. Unless, of course, the designer is looking for help in technical matters.

Sariola & Martinsuo (2016) also found that – contradictory to prior studies in contractual relationships – designers do not perceive suppliers' reputation or level of cooperation beyond project boundaries as predecessors of trust in non-contractual relationships. However, the context of their research may explain this surprising result, as all surveyed designers had worked with the selected supplier earlier at least in one project. (Sariola & Martinuso 2016) In other words, positive first-hand experiences from working with a supplier may have overridden general views on reputation. And as only 38 percent of designer's had ever cooperated with suppliers beyond project-level, this could explain why level of cooperation beyond project-level was neither seen as a predecessor of trust.

Lastly, designers have been shown to utilize so called gatekeeper mechanisms towards external information about construction products and new innovations (Emmit & Yeomans 2008, p.156). This finding supports a more generalized view by Rogers (2003), who argues that individuals do not expose themselves to new innovations if they do not have an acute need for it. And even if these individuals are exposed to the innovations, according to Emmit & Yeomans (2008, p.158) "there will be little effect unless they perceive the innovation as relevant to their current needs and consistent with their existing attitudes and beliefs". This gatekeeping mechanism could thus imply that the best moment to ask for involvement into supplier's NPD would be during the times when the gate is "visibly" open, i.e., when architects are actively seeking solutions to their problems. This time could be, for example, during construction projects when architects are required to seek information about products not previously familiar, or if a previously used product had failed to perform. Indeed, Vaquero Martín et al. (2016) support this as professional users are extrinsically motivated to participate in supplier's NPD if they are looking to overcome unsuitability of existing technologies. Another potential situation would be that of a product presentation held by the supplier, which are also very common practices at the target company and the industry in general. This latter method is supported by Emmitt & Yeomans (2008, p.166-167) who found how successful trade representatives are eager to exploit all the meetings and opportunities for involvement with designers to access feedback on existing products and products in development. And conversely, they demonstrated how construction product suppliers' habit of bombarding designers with information is extremely insufficient due to the gatekeeper mechanism (Emmit & Yeomans (2008, p.158).

2.3.4 Client's perspective

A variety of definitions for *clients* exists in construction project networks. In Finnish professional language, a concept of *rakennuttaja* is often used which roughly translates to a *builder*. The concept of builder is also sometimes used in English professional language in the context of building private housing (see e.g., McCoy et al. 2009), but in the context of this research this role is somewhat closer to a contractor. In this thesis, the term client therefore refers to “an actor in project network who acquires a head contractor to do the on-site construction work and further acquire the needed suppliers”. This client could thus be a *real estate developer*, their representative such as a *consultant*, but also an *end user* to some extent. It is also important to note that in some cases the head contractor could also be the client of a project if the building is recorded in the contractor's own balance sheet.

Recent studies suggest that clients are the fundamental drivers of construction innovation with an authority to demand innovation and to create a favorable environment for other stakeholders to innovate (Bygballe & Ingemansson 2014; Loosemore & Richard 2015; Ozorhon 2013). Indeed, clients have been recognized to act as an important catalyst for construction innovation by demanding improved performance (Barlow 2000; Gann & Salter 2000), or by expressing novel requirements (Seaden & Manseau 2001). However, there is a large variety of clients in construction with different capabilities and needs, and thus clients are not equally willing or mature to promote innovation in construction projects. Sexton et al. (2008) argue how client's role in construction innovation can range from “passive” to “balanced” to “dominant”. Manley (2008) note how large and repeating clients are the most likely to take upon this dominant role, whereas non-recurring clients are less likely to promote construction innovation. Furthermore, Roos et al. (2010) show how the real estate developers in Finland hold the most control over material selection, whereas the end-user only has weak control. This wide variety of types, roles, and ascendancies of clients in construction also creates a significant challenge for finding strong empirical evidence of any type of generalized client behavior. Especially regarding the involvement of construction project clients in supplier's NPD, the amount of applicable research is very scarce.

Bresnen (2010) and Tzortzopoulos et al. (2008) argued how most clients in construction are not prepared for innovation with coherent plans and are usually driven by extrinsic drivers such as reducing the costs and risks on product and service deliveries. Indeed, such traditional procurement methods still most often adopted by clients have been argued as a key reason for maintaining adversarial and transactional relationships in the industry (Blayse & Manley 2004; Bygballe et al. 2010). In addition, Rose et al. (2019)

showed how construction consultants in Australian infrastructure projects think there is not enough emphasis on lifecycle costs from clients, but rather too much emphasis on direct purchase costs.

Further according to the research by Rose et al. (2019), the clients of Australian infrastructure projects consider the biggest barriers for innovation to result from suppliers' insufficient testing of new products and reluctance to carry increased risks in case of product failures. This result showcases similar risk-averse behavior to that of contractors, in which short-term project-level benefits surpass possible long-term benefits on the business-level. Indeed, according to Bygballe & Ingemansson (2011), the construction industry as a whole both in Sweden and Norway perceives business-level R&D projects as of less importance for renewal and innovation compared to "smaller steps" and continuous development within construction projects. However, there is a wide difference in perceptions between smaller companies and larger corporations within the industry, as the largest corporations seem to have more positive attitude towards R&D with substantial investments. But despite this, the general point of view within the industry is very focused on seeking short-term benefits, with an apparent inability to see that investment in long-term R&D and innovation is in fact a prerequisite for reducing long-term costs. (Bygballe & Ingemansson 2011)

According to the industry findings by Pahikkala (2020), Finnish real estate developers recognize many problems in reinventing building design to respond to new trends. In the case of developing shared office environments, as an example, the change would require a development of completely new business models and the involvement of all the possible stakeholders at the earliest possible stage, including the space operator of shared environments (Pahikkala 2020). Although the role of product suppliers was not namely recognized in this setting, it is evident that the suppliers have an important role in providing the tangible solutions; in this case the means to operate the office space. Therefore, we may argue that real estate developers and product suppliers could find common grounds for co-development to find new solutions to most recent trends.

2.4 Literature synthesis

Discussed literature findings are synthesized in Table 9 separately for each customer group discussed in previous chapters. These findings have been further classified roughly according to the three research questions to recognize what is already known about customer involvement in construction product supplier's NPD and what is yet to be uncovered.

Table 9: literature synthesis

| | Contractors | Designers | Clients |
|---|---|---|--|
| Role in project networks from supplier's perspective | <ul style="list-style-type: none"> • Firsthand paying customer and the ultimate decision maker | <ul style="list-style-type: none"> • Professional users (Vaquero Martín et al. 2016) • Firsthand target group for product marketing (Emmitt & Yeomans 2018) | <ul style="list-style-type: none"> • Large variety of clients with roles varying from passive to dominant (Sexton et al. 2008) |
| Perceptions and drivers on construction innovation | <ul style="list-style-type: none"> • Low intrinsic drivers (Vaquero Martín et al. 2016) • High extrinsic drivers for reducing costs (Frödell 2011; Lagrosen 2005) and achieving two-way benefits (Akintoye & Main 2007; Bosch-Sijtsema & Postma 2009) | <ul style="list-style-type: none"> • Intrinsic interest in new knowledge and innovation (Martinsuo & Sariola 2015; Vaquero Martín et al. 2016) • Overcoming unsuitability of existing technologies. (Emmitt & Yeomans 2018; Vaquero Martín et al. 2016) | <ul style="list-style-type: none"> • Intrinsic drivers expected as low (Bresnen 2010; Tzortzopoulos et al. 2008) yet dependent on project frequency and firm size (Manley 2008) • High extrinsic drivers for reducing costs (Bygballe et al. 2010; Rose et al. 2019) |
| Perceptions on construction product supplier's role and NPD | <ul style="list-style-type: none"> • Innovation potential of supplier's is recognized, but better enhanced relationships are required (Sariola 2018) • Ideas and opinions of co-workers and clients seen more important than those of suppliers' (Håkansson & Ingemansson 2013) | <ul style="list-style-type: none"> • Suppliers seen to have a key role in innovation (Hemström et al. 2017) • Professional users value suppliers' technical capabilities and problem-solving skills (Emmitt & Yeomans 2018; Sariola & Martinsuo 2016; Vaquero Martín et al. 2016) | <ul style="list-style-type: none"> • No generalized perceptions recognized • Supplier's insufficient testing of new products and reluctance to carry increased risks seen as a barrier to innovation by some clients (Rose et al. 2019) |
| Knowledge contribution to supplier's NPD | <ul style="list-style-type: none"> • Product implementation on construction sites (Sariola 2018) • Value proposition of new innovations (Akintoye & Main 2007) | <ul style="list-style-type: none"> • Non-technical topics such as visual design (Emmitt 2006) • New and radical ideas from professional/lead users (Vaquero Martín et al. 2016) | <ul style="list-style-type: none"> • Catalyzing innovation by expressing novel requirements (Barlow 2020; Gann & Salter 2000 Seaden & Manseau 2001) |
| Involvement practices for supplier's project-level NPD | <ul style="list-style-type: none"> • Early involvement of and collaborations between all project stakeholders including suppliers (Bygballe et al. 2010; Hemström et al. 2017) • Checking designs in detail and proposing alternative solutions (Sariola 2018) | <ul style="list-style-type: none"> • Project-level collaborations between suppliers and designers in general (Ozorhon 2013; Rutten et al. 2009) | <ul style="list-style-type: none"> • Exploiting projects where clients demand innovation and/or create favorable environment to innovate (Loosemore & Richard 2015; Ozorhon 2013) • Earlier involvement of supplier's and other stakeholders (Manley 2008; Pahikkala 2020) |
| Involvement practices for supplier's business-level NPD | <ul style="list-style-type: none"> • Presenting new products and solutions to contractors (Sariola 2018) • Aid in developing the value proposition (Akintoye & Main 2007) to improve commercial success (Vaquero Martín et al. 2016) • Piloting new products and solutions from supplier's initiative and guiding in new product implementation (Sariola 2018) • Transactional involvement as information source if long-term relationships are not established (Lagrosen 2005; Sariola 2018) | <ul style="list-style-type: none"> • Involvement when receptive for new information, e.g., during product presentations (Emmit & Yeomans 2008) • Interest towards early stages of supplier's NPD (Martinsuo & Sariola 2015) • Expected possibilities for facilitative involvement as co-developers or even integrative involvement as innovators. Involvement at least in early development stages and testing (Lagrosen 2005; Martinsuo & Sariola 2015) | <ul style="list-style-type: none"> • Not recognized • Business-level development viewed as less in importance compared to incremental project-level development (Bygballe & Ingemansson 2011) |
| Key barriers to involvement in supplier's NPD | <ul style="list-style-type: none"> • Reluctance to build long-term relationships with suppliers (Bygballe & Ingemansson 2014; Frödell 2011) | <ul style="list-style-type: none"> • Low level of business-level cooperation with suppliers in general (Sariola & Martinsuo 2016) | <ul style="list-style-type: none"> • Access barrier to clients' knowledge due to supplier's non-central position (Larsson et al. 2006; Sariola 2018) |

Regardless of the customer group in construction project networks, past literature findings have shown the importance of recognizing and involving lead users in NPD (Cooper et al. 2004; Gruner & Homburg 2000; Von Hippel 1988) through long-term and trustworthy relationships with two-way benefits (Bosch-Sijtsema & Postma 2009; Sariola 2018), and by allowing for informal knowledge sharing (Lawson et al. 2009; Sariola & Martinsuo 2016). But it is not only the lead users that should be involved, as the utilization of diverse user groups (Chatterji & Fabrizio 2014) and increased involvement breadth are generally shown to have a positive effect on NPD performance (Gruner & Homburg 2000; Lin et al. 2013; Vaquero Martín et al. 2021) with mostly limited by firms' willingness to spend on the involvement (Lagrosen 2005). But this positive effect can however be lost if the level of involvement does not suit the nature of innovation. Despite construction industry generates mostly innovations that can be considered low-tech (Reichstein et al. 2005; Seaden & Manseau 2001), possible high-tech or even radical innovations could suffer from transactional involvement of customers as information source (Lagrosen 2005; Lin et al. 2013), and thus customers should be involved as co-developers (Chatterji & Fabrizio 2014; Lin et al. 2013) through facilitative relationships (Lagrosen 2005).

As the literature in integrative NPD is scarce from the point of view of construction product suppliers (Manley 2008), there is practically no research combining the innovation-oriented perspectives and drivers of designers, contractors, or clients with the lateral dimension of customer involvement. The only applicable research by Vaquero Martín et al. (2016) does give some insights from a similar context of medical devices industry but does not explicitly link the perspectives of different customer stakeholders to the stakeholders in construction project networks. Thus, the perceptions of contractors, designer, and clients on construction innovation and involvement in construction product supplier's NPD are still needed to unravel explicitly.

Although some practical insights are already recognized regarding the lateral dimension of customer involvement, there is a very large knowledge gap when considering the longitudinal dimension and the possible knowledge contribution of each customer group in construction project networks. Some preliminary ideas are recognized for involving designers and contractors, such as the designers' interest towards early stages of development (Martinsuo & Sariola 2015) and contractors' knowledge on product implementation on construction sites (Sariola 2018). But if a comprehensive framework is to be designed, these snippets of information are far from enough. Furthermore, practices for involving construction project clients into supplier's NPD are completely lacking in literature. Thus, there is a clear need for this research to answer on what knowledge can each customer group in construction project networks contribute for each stage of construction product supplier's NPD process.

3. RESEARCH METHODOLOGY

The definition and selection of empirical research strategy and methods used in this thesis are based on Saunders et al. (2019). The research relies primarily on an interpretive philosophy; according to which the reality, research information, and research results are strongly dependent on individual interpretations and values (Saunders et al. 2019, pp. 148-149).

3.1 Research design

Interpretivist research philosophy is often linked with an inductive approach in constructing new theory (Saunders et al. 2019, p. 155). In other words, the construction of new theory in the form of a framework is based primarily on empirical findings made during the research rather than existing theories. On the other hand, the research also seeks, if possible, to test and verify the theories found previously in literature. Therefore, the research logic could also be defined as abductive.

The purpose of the research is exploratory. The advantage of exploratory research is the flexibility of the approach, i.e., the subject of the research may change on the basis of new information found during the research process (Saunders et al. 2019, p. 187). To highlight this iterative nature of the research process, the research problem changed completely twice within a period of three months before the final approach was identified. Although this led to a much longer research schedule than initially estimated, the whole process constituted greatly to the learning of both the researcher and the target company. Despite the long process, the research is conducted as cross-sectional research with the time horizon focusing on the present moment.

The research strategy follows design science research, which is often defined in conjunction with exploratory research (Holmström et al. 2009). Essentially, the result of a design science research is a “*purposeful artifact created to address an important organizational problem*” (Hevner et al. 2004, p.82), which is here a generalized framework for customer involvement in construction product supplier’s new product development. Furthermore, Hevner et al. (2004) formalizes a total of seven guidelines for a successful design science research, that are assessed in the context of this research in Table 10.

Table 10: design science research guidelines (Hevner et al. 2004)

| Guideline | Assessment in this research |
|-------------------------------|---|
| 1: Design as an artifact | Generalized framework for customer involvement in construction product supplier's new product development. Designed as a visual artifact. |
| 2: Problem relevance | Research problem has been recognized by industry practitioners. The artifact is designed to solve this novel problem and further evaluated by the target company. |
| 3: Design evaluation | The utility, quality, and efficacy of the designed artifact are evaluated through informed arguments based on relevant research, and these arguments are then discussed with the target company on a designated seminar. |
| 4: Research contributions | The generalized framework is designed to answer a novel problem in the realm of construction innovation, and thus contributing new and interesting knowledge. |
| 5: Research rigor | Research rigor is acknowledged as a possible shortcoming, as the novel research problem asks for explorative and unstructured methods, and the short time frame does not allow for the most rigorous evaluation of the artifact. Lower rigor is, however, counterbalanced by higher research relevance. |
| 6: Design as a search process | The designed artifact is a visual framework requiring a creative search process for the best design. To find the best design, multiple iterations are conducted and evaluated qualitatively against project requirements and constraints. |
| 7: Communication of research | This thesis is published in public through the open institutional repository of Tampere University. |

The research material utilized is exclusively qualitative data from multiple stakeholder interviews and participatory observation conducted within the target company. Indeed, qualitative research methods are often combined with interpretivist research philosophy (Denzin & Lincoln 2018).

3.2 Interviews

Interviewee candidates were grouped in clients, contractors, and designers according to the classification in chapter 3. However, from here on the designer group is referred mostly as architects, as all the interviewed designers were either graduated architects or structural architects. It should be also clarified that in Finland, the title "architect" can be used by graduates from both universities and universities of applied sciences. Thus, the postfix "SAFA" shown in Table 12 is often used by master's degree university graduates to dissociate from i.e., structural designers. To use the postfix, an architect needs to be a member of the Finnish Associate of Architects (SAFA).

Five interviews were conducted from each target group and thus resulting in total of 15 interviews. Details of each interview are presented in Tables 11, 12, and 13. Interviewees were chosen and contacted from a list created by the target company. It was known before the interviews that many of the listed candidates and their respective companies were regarded as some of the more innovative actors within the field with close relationships to the target company. This was seen as appropriate, as the main purpose of the research was indeed to explore innovative practices rather than conservative ones.

Table 11: contractors interviewed

| Index | Date | Title(s) | Industry focus area | Duration |
|-------|------------|----------------------------------|-----------------------------------|----------|
| CO1 | 23.9.2021 | Procurement Manager | Residential construction projects | 56 min |
| CO2 | 24.9.2021 | Procurement Manager, Shareholder | Public & commercial projects | 60 min |
| CO3 | 4.10.2021 | Procurement Director | Strategic procurement | 51 min |
| CO4 | 26.10.2021 | Regional Procurement Manager | Public & commercial projects | 53 min |
| CO5 | 29.10.2021 | Project Director | Large scale commercial projects | 56 min |

Table 12: architects interviewed

| Index | Date | Title(s) | Industry focus area | Duration |
|-------|------------|---------------------------------------|--------------------------------|----------|
| AR1 | 22.9.2021 | CEO, Architect SAFA | All types of building projects | 58 min |
| AR2 | 29.9.2021 | CEO, Architect SAFA | All types of building projects | 53 min |
| AR3 | 11.10.2021 | Structural Architect, Project Manager | Public school projects | 62 min |
| AR4 | 13.10.2021 | Architect SAFA, Shareholder | Public projects | 62 min |
| AR5 | 14.10.2021 | Architect SAFA, Head Designer | All types of building projects | 63 min |

Table 13: clients and consultants interviewed

| Index | Date | Title(s) | Industry focus area | Duration |
|-------|------------|---------------------------------|-----------------------------------|----------|
| CL1 | 20.9.2021 | CEO, Project Director | Property development & consulting | 36 min |
| CL2 | 23.9.2021 | Property Development Manager | Property development & consulting | 64 min |
| CL3 | 15.10.2021 | Project Manager | Property development & consulting | 58 min |
| CL4 | 15.10.2021 | Investment Project Director | Property owner | 54 min |
| CL5 | 29.10.2021 | Team Manager in Cost Estimation | Property development & consulting | 81 min |

Non-probability, purposive sampling was used to select the most diverse group of interviewees as possible, and an adequate number of interviews were conducted until sufficient level of data saturation was reached (Saunders et al. (2019, p.315-321). Five interviews per target group was deemed as a representative sample, as similar answers started to circle around towards final interviews. Although purposive sampling can never reach statistically representative sample size, this sampling method was the best possible available and well suited for explorative research.

The only troubling area in sampling emerged with construction project clients, as these actors operate quite far away from construction product suppliers, and usually through other actors in construction project networks. In addition, the client sector in construction industry is highly divergent consisting of countless of different types of clients. Therefore, four out of five interviews were conducted with real estate development and construction consultants (CL1-CL3, CL5), and only one with a representative of an actual client (CL4). During this one interview it also became very apparent how far away even the frequent clients are from product suppliers, as many of the questions were left unanswered for

being irrelevant. Despite this, the discussion was very fruitful and yielded many important findings beyond the structured set of questions.

Considering the explorative nature of the research, the interview themes and questions were designed to stimulate discussion and an emergence of new and unexpected information. In addition, the goal was to find past experiences and concrete examples on stakeholder involvement in construction innovation rather than hypothesizing possible ways for stakeholder involvement. The questions were reviewed with the target company before the interviews, and only minor changes were made after the initial interviews. The final set of themes and questions is shown fully translated in Appendix A.

The interviews were conducted as semi-structured, one-to-one remote interviews through Microsoft Office Teams. All interviews were conducted in Finnish and the questions were presented in a structured order with a PowerPoint slide set. A translated example of an interview slide is shown in Figure 4. Albeit the order of the questions was fully structured within the slide set, the framing of questions and follow-up discussions were treated flexibly depending on emergent findings (Saunders 2019, p.437-442). Thus, the interview questions shown in Appendix A also shows some of the most common follow-up questions, that were defined beforehand but not shown to the interviewees.

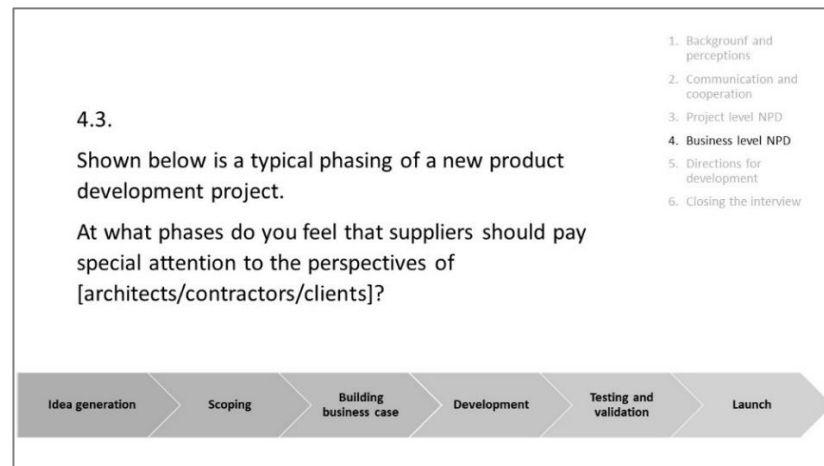


Figure 4: example of a PowerPoint slide used for the interviews

3.3 Data analysis

All interviews were transcribed by hand from verbal data into textual data, resulting in roughly 320 pages of data. Although there was also visual data available from all interview recordings, this data was not utilized. To accommodate the interpretivist research philosophy, the transcription process was carried out as in-detail as possible, including some significant signs of emotion such as long pauses, stuttering, laughter,

and confusion. The transcription process and thus the analyzing of data was initiated and carried out meanwhile the interviews were still ongoing.

Each interview was read through multiple times and relevant information was coded in an Excel spreadsheet. The data was coded and classified in distinctive sections according to the three research questions and pre-defined ways of presenting the results. The codes used were mostly data-driven short phrases that represented what interviewees had said. The codes were created mostly by the researcher through content analysis, but also *a priori* codes such as NPD process stages and different levels of customer involvement were derived from the literature. More data-driven codes were added the more data was analyzed, but some codes were also consolidated later in the process to reduce the complexity of analysis. The quotations of what interviewees had said were coded to the Excel in full for it to be later easier to export and translate these quotations into this document. Finally, the coded qualitative data was visualized “quantitatively” with simple histograms, that showcased how many interviewees had said something represented by an equivalent code in the data analysis.

The data was translated from Finnish to English only in part for the quotations presented in the following chapter of results and discussion. As these two languages are very different, some corners had to be cut especially in terms of dialect and idiomatic speech. This translation process did not, however, affect the actual process of data analysis or the results, as all the data was analyzed in Finnish.

3.4 Validity and reliability of methodology

Semi-structured interviews are associated with many possible data quality issues (Saunders 2019, p.447-451). Firstly, interviewer bias and appropriate level of knowledge to conduct the interviews were addressed through preceding four-month period spent fulltime in the target company, during which the researcher got thoroughly acquainted with the industry, target company, relevant products, relevant literature, and relevant research methodology. But at the same time, the interviewer was never in first-hand contact with, let alone responsible of any operative activities within the target company, and thus was able to remain as an objective observer. In addition, the interviewer was not in an employment relationship with the target company before, during, or after this research, and thus not biased towards the target company.

Participant bias was addressed in the first instance through the selection of candidates from a wide variety of backgrounds. In addition, the invitations for interviews were constructed to motivate the candidates as much as possible to participate. First, the possibility for the interviewees to get their voice heard was highlighted in terms of

perceived problems in construction industry and its innovativeness. Second, the neutrality and non-commercial motives of the research and the researcher were highlighted. In the end, the targeted number of 15 interviews were arranged and conducted with invitations sent to only 34 different candidates. With the participation rate being as high as 44,12% with a wide variety of participants, the possible effect of participant bias can be deemed low.

As the interviewees were mostly well aware of the target company's business and the supplied products, a slight participant bias was suspected in terms of emerging examples and themes. But quite surprisingly, the majority of the examples did in fact concern very different types of products from what the target company supplies. These included, for example, HVAC-products, insulation materials, outdoor facades, locking systems, and timber construction. One suspected reason for this could be the relatively small product segment in which the target company operates, which why some of these other larger product segments may have yielded more examples. But as the purpose of this research is to construct a generalized framework, a broad variety of examples from the whole construction industry was more than welcome.

4. RESULTS AND DISCUSSION

In this chapter, the results are presented and discussed to answer each of the research questions separately. Finally, a generalized framework is constructed and discussed. It is important to note that the emerged perceptions were not directly asked from interviewees to allow new information to emerge. Thus, for example, it could be that all the interviewees agree that conservative opinions are a risk in involving customers in supplier's new product development, despite only four interviewees brought it up on their own initiative. In addition, the results represent recognized perceptions and practices within different customer groups and may not necessarily be shared by all the interviewees themselves.

4.1 Customers' perceptions on innovation and involvement in supplier's NPD

Perceptions on innovation and involvement in supplier's new product development were explored throughout each of the interview questions. Figure 5 shows all the most frequently brought up perceptions. To keep the presentation of results concise, the wordings of different perceptions were carefully formulated to incorporate broad range of answers and expressions. For example, if one interviewee said that "nothing is lost when asking an opinion, so it is always worth asking", this would have been interpreted as "informal involvement in supplier's NPD out of project boundaries is seen important/desirable". But often times making such crude interpretations was not needed as such perceptions came clear from multiple answers.

The number of different types of perceptions and the relatively low frequency of each observation refers to somewhat personal opinions about construction innovation. The total number of observed perceptions were 32 for clients, 35 for architects, and 22 for contractors. The significantly lower number of observations for contractors could thus imply contractors having less opinions about construction innovation and involvement in supplier's NPD compared to clients and architects. One of the contractors supported this observation by saying:

"... [when] product suppliers are in contact with a construction company, that "we now have a product like this, and that this is so and so good". But as a construction company... like we are not per se always interested in what is so new about it. Rather it is the client who buys that new thing, if buys." (CO4)



Figure 5: perceptions on construction innovation and involvement in supplier's NPD

4.1.1 Perceived drivers and barriers

The most brought up theme from the interviews was that construction innovation is difficult at the project-level; a finding that has been made in past literature (Blayse & Manley 2004; Keegan & Turner 2002; Winch 1998). Only one construction consultant thought that innovating might be easier at project-level, because the project could facilitate a tangible context and resourcing for development. But in general, the point of view was exactly the opposite, as one consultant explains:

“Suppliers usually only get involved in the project at that point when... unless a construction consultant or designer or someone else asks them something product-related matter. So it's usually not until it goes for construction companies to calculate. [...] So that's the first time you get those papers in front of you. So it's like... I don't know if it's the right time or the wrong time, but from the perspective of product development, it's kind of too late”. (CL2)

Related to this, seven interviewees recognized the aim of using standardized solutions within projects, which can be a barrier to innovating within projects and attempting to introduce new products to new projects. This finding is very much in-line with past literature, especially when considering decisions made by architects (Emmitt 1997; Sariola 2018) and contractors (Frödell 2011). As this practice is quite common in construction, most interviewees were open to explain the reasons for this prudence:

“In general, our design tends to start from the idea of using construction products and materials that have a long history and experience in the Finnish market and within the scope of Finnish legislation. That is, I’m a bit prudent to include such unknown solutions in the plans. And that prudence is due to a number of reasons, in part from the perspective of contractual risks, and a prudence that looks to the future”. (AR2)

And as one contractor explained, there are also practical advantages when using existing solutions such as making design and bidding processes easier:

[...] after all, designers design those projects with such products that the project can be done. Nor can we calculate or offer a project if there are no solutions for it. In principle, we deliver those projects according to customer's plans, and if we have that designing responsibility, then yes, we will use existing solutions”. (CO4)

Despite project-level innovation was generally viewed difficult, eight interviewees brought up how innovation within construction projects can be made easier with collaborative contract models such as alliances. This would partly support findings by Manley (2008), where collaborative relationships were thought to be an important driver for NPD performance in construction. As one architect and CEO also put it:

“But fortunately, the construction industry is gradually moving more in the direction that there are these collaborative project models. And I would recognize that especially in those projects ... there is more leeway in the direction that different product supplier’s pilot solutions could come into play if they solve the problem or need well in that particular project. That is even very much desirable.” (AR2)

And what is more, one of the consultants recognized an ongoing project where supplier’s piloting was possible because of earlier supplier involvement enabled by the alliance:

“We now have, in fact, one project here... coincidentally, when this product manufacturer, an insulation manufacturer, was chosen and it is an alliance project [...] So it happened to come out through this kind of development and discussion that there may be a product that is just right for our needs, that... which is not yet

on the market, but we immediately got a time frame and it was found that it may well make it in time for our project.” (CL3)

Informal involvement in supplier’s NPD was seen important or even desirable especially by architects. This observation supports the findings by Hemström et al. (2017) that architects find suppliers to have a key role in construction innovation, and the findings by Vaquero Martín et al. (2016) that professional users such as designers in construction demonstrate intrinsic interest towards new technologies, innovation, and obtaining new knowledge, but also extrinsic interest for overcoming unsuitability of existing technologies. As some of the architects explain:

“My starting point is that in order to keep up, you have to deliver new products to the market. New solutions, new innovations. And to deliver them, I would see very much potential in taking advantage of the comments of those people involved in either the design process, the whole process, or the user lifecycle”. (AR1)

“Even if you participate anonymously, these are the opportunities when you can, in a way, open your mouth and say what you think about it. So then you can at least state that the moment a thing is topical, you have seized the opportunity that can be used for it. Like if you don’t take advantage of them, then it’s useless to complain about it afterwards [laughs]”. (AR5)

“Quite often we think that suppliers are happy when they get to sell what they have. But maybe it’s also that such criticism and asking about new things can be at least as valuable”. (AR4)

In addition, one of the contractors thought that sharing information across the industry has intrinsic value, and thus highlighted the importance of obtaining information from the whole project network throughout the NPD process with an additional emphasis on architects:

“Like absolutely, and we do very gladly provide that information... that what feedback we have received from customers about the products in use. We are extremely willing to take things like that forward. [...] I think it’s kind of part of this whole thing. [...] So I think it’s as very important to get information from the head contractor and the end users through that. [...] And I would see it as a chain, that if you want to renew the whole construction industry, then such an excursion with architects is very important”. (CO3)

Expected compensations from informal involvement were very much connected with overall opinions about the importance of involvement: those interviewees who saw informal involvement as important or even desirable did not generally expect direct

compensations from involvement. The most cited expected compensation was therefore to purely learn something new from the involvement process, the products in development, and to be able to contribute.

“I do see that cooperation beyond projects allows for both [supplier and designer] to develop. That is what I think as the compensation [...] because if a design office always offers the same solutions, it will stale from every direction”. (AR1)

The second most cited form of expected compensation arose from extrinsic drivers, as some of the interviewees showed interest to promote development generally within the industry:

“Surely it is based on that there is such a will and desire to be involved in this construction industry, and that one wants to be of help if something is to be developed and taken forward”. (CO5)

“For example, that's why I have gone to polytechnic and elsewhere to teach project management, real estate development, supervision. I didn't go there so much because of the money, but for this industry to move forward”. (CL1)

Some interviewees mentioned separately that monetary compensations should come in to play with deeper modes of involvement such as hands-on design work or anything that relates to utilizing the core capabilities of the customers. This finding also supports the extrinsic, material drivers recognized by Vaquero Martín et al. (2016) for professional users. But at the same time, this finding is somewhat obvious, and acquiring paid services is not accounted here as customer involvement in supplier's NPD. Furthermore, the borderline between involvement in NPD and acquiring paid services can vary wildly from situation to situation and is hard to measure.

Very much related to expected compensations from involvement, seven interviewees thought that lack of time and/or interest is a barrier to involvement beyond project-level. This quite strong finding is very interesting in the sense that the literature exploring customer involvement in NPD seems to overlook this aspect quite often, and rather focuses only on the aspects of choosing and interacting with customers. But obviously it does not matter how good candidates are found for involvement or how good inter-organizational processes are put in place if the customers have no time or interest to participate in the first place. Especially in construction industry, most of the time is spent within projects, and thus anything beyond project-level is just extra:

“Well, the only barrier I can see, especially these days... is the use of time ... like if these would start to emerge here and there all the time, then ... as there is barely

enough time for the design work itself, so then there may not be enough [time] for something like this either". (AR3)

"If it is interesting, you might find time for it and so on, so I'm not ruling it out. [...] That [time] is maybe the challenge in it no matter how much there's interest... [...] May I say that at the moment I wouldn't really be able to break out for many hours a week for some development work. As there are these projects on hand". (CL1)

To overcome the barrier of time and interest, the innovation should arouse genuine interest or even enthusiasm to attract as wide audience as possible. In addition, one of the architects perfectly displayed the gatekeeping mechanism recognized by Emmit & Yeomans (2008, p.156), where designers only expose themselves for messages about new innovations if they have an immediate need for it:

"I do notice that the motivation is much higher when... as there are a lot of those calls. So you take it when you have an immediate need for it. Or there must be some... some kind of general educational subject that you don't know yet about, or something novel. That half of them are like [sighs]... like for the marketing alone we really don't have time to take. [...] But yes, our profession is probably in that sense... people take on competitions as a hobby and a lot of things like that related to the profession. So, if it is perceived as interesting and important, then it will probably get people moving. [...] But it's just that no one is going anywhere for the gray tones in plastic carpets. [...] So it has to be something like "wow, even something like that exists"". (AR4)

In addition, the barrier created by the lack of time should always be minimized by keeping the informal involvement short and effective:

"So if you are spontaneously asked for opinions, then the kind of approach should always be short and concise". (CL2)

Four out of five clients/consultants recognized the importance of earlier supplier involvement within projects to promote innovation, albeit often very difficult with traditional forms of contracting.

"I definitely think that it should be at the early stage. But there are so many things that are so hand-binding, which why you can't do that, quite frankly". (CL5)

One construction consultant brought up the growing trend of prefabricated construction where supplier's expertise and early involvement would be especially important due to the novelty of techniques being used. This somewhat supports the finding by Gil et al. (2001), who found how trends in lean construction had increased early project involvement of suppliers.

“One should be able to... catch up on projects at such an early stage that it is possible to bring that knowledge of the supplier to the projects. [...] Modular construction is a good example when wanting to build from wood. The client may go into the project with completely wrong implementation and contracting model and may even do the design in advance. And then it is found out that if you want to do it like this, everything must be re-designed”. (CL3)

The one actual representative of a client with a vast experience from the industry further opened up the issue of earlier supplier involvement, which apparently has been an ongoing discussion for a very long time within the industry.

“If you thought about a planning meeting, there was construction consultants, architects, designers, users, everyone. Everyone pulled in a different direction. Everyone had their own goals. [...] That is to say; to build a common vision, common goals... and that's where our role as a client is big. And that of construction consultant. [...] And so how could we create such an operating model in the industry's culture that... and to the process, so that we could utilize suppliers earlier. I'm totally in favor of that. But it would require changes in processes and, to some extent, in the know-how and organization of the industry. And that's why it may not have succeeded to the extent that was desired sometimes already 20 years ago”. (CL4)

These words also very much support the findings by Pahikkala (2020), who found how reinventing construction industry in such a way would require development of completely new business models across the industry. It was also noted by some interviewees how the client always has the responsibility of earlier supplier involvement within projects as the potential suppliers have no ways to recognize such needs. However, with traditional contracting models the supplier may not have an initiative to get voluntarily involved in the project earlier on, because the supplier may still lose the project later during the bidding process. These findings further highlight the importance of cooperative project implementations for construction innovation, but also the difficulty of innovation during projects and the need for supplier's own innovation beyond project boundaries. Practices for project-level involvement in supplier's NPD are further discussed on chapter 5.3.

4.1.2 Customer selection and relationships

Regarding the process of choosing customers to involve and especially recognizing potential lead users (Cooper 2014, Gruner & Homburg 2000; von Hippel 1988), architects were seen as more inherent innovators compared to clients and contractors. Four out of five architects found informal involvement in suppliers' new product

development projects to be important or even desirable, and a great contributor for this perspective seemed to stem from architects' education and professional landscape:

"[...] it is perhaps the tradition of this profession in the sense that we are accustomed to prototyping and exploring". (AR1)

Thus, finding innovative architects as partners should not be as challenging as with clients and contractors. But rather challenging with architects can be their high willingness to remain as neutral actors as possible within the industry. Four out of five architects recognized neutrality as an important value and therefore a possible barrier to customer involvement. The willingness to stay neutral and staying out of conflicting interests and commercial pursuits were also recognized as barriers in customer identification by Vaquero Martín et al. (2016). Three architects discussed the phenomenon as follows:

"Then perhaps there is that some colleagues may be prevented from participating in a single supplier's product development project just for... for ideological reasons, so to speak. That intriguing with an industry is perceived as a negative thing and is not wanted to be done". (AR2)

"I personally feel that I would rather act in it as an anonymous expert in the background. As it is not our job to market some workshop's wooden panels, we'll rather act universally with certain materials or certain topics". (AR5)

"However, it must always be borne in mind that one must be very neutral and objective in this. That if [laughs]... if you are involved in developing something, then will it lead to... that then it will take precedence over other competitors' products in the future. Although I guess it's only natural if you get to influence and push forward something important to yourself... then why not to use it?" (AR4)

Four architects and one consultant thought that involvement in supplier's NPD has to be goal-oriented and concise. For example, just asking customers "if they have any new product ideas" without a context was not seen particularly fruitful form of involvement:

"It is difficult that if now you call and ask, "well what you may need?". Like that's not what comes to mind in the middle of everyday life". (AR4)

"Daydreaming should be done on one's free time, like any activities purely without goals". (AR1)

Indeed, it is also recognized by Vaquero Martín et al. (2016) as a success factor to being able to design adequate interaction patterns in terms of duration and range of methods used in customer involvement. However, it is important to note how practically every interviewee thought that different professional practices, language, or communication

are not barriers for successful involvement in construction, as professional practices are very much universal throughout the construction industry. This observation thus diverges from the findings by Vaquero Martín et al. (2016) from medical device industry.

Five interviewees emphasized the importance of confidential personal relationships, through which it is possible to attain informal information. As one construction consultant summarized:

"If there is no personal relationship, then one doesn't know what can be even asked from the other." (CL2)

Confidential relationships were also seen important for promoting transparency and vice versa, as one architect and one contractor explain:

"In my opinion, it is a matter of accepting that if something is developed, it may end up being used by others. And similarly, from the supplier's perspective, the designer may use other products if [the supplier] does not have the latest solutions in place. [...] And in my opinion, there is nothing to hide here. We are acting transparently and openly anyway because that is also by today's standards." (AR1)

"In my opinion, the big obstacle is that if there is no longer-term cooperation, or like continuity. Trust. So then it is often quite a big obstacle that firstly, head contractors may not be very keen on using their resources for something like this, if they do not see any benefit. And secondly, perhaps from the supplier's perspective, there may be a risk that if there is no trust, one won't dare to share such information that is business-critical or sensitive. Like it is feared that then the head contractor may possibly share that information to other suppliers". (CO1)

The latter contractor further gave an example on how confidential relationships with suppliers can create mutual benefits for the contractor in the early stages of construction project development:

"For example, getting a supplier involved... or getting a design resource, for example, from that supplier already in our project development stage. [...] It is by no means a sure business for that supplier. [But] it is easier to get suppliers involved when it is collaborative." (CO1)

Indeed, this and all the latter observations support the findings by Bosch-Sijtsema & Postma (2009) in that both parties should perceive two-way benefits in cooperating, and that the project should receive sufficient, goal-oriented support from higher management. This is especially true with clients and consultants, for whom acute project needs are

usually the main drivers for cooperating with suppliers, and mutual benefits beyond project boundaries can be difficult to find:

“Indeed, we are quite far from suppliers in that sense. But then in projects, of course, there can be contacting as needed”. (CL4)

These results for the first research question highlight the importance of finding both innovative and motivated partners to be involved in supplier’s new product development. Although the concept of “innovativeness” is hard to conceptualize and is very much context dependent, a tentative observation was made. It became evident that those interviewees who worked on a more strategic level beyond project boundaries (e.g. CEO’s and Strategic Managers) and architects in general were more likely to provide more insights and enthusiasm to the topic. As one contractor and one consultant put it:

“There are not many people in regard to their job description who are able to give something in the first place for that product development so that one has enough interest and enthusiasm for it. And/or they have to have that technical know-how, and also their job description has to be like that it makes it possible for their schedule”. (CO4)

“I don’t see any barriers in asking me [about new products] other than that I might be the last guy then. On behalf of the client, I cannot say whether they want it or not. [...] Unless you tell me directly, that “hey, this is 50% cheaper than this”. Then I say it is a good thing [laughs]”. (CL5)

Another very important point regarding the selection of customers to involve was to avoid conservative opinions about new innovations especially on the early stages. As one contractor jokingly put it:

“Well, screening out ideas probably works well for construction companies as they’re mostly quite conservative people”. (CO5)

4.1.3 Overview on customers’ perceptions

The results from this chapter are compressed in Table 14 in the footsteps of the research by Vaquero Martín et al. (2016). Although most of the points mentioned in Table 14 were directly mentioned by the interviewees, some points have been extrapolated from observing the industry and literature. For example, contractors’ habit of tendering with incomplete designs was mentioned by Sariola (2018) and also observed in the target company. However, it is worth noting that from supplier’s perspective this behavior can be a bit challenging as projects will usually not allow enough time for in-depth development, and thus supplier’s usually end up offering the “good enough” solution

perhaps with slight modifications. But nevertheless, this tendency can be accounted as enabling new product development for the supplier. Finally, some of the points presented in Table 14 will be observed and discussed more thoroughly in upcoming chapters.

Table 14: drivers, enablers, and barriers for customer involvement in supplier's NPD

| | Designers | Contractors | Clients and consultants |
|---------------------------------|--|---|---|
| Intrinsic drivers | <ul style="list-style-type: none"> • Interest in innovation, new knowledge, and progress of the industry | <ul style="list-style-type: none"> • Willingness to improve the industry as a whole | <ul style="list-style-type: none"> • Willingness to react upon new trends |
| Extrinsic drivers, non-material | <ul style="list-style-type: none"> • Overcome unsuitability of existing technologies | <ul style="list-style-type: none"> • Improving quality of services | <ul style="list-style-type: none"> • Finding solutions to their own challenges |
| Extrinsic drivers, material | <ul style="list-style-type: none"> • Monetary compensations for professional services | <ul style="list-style-type: none"> • Reduced cost of service delivery | <ul style="list-style-type: none"> • Reduced cost of service delivery |
| Project-level enablers | <ul style="list-style-type: none"> • Collaborative contracting • Design work for products from project resources | <ul style="list-style-type: none"> • Collaborative contracting • Tendering with incomplete designs | <ul style="list-style-type: none"> • Collaborative contracting • Direct contacting of suppliers for expertise |
| Project-level barriers | <ul style="list-style-type: none"> • Late involvement of suppliers • Limited resourcing within projects | <ul style="list-style-type: none"> • Late involvement of suppliers • Limited resourcing within projects | <ul style="list-style-type: none"> • Late involvement of suppliers in projects • Limited resourcing within projects |
| Business-level enablers | <ul style="list-style-type: none"> • Transparency • Novel innovations • Goal-oriented involvement | <ul style="list-style-type: none"> • Long-lasting, trustworthy relationships | <ul style="list-style-type: none"> • [Marginally mentioned] • Informal, trustworthy relationships with individuals |
| Business-level barriers | <ul style="list-style-type: none"> • Time relative to interest • Finding mutual benefits | <ul style="list-style-type: none"> • Low interest in general • Not finding any mutual benefits | <ul style="list-style-type: none"> • Restrictive business and process models |
| General risk factors | <ul style="list-style-type: none"> • Conflicting values • Overly abstract ideas | <ul style="list-style-type: none"> • Conservative opinions | <ul style="list-style-type: none"> • Getting hold of clients' views in the first place |

To further recognize additional information sources for supplier's NPD, one architect brought up industrial designers as a potential reference group, as they are often trained professionals specifically in NPD:

"...architects are not the only reference group in the construction industry that may be worth bothering, but also industrial designers. [...] So if there would be such a multi-professional team with industrial designers, architects, and then engineers. And of course commercial know-how. Should already be quite superb". (AR2)

In addition, some interviewees that operated more on a project-level themselves did bring up the innovativeness within their employing firm's own development functions that were not targeted in this research.

"We also have our own development units, which certainly have such up-to-date problems on the table. So there may be ideas available through them". (CL3)

These previously unidentified sources of information can however be hard to reach for product suppliers because most of the personal contacts and confidential relationships

are found in customers' procurement functions, and similar. This is also the reason why such stakeholders were not recognized as interview candidates. In addition, these development functions and industrial designers will hardly provide their knowledge for free, but rather as paid services that are not accounted here as a customer involvement.

4.2 Customers' knowledge contribution to supplier's NPD

Compared to the perceptions on innovation presented in the previous chapter, the results on customers' knowledge show much clearer differences between different groups. Also, the number of observations is here more evenly divided compared to the findings presented in previous chapter, although architects provided once again the most data points with 26 observations, whereas contractors provided 21 and clients/consultants 19 observations. These numbers of observations for each group seem quite logical in a sense that architects are the closet customer group to supplier's whereas the clients and consultants are the farthest. The results on customers' knowledge contribution are presented in Figure 6 and went through in detail separately for each group. Then in the following chapter, these results are connected to the NPD process model in terms of longitudinal and lateral dimensions.

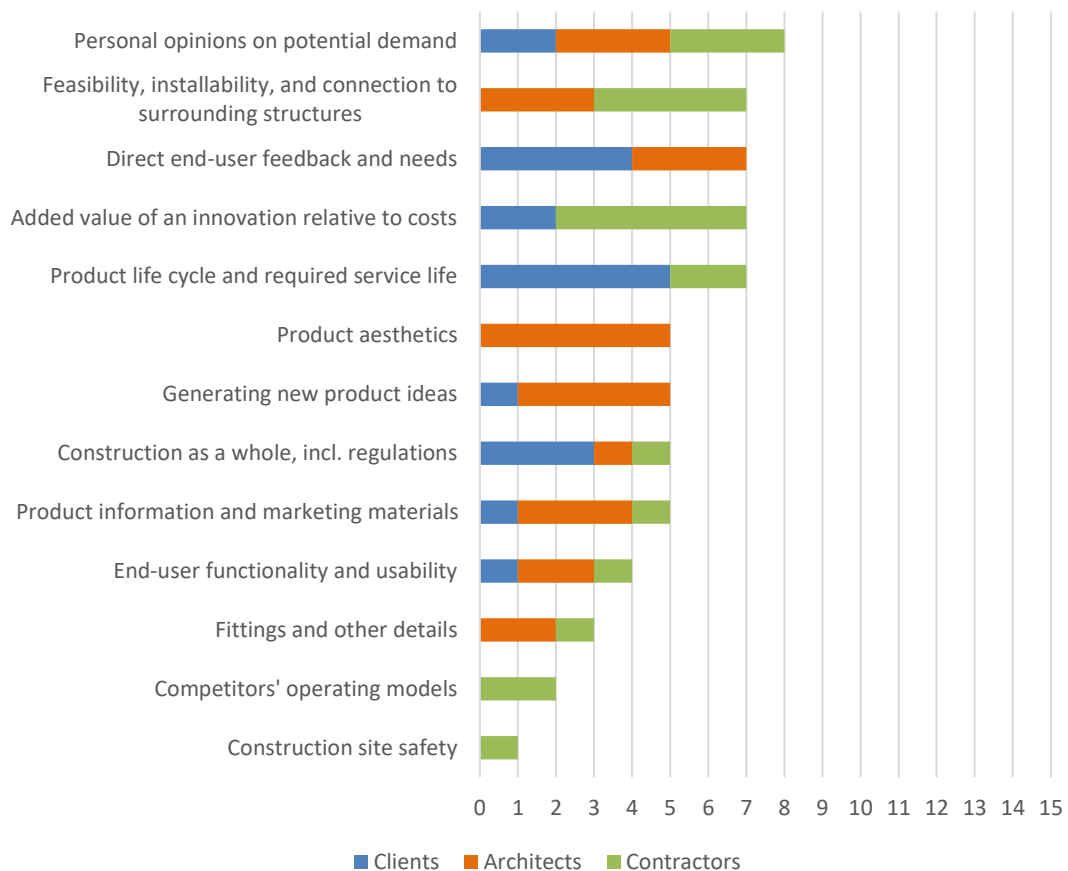


Figure 6: customers knowledge contribution for supplier's NPD

Eight out of fifteen interviewees indicated that they could be asked about personal opinions about potential demand of a new product or idea. Although every aspect of customer involvement is more or less about customers' personal opinions, the opinions on *potential* demand should always be taken with extra precautions. Thus, this result also should be taken with a grain of salt.

4.2.1 Contractors

Contractors are recognized to have the best knowledge for evaluating added value of a new product, as all five interviewed contractors demonstrated a very cost-conscious way of thinking. This is somewhat logical result considering contractor's position as the first-hand decision-making organization with an incentive to reduce costs (Frödell 2011; Vaquero Martín et al. 2016). As one contractor summarized this perspective:

“So I mean how much it adds value to the head contractor. Of course, we are not willing to pay more if it does not add value. But if it can be concretely justified that it will bring schedule savings or increase work safety...” (CO1)

And when discussing specifically about transferring contractors' cost perspective to supplier's NPD, one contractor added how these views could be shared with suppliers with certain limitations:

“We do open up these matters up to a certain limit, of course. That this is not how... this industry never develops, like if everyone holds on to their own bits of information and so on”. (CO4)

Another expected result due to contractor's expertise on construction site environments and conditions was their ability to contribute knowledge on installability and on-site feasibility of new products. As two contractors explained:

“When there is a product, installation, functionality, and so on – the entirety of it - ... and then we also consider the customer interface. So yes, these kind of products in everyday use... so I would see that the knowledge of head contractors builds up quite strong”. (CO3)

“Probably like these traditional logistical things. [...] like storing, installability are probably one of those. And then of course the finishing, like how finished it can be brought to the construction site”. (CO5)

Knowledge on product lifecycle was brought up by two contractors, but mostly from the point of view of how construction companies are usually not too keen to promote lifecycle thinking. As one contractor with long experience from the industry explains:

“One must have a slightly broader point of view also on the side of the construction company and the head contractor, so that they are not just thinking about their own narrow box on the implementation, but like... sees the whole of what is being done, which is then 50 years in place. [...] Even if you think about how much construction costs and how much it costs to maintain over its lifecycle. It may be a challenge to understand for someone who has done contracting only from a narrow point of view”. (CO5)

Another contractor specifically pointed out how contractors may not be motivated to promote lifecycle thinking in construction, let alone in single products due to the lack of extrinsic and political drivers.

“But what’s foolish about our society is that our liability under warranty is usually for 2 years... [...] Like a construction company may not have as much interest in developing it from a lifecycle perspective. Of course, there are these lifecycle projects, but we as a construction company do not get involved in those. As we don’t have the resources for such large projects”. (CO2)

Indeed, this observation supports previous findings on how decision-making organizations are usually only motivated to participate in development if extrinsic drivers are put in place (Vaquero Martín et al. 2016). But nevertheless, knowledge on possible barriers is also valuable knowledge for supplier’s NPD.

Lastly, contractors were seen to have fairly good knowledge regarding products of multiple suppliers within same product categories. Accessing this type of information could therefore provide valuable insights for competitor analysis as a part of NPD.

“As a product expert we are not quite at the top of it, but yes, we do have a long experience with products from different suppliers and... and we do always have such a view of our own in terms of functionality. That what we then try to convey to the client. [...] How they work then in practice. Like many suppliers have then said [in a case of malfunction] that well, the fault is in the user”. (CO2)

4.2.2 Architects

Architects are recognized to have a strong expertise for aesthetics on the basis of their profession, as all interviewed architects demonstrated either direct or indirect ability to contribute to this area. As one architect put it:

“Well, when it comes to aesthetics, for example, I feel that architects are strong experts. That is, what the product looks like... and not only what the product looks like in photos and marketing, but especially what the product looks like in the

natural and built environment and in the finished project. So in those matters it is worth turning to architects, because an architect faces those challenges and problems every day in his or her work". (AR2)

Also included in this area of knowledge are some more technical details such as installability, fittings, and connections to surrounding structures, that were especially highlighted by the one structural designer interviewed:

"Quite often you pay attention to the design at the level of detail [...] like joining's to the surrounding structures and edge joints would be those you liked to see then. [...] And also the fittings and else". (AR3)

As it was already touched on the previous chapter, architects have a good ability to generate completely new and even out-of-the-box ideas based on their profession. This type of skill can obviously be beneficial for generating new product ideas out of thin air, but as these two architects explain, it is still a task for supplier's or other stakeholders to take an initiative on these ideas:

"Those ideas could come a bit more freely... from groups in our profession, who are like browsing through projects that are even not always so realistic". (AR4)

"Sometimes there have been situations in projects where ideas have then been thrown into the air. Like "why don't you take this further" and "could there be an idea in this" and so on. But never have those led to anything further". (AR2)

Architects were seen as an important link in conveying direct end-user feedback and needs towards suppliers, which supports previous findings regarding the fairly central position of architects throughout each construction project (Hemström et al. 2017; Jalkala et al. 2010; Sariola 2018; Yang et al. 2011). As two architects comprehensively explained on their overall role and knowledge contribution:

"Well, I would say it's like understanding the user. [...] I'll take such an example that an office building is being built somewhere and it's owned by some foreign investor, for example, and operated by some Finnish operator. So then it means that the end user of the building might be our "customer's customer's customer", and we should at all times maintain that end user's needs. And in that I claim we're aware the most, like from a design perspective. [...] So because we naturally operate very much with those users, [...] there might be feedback coming for us that the product manufacturer does not have". (AR1)

"I would approach this in a way that the architect is like... a messenger or... and also like the one trying to implement what the user/client wants and what needs they have. And then there is what a product supplier or a manufacturer of a

specialized product can do. And then the end result is a compromise where the architect then negotiates in between with both to decide where to end up". (AR3)

Finally, three architects demonstrated views on marketing channels and materials utilized by suppliers. These views were especially targeted from the point of view of specifying products, thus meaning the level of detail in marketing materials, the accessibility of these materials, and the possible IT tools provided for specifiers such as BIM objects and other online tools. To demonstrate designers' point of view, one architect described an ordinary trouble during the specifying process:

"So that ... that the only things that interest us [laughs] would be them to easy to find. Like quite often you must first search the website and then find somewhere a pdf. list. And then from there you browse that what is the right pdf." (AR4)

Especially regarding the BIM objects, two more architects pointed out how they usually do not need nearly as many details as supplier's would like to provide:

"In addition, before one starts to build data models [of a product] ... that one could ask what of those features are really needed [to be modeled]. [...] It's one such thing that I think many times, like "gee these are fancy data models", but they are like... usually always made too much in detail that we can't start using them when they're too cumbersome and difficult and unnecessary for our use". (AR4)

"[...] what the wish for that object is that it would be very much like a reduced and raw version. That it would not have all the nuts and other gadgets. In a way, it would be like a space reservation and requirements on the structure itself. Because if there's... if those objects are very meticulously executed, then they're quite heavy". (AR3)

These latter findings are important in a sense that designers have been shown to be one of the most important – if not the most important – target group for suppliers' marketing (Emmitt & Yeomans 2018, p.153; Sariola 2018), and the construction of marketing materials is an important part of the launch stage of NPD process. Indeed, the target company of this research had utilized the knowledge of architects when developing their websites, but no such knowledge has yet been utilized for product-specific marketing.

4.2.3 Project clients and consultants

Clients and consultants are recognized as the best sources of information when analyzing product lifecycle and regulatory requirements, and even the construction industry as a whole:

“It could be thought of as recognizing the requirements in client’s activities. Like understanding the big picture. [...] That the real estate developer should in my opinion ... like they if someone will understand”. (CL5)

This observation supports the findings by Vaquero Martín et al. (2016) in a sense that “end consumers” are regarded as an important information source for meeting the requirements of regulatory bodies and making decisions related to market trends and competitive landscape. Two construction consultants even demonstrated this type of capability of analyzing the big picture already during the interview:

“I think that we are a bit of a melting furnace as a construction consultant, that we must realize all the connections this product should make me reflect. Like what matters does this [product] affect. Which designers should we contact if we want changes to this? If you want to change this window, who will be contacted in this project and design organization? Who all are affected by it, and what areas of design are bringing limiting factors? Is this a matter of fire technical ... like a consultant to comment on? Can we decide this without the approval of a fire consultant? Like... in that sense I feel that the input should come from us on who needs to be approached before decisions are made”. (CL3)

“And how many years it [the product] needs to be in use, for example. [...] After all, you don’t always have to buy something that lasts for 150 years if you know that in three years it will be thrown away. Commercial construction... or like construction of business premises is currently like this”. (CL2)

In addition, one consultant added that if the consultant cannot give direct answers, they could rather help the supplier to ask right questions from the actual clients and end users:

“If we say that you now truly get those users to contribute to this kind of idea generation, like what are these beyond project-level. So, in a way real estate developers could give you some help in that what are the right questions, the right subjects you then go through with that client”. (CL5)

The one actual client provided similar answers as the consultants, although with more caution regarding the products and systems their knowledge might be applicable for:

“As a property owner we are a long-term investor [...] so the lifecycle aspect may come better through a client/owner like us. [...] So yes, our expertise, if there is one, is then in how that building is used by our clients. But how relevant or comprehensive information it is to a system can vary from system to system”.
(CL4)

In addition to the knowledge contributed by clients and consultants, two contractors strongly emphasized the importance of accessing the very end users for market input rather than those of owner-clients’:

“Well maybe that new product development can come when they are on site and in use. So maybe after that it will come to light. And maybe it just comes from the point of view of the client, i.e., the end users. That you might want to head directly there and probe that point of view”. (CO1)

“Then I would recommend that like after five years or so – as a lot of these schools have now been built – you go through them a little bit. As we no longer have that information.” (CO2)

Finally, two interviewees who were directly dealing with investments and cost accounting in their work did demonstrate a very cost-conscious way of thinking also when discussing about products. This finding, however, seems to be more dependent on the individual’s position and expertise at work, rather than collective knowledge within clients and consultants.

4.2.4 Overview on knowledge contribution

To conclude this chapter, almost all interviewees noted how it should always be the supplier itself who has the technical expertise regarding the products they manufacture and develop. Indeed, multiple previous studies have suggested how customer involvement is the most important in the early and late stages of NPD while especially technical development should remain as the main competence of a focal firm (Cooper 2001, p.52; Gruner & Homburg 2000; Lagrosen 2005). But in addition to this, three of the clients/consultants interviewed and one contractor thought that suppliers should know pretty much everything better than their customers and thus did not fully grasp on their role in suppliers’ NPD. As this one contractor put it:

“Indeed, the supplier knows the best about all of it compared to the construction company. That if I know something, then you always know it ten times better and you know like where the industry is going. And you know all the movements of a

competitor: where it stands and what it utilizes at any point. So, in a way we are just such kind of a contact person". (CO4)

Indeed, it seems that some interviewees not only expected suppliers to have a better overall knowledge regarding their product segment, but also thought it as an undisputed fact. Although this is probably true in most cases, such high expectations towards suppliers' expertise does not leave much room for suppliers to exceed these expectations. Rather we can argue how such high expectations could lead to a disappointment if supplier is found not as capable as expected, and thus further leading to a lower level of trust in informal relationships (Sariola & Martinsuo 2016). Although this conclusion cannot be proven empirically, there should be no harm in being precautionary when reasoning the need of involvement for customers (if such reasoning is needed).

Finally, the only interviewed client not only thought that supplier's hold better knowledge, but also expressed strong

"Like I don't see this as my own job though. [...] I'm not really warming up to this area of new products and new product development". (CL4)

But as a large variety of construction project clients exists with varying views on innovation (Manley 2008; Sexton 2008), no conclusions can be made from a single expression – albeit a strong one. And if a more hopeful perspective is taken, this observation can simple be interpreted as a challenge for finding the most adequate practices and the most innovative customers to involve in supplier's NPD rather than concluding certain customer groups as not willing or capable to contribute knowledge in supplier's NPD. And to answer this challenge, some tangible practices for involving customers in supplier's NPD are discussed in following chapters.

4.3 Customer involvement practices for supplier's project-level NPD

Practices for customer involvement in supplier's NPD are discussed separately for project-level and business-level NPD. In this chapter, only potential practices for project-level NPD are discussed without the longitudinal dimension, as project-level NPD usually has not enough time or resources to follow rigid business-level NPD processes. But in the following chapter, the results for business-level NPD are discussed in-depth both in terms of longitudinal and lateral dimensions.

Despite supplier's new product development is seen difficult within construction projects and most of the results are better applied for supplier's business-level NPD, some tangible examples from project-level NPD did also emerge. For example, contractors

recognized mostly efforts in small incremental developments within projects that help streamline their processes on-site and thus creating cost benefits:

“For example, in collaboration with a roofing supplier, we developed some kind of sheet metal moldings that will be used on site. Just these kinds of small concrete things, which again will have big ... both a cost benefit and a schedule benefit”.
(CO3)

“For example, if we talk about removing cement glue. [...] it is like the kind of development and innovation that we do a lot with suppliers.” (CO4)

Indeed, these examples also support the findings that contractors and construction industry in general are motivated by such iterative development that are viewed to bring benefits on a relatively short term (Bygballe & Ingemansson (2011). Architects, on the other hand, recognized façades, furniture, and other surface materials as frequent targets for new product development within construction projects.

“Today we have a meeting at 11 a.m. where such façade profiles are designed that will be tailored specifically to this project. And there will be suppliers involved”.
(AR5)

“Well, maybe it's more like that in the furniture design [where product development happens within project boundaries]”. (AR3)

“We made like a student locker system. We had a plan for that, which was, of course, quite impossible to implement. And then the supplier came towards with their own plans. And then like even every board at the end, and the locker door... was like thought thru how to make it really work and then what it should look like. It was really fun, and the end result came out good”. (AR4)

Compared to the incremental development described by contractors, these examples by architects show much more of a focus towards generating unique solutions for unique projects, with even the architects acting as the innovators (CIN). However, neither these examples show a significant long-term focus from the designer's perspective, thus leaving possible long-term implementation for supplier's responsibility. But nevertheless, it seems that in these certain types of product segments a supplier could benefit greatly from product level NPD if getting free design work from project resources.

For clients and consultants there was only one real life example from new product development within projects, which happened during the same alliance project already mentioned in previous examples:

“Well again in this our alliance project, the customer has driven this wood construction method very hard and wanted a firewall to be made from wood. [...]

Maybe it was to someone ... a silly joke in some meeting that "should that be also made from wood" [laughs], so it just came to life and thus we have in the name of this project developed [the product] and done the necessary fire tests and ... and proved that the structure works". (CL3)

In addition, the one interviewed client further described how other types of contracting models, more specifically project management contracting and whole contracting generally affect the level of co-development with suppliers during projects:

"When you begin to acquire a system, so then you look for a supplier/planner for it together with the contractor, including those planning boundaries. So it is mainly through the procurement process of a project management contract. So in that context we will participate too. But if we have sold a whole contract, then it depends on what the designers have planned and, in that context, there is not much of cooperation with the suppliers". (CL4)

These latter examples even further highlight the better possibilities for innovation within co-operative contracting models as already observed in chapter 5.1. In the best-case scenario, it can even create a win-win situation for the supplier if the project is already won and the alliance can provide resources for the development. But for these same reasons it can be difficult for suppliers to take upon development tasks within more typical projects, as more in-depth development would have to begin before tendering and at the expense of the supplier. In fact, one construction consultant recognized a recent case where no suppliers were interested in a product development case offered within a project:

"We in fact discussed today that if we must do this kind of [product development] thing [within project] ourselves as no suppliers were particularly interested. It is a bit rarer, so we just considered what the risk will be for the client and for us when this kind of thing is done." (CL1)

Despite seeking end user input was generally seen very favorable beyond project-level, some of the interviewees were very rejective to the idea of suppliers contacting the end users and/or clients during construction projects and thus bypassing contractors, architects, and consultants in project networks. Especially the only actual client interviewed thought this would not be desirable, as consultants and architects are there for the exact reason that clients do not have to be in direct contact with suppliers. In addition, this particular client noted that procurement in typical construction projects should always stem linearly down-up according to specifications. But on the other hand, one consultant thought the opposite and would rather direct clients to talk directly with well-established suppliers in unclear situations.

Despite new product development was generally viewed difficult at the project-level, projects were seen as an important source for new ideas and new co-development relationships to take forward at the business-level. One architect especially encouraged supplier's to be more open to new ideas within projects despite the idea would not advance within a particular project:

“That it often happens a bit like “this is the product: take it or leave it”. When a project needs something a little more, then if the answer is that “well this is our solution”, then the conversation will end there. [...] So those who dare to take on the challenge and come up with a solution... if not in that project, then quite often it will lead to it circling around for upcoming projects”. (AR5)

Some examples of business-level development that have started from construction projects will be further discussed within following chapters.

4.4 Customer involvement practices for supplier's business-level NPD

The results for customer involvement in business-level NPD are presented separately for each customer group. For each group, a histogram is drawn with NPD stages on X-axis and the frequency of observations on Y-axis. Resulting histograms show whether the interviewees felt their target group should (“yes”), should not (“no”), or could (“maybe”) be involved in each stage of supplier's NPD. These results thus only account for the longitudinal dimension of NPD, and not the level of possible involvement.

To gather these quantitative results, each interviewee was first asked “at what stages do you feel that suppliers should especially pay attention to the perspectives of [architects/contractors/clients]?” After the initial answer, opinions were also asked about all the other stages they did not consider essential. Therefore, it was possible to capture opinions regarding each stage for each interviewee. Although most answers were unambiguous, some required more interpretation during the data analysis. A third possible answer “maybe” was included and chosen if the interviewee was not sure or if there were inconsistencies in the answers.

It is important to note that the quantitative results showcased in figures 7, 8, and 9 include both actual experiences in being involved in suppliers NPD and personal opinions without actual experiences in such activities. However, the actual experiences brought up were later found to support the overall results. Thus, this chapter only further discusses these tangible examples that do (or do not) support the quantitative results.

4.4.1 Contractors

Contractors are recognized to have most knowledge to contribute during the stages of building business case, testing and validation, and also the launch. All the other stages with one or two positive indications however seemed to be a bit more of personal opinions. Especially one contractor (CO3) saw very much intrinsic value in being involved in supplier's NPD, and thus considered almost all stages worthwhile to contribute something if being asked.

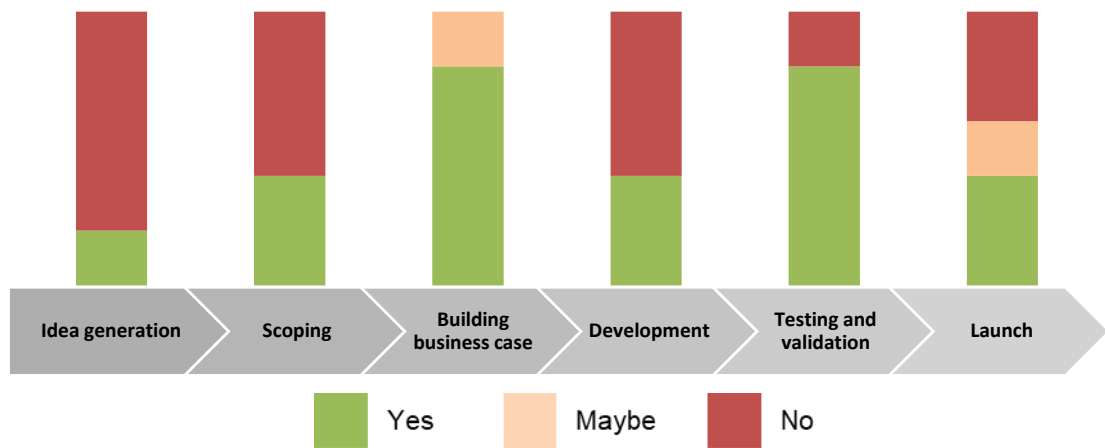


Figure 7: involving contractors in supplier's NPD

When generating new ideas, only one contractor thought they could contribute some ideas that the supplier might not come to think about and vice versa. This contractor was also the most eager to highlight the importance of two-way, long-term, and trustworthy relationships in informal involvement, which is also reflected in this point of view:

“Well especially there in the early stage. [...] Like the supplier can come up with such ideas that the head contractors can't think of, and conversely the head contractor can come up with such points that the supplier doesn't acknowledge. Related to that kind of on-site level. Perhaps. And how it like links up with other plans”. (CO1)

One another interviewee also initially thought that the idea generation stage could be the most appropriate stage for involving contractors, but then quickly changed the opinion from idea generation to scoping ideas. Also, the reflections of this contractor on real life experiences better suited the nature of scoping stage.

“Or maybe that idea generation stage may be a little too early. [...] if there are a lot of ideas, then it's like pretty time consuming for the contractor. Whereas if the ideas have already been limited by the product manufacturer to some extent;

manufacturing restrictions have already been partially removed and so on. [...] And in that sense... that scoping stage could be the most sensible stage". (CO3)

"I have such experience, that some supplier has been in contact with us and asked, that "we are starting to plan a product like this, so could it have a use in projects of your type? And what kind of things have you encountered, that a similar product has had problems in the past?" [...] So yes, in the course of history there have been these kind of discussions with even several products, suppliers." (CO3)

The other interviewees were more explicitly reluctant to the idea of involving contractors at either of the earliest two stages mostly because of the risk of being exposed to overly conservative opinions.

"But here also we must then remember that on the side of construction companies it's maybe quite... conservative – as the construction industry surely is in many respect – even though this new product development and other innovation has been tried to take forward in the industry". (CO4)

"Well, screening out ideas probably works well for construction companies as they're mostly quite conservative people. [...] Like the latest reforms are the concrete elements of the 50's, so... In that sense I think it might still be worth doing that [idea generation and scoping] with some other group". (CO5)

Another contractor who also did not consider idea generation as the most suitable stage of involvement, did specifically underline the importance of involving clients and designers in this stage rather than contractors:

"I don't really [see it] because [the early-stage development] goes then more to the perspective of users, as they'll be then using them. [...] And the designers also!" (CO2)

The stage of building business case showed much clearer consensus between interviewed contractors, as almost all five thought this would be the most suitable stage for involving contractors. This result supports the findings by Akintoye & Main (2007) in that contractors should play a crucial role in the development of the value proposition of construction innovation. As one contractor explains, suppliers could benefit here greatly if getting access to the logic of value creation from the point of view of contractors:

"Well that's where the construction company should come in ... or to be involved. [...] How the product supplier sees or calculates the benefits of this and this and this... we price those things then like completely different ways". (CO4)

In addition, long-term cooperation, trust, and transparency were seen especially important if contractors are involved in building the business concept. One of the contractors explained this point of view quite comprehensively:

“The trust between the parties is perhaps the most important thing, so that the supplier dares to bring out their own... like to open up their own perspective on what the business concept is and then test it openly with the contractor. [...] For example, if a product solution is developed, [but] it is not talked about how much it could potentially raise the price, but it’s very vague. And then like the benefits; [if] they haven’t been thought thoroughly enough, then it’s very difficult. One cannot get concrete in that, but rather one should openly say what has been developed and if it raises the price, then how much does it raise it? And then again to describe as well as possible the benefits of the solution. And then maybe the head contractor’s perspective is to assess whether those benefits outweigh the additional cost”. (CO1)

Thus, in the best-case scenario the level of involvement during the building of business case could be even cooperative in nature, if such long-term and trustworthy relationships towards contractors are available and mutual benefits can be found. But if not, suppliers could still benefit from utilizing contractors as an information source through getting simple reviews on feasibility calculations. For example, one another contractor shared such a practical example concerning intermediate floor structures:

“There are like many different... like calculation models and different versions of that intermediate floor structure. And from there when an element supplier comes like: “I have a brand new one. This is just awesome thing. And with this we’ll now penetrate the market. No one else has this. This is 10% cheaper than what you are doing”. And then there’s a prepared Excel on how it’s calculated. And when we review the Excel, [we see] that it’s not true from our point of view at all”. (CO4)

One contractor expressed how getting involved only later during the technical development stage could allow more tangible context for the involvement, but then also noted how it then can be already too late to contribute to the product itself, as most of the significant decisions need to be made at latest when building the business concept:

“Preferably you could [get involved] for instance... there in the technical development work. Not until that stage. But it can often be a little too late”. (CO3)

Furthermore, one contractor further conformed to the finding already made in the previous chapter that the technical development work should always be more in the hands of the supplier itself:

“That technical development which is... I would see that it is more like the work of the supplier and the supplier's [upstream] stakeholders, so I don't know how much the head contractor can actually bring out benefits in it”. (CO1)

Regarding the later stages of testing and validation and launch, most of the interviewees thought that these are the stages where contractors should once again be involved more significantly after the initial stages and building of business case. Indeed, it was also shown by Sariola (2018) that contractor's innovation-oriented practices with supplier's usually includes the piloting of new products and solutions and guiding supplier in new product implementation. For example, one contractor recalled how there are constantly some new products being piloted on their sites, and how they reserve some extra resources for piloting's to go out smoothly:

“At our sites, it is often the case that something is being tested or piloted. And well, it works out pretty much so that it's agreed together what project is involved in that [testing]. They will know what will be tested/piloted. And usually, some extra resources are set aside on our part in a way, so that it is not directly off the backbone of the construction project, as in “this will now be like extra work for you”. [...] Mostly it's worth to do the testing in the conditions it will be”. (CO1)

Another contractor also recognized the prevalence of piloting projects going on their construction sites but added how these projects should also yield some project-specific benefits for the contractor. Indeed, contractors have been shown to enter collaborations only if it were a viable proposition for them, and not as a result of what their competitors are doing (Akintoye & Main 2007). As the contractor explains:

“So probably that testing and piloting and launching, in terms that suitable projects are found in the first place where we can then test it or take it forward together. Like yes, we also utilize them a lot... or we're involved in taking piloting stuff forward. But indeed... there needs to be some certain kind of driver for why we want to go into that piloting.” (CO4)

Furthermore, one contractor stressed the importance of well-backed concept before on-site piloting. This observation supports the risk aversion of contractors demonstrated by Blayse & Manley (2004). As the contractor explains:

“And that [testing and piloting] is where we have often been involved... or as if someone is bringing something a bit newer to the market. But it also means that... [...] it has to be a pretty functional concept for us to dare to take forward”. (CO2)

But not all contractors were too enthusiastic about piloting new products. One contractor even stated very clearly how they do not take on pilot projects unless they are separately

funded or well backed-up. This however creates a chicken-egg problem for the supplier's as having a well backed-up product usually requires adequate on-site testing.

"I have sometimes also said on the client side that we do not carry out pilot projects, that they are separately funded projects. As it comes with the quality and functionality and ... and of course some cost and ... like warranty issues and more. Like it is quite difficult to get on with that if you do not have experience with such products. They must be well-backed and that there are good test results, and everything is done by outsiders, so that they can be trusted in that respect". (CO5)

But nevertheless, it seems more practical to get contractors involved during the later stages of NPD because the involvement can be integrated into contractors' project-based business through on-site piloting. This would also eliminate the challenge of getting contractors to pursue separate short-term projects beyond project-level (Bygballe & Ingemansson 2014). But despite this approach would not necessarily require long-term relationships, the level of involvement with contractors in the later stages of supplier's NPD should definitely be more cooperative in nature in order to find mutual benefits from the piloting. And having trustworthy relationships would not hurt either when conveying the benefits of an innovation to contractors.

Lastly, although contractors have been found to have very low initiative to pursue short-term innovation projects beyond project-level (Bygballe & Ingemansson 2014), one contractor further described a complete NPD collaboration made with a supplier through long-lasting and trustworthy relationship.

"[...] It has started from the very beginning, as in we have been already together generating ideas and scoping what has been taken forward. We have also been involved in this building of business concept, as it is also related to our business. And that cooperation has also been done in this technical development [stage]. Now we are little by little in the testing-piloting stage, as we are piloting them on our construction sites. And the launch will hopefully come at some point next year". (CO1)

Thus, it can be concluded how such thoroughly cooperative NPD development projects are also possible between supplier's and contractors, if only long-term and trustworthy relationships and mutual benefits are found.

4.4.2 Architects

Architects are recognized to have the most knowledge to contribute during the early stages of idea generation and scoping, but also the more hands-on technical development, piloting, and testing of new products. But on the contrary, most of the architects rejected the idea of being involved for building a business case, launch, or any activity driven by commercial motives for that matter. Especially regarding the stage of building business case, the opinions were quite clear:

“I would leave that business case in the sense that it’s probably like – if one thinks of different product manufacturers – pretty sensitive and it’s different for everyone. So I think I would leave us out of it unless one wants to act in full transparency”. (AR1).

“Surely an architect may not have so much to give for that building of business case” (AR2)

“But of course, that building of a business case maybe is one that probably won’t ... every company does it in their best way possible”. (AR5)

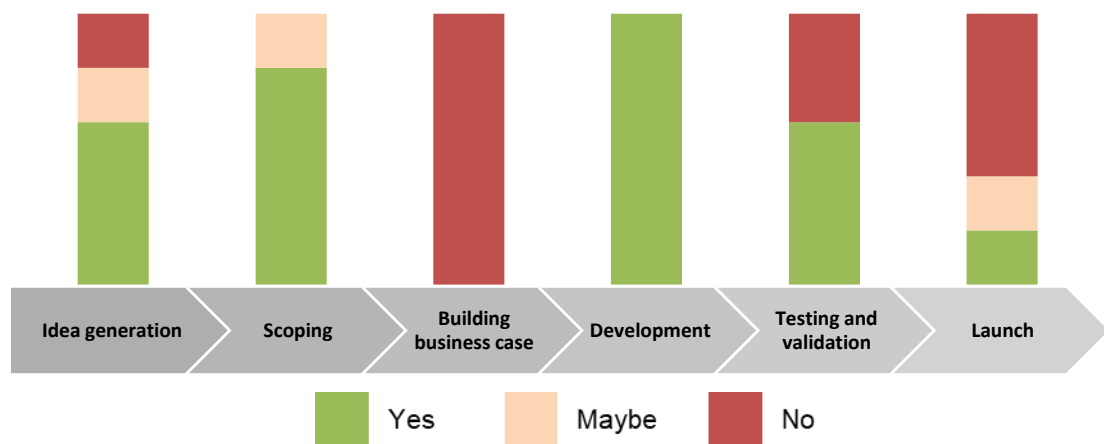


Figure 8: involving architects in supplier’s NPD

As it was already observed in chapter 5.3.1, architects can be seen as more inherent innovators when compared to clients and contractors. Thus, it was no surprise that many architects found their knowledge most useful at the early stages of supplier’s NPD. This observation strongly supports the findings by Martinsuo & Sariola (2015) that Finnish designers would be interested in the possibility of being involved beyond project-level and especially by bringing in their perspectives early in an NPD process. And whether this early stage translates specifically to idea generation or scoping seemed less relevant, as most interviewees settled for defining their role to be the best “at the early stage of development” or at both two initial stages. As two architects explain:

“I would probably take that initial stage in particular. The biggest decisions, delimitations are made there. Like where it is also the greatest change to go wrong or conversely take some essential component into account. [...] So that's why I'd suggest that idea generation with even more weight. And then if you still want to take further steps, then for me that scoping and that further developing, tightening could also be involving”. (AR1)

“It would perhaps be interesting there at the very beginning like what the thing is and where it will be needed altogether, and ... and of course, if those ideas come in awful, it would be also nice to scope down the excess”. (AR4)

Workshops were largely identified as the best tool for generating new product ideas cooperatively with designers, weather the nature of involvement is formal or informal. Indeed, such cooperative methods were also recommended by Lagrosen (2005) in these types of facilitative relationships. Furthermore, an answer by an architect CEO also highlighted the previous observation that architects generally view possible involvement as an important activity or even desirable for that matter:

“A good concrete tool for the first stage of idea generation is like organizing a workshop day on the topic. After all, it doesn't have to bind either party more than that when throwing ideas in the air. And then it's up to other people to start scoping those ideas and focusing on that. Such workshop days could be quite nice to take part, where questions and ideas are thrown into the air, and together thought in which direction the thing should be taken. Could be quite meaningful”. (AR2)

As another possible tool for utilizing designers' knowledge in early stages, many of the architects recognized how supplier's frequently ask architects' opinions about product needs and new ideas. Although this was mostly appreciated due to supplier's taking the initiative on development, one architect noted how such ad hoc calls especially from salespersons might not yield the best results for idea generation. In addition, architects themselves have only little influence on what type of suppliers will contact them, which may lower the interest to get involved through such ad hoc methods. Indeed, it was also observed by Emmit & Yeomans (2008, p.158) how product supplier's habit of bombarding designers with information is extremely insufficient due to the gatekeeper mechanism. For example, two interviewed CEOs pointed out how flooring and tiling manufacturers are doing this especially frequently:

“[...] if I think about tiling manufacturers, for example, they are asking us diligently like what [and] what kind of needs you have and what may be needed.” (AR1)

“And after all, many salesmen call a lot to designers. And nothing wrong with that, good thing they do because that’s when that active role is taken. But as a designer, I often feel that it is a bit random which product category’s companies are active towards designers. [...] There is a strong emphasis at the moment in that communication, as in our direction, with flooring material suppliers as an example. And it is perhaps a problem of a certain kind that I might wish for those contacts to come more evenly. [...] It would be nice to know why flooring companies bombard architects so much and why other sectors on the other hand don’t. I haven’t come up with a clear reason why so.” (AR2)

One architect thought that involvement at the very first stage of idea generation might be redundant if there is a predefined reason for the involvement and preconditions for innovation. Thus, the stage of scoping would be more suitable.

“Of course, at that point when a company is generating ideas, I do think they already know what kind of things they will be. Like if we take window industry or someone else making them as an example. Like hardly is there any further brainstorming on whether to start making bricks or something else. So somewhere in that scoping of ideas is probably one such moment when it would be good to know for sure what kind of demand/need there is. And how, for example, these future regulations or other matters in standardization regimes possibly affect”. (AR5)

Indeed, involving designers only at the stage of scoping would address the risk of encountering “chicken and egg” -problem (Rogers 2003, p.164-167) especially in case the involvement is more ad hoc in nature. In other words, when involving designers with ad hoc methods it would seem beneficial if there is something tangible to contribute upon. To demonstrate how this can work in practice, this latter architect shared a real-life example where such ad hoc involvement had yielded great results:

“[...] he [the supplier] had an idea for this new handrail thing, [...] and he introduced the idea, and then we brainstormed in the meeting that “this would be a really good product if made this way” [...] And then he came like a year or half later ... like came with the product [...]. That it is now one of Finland's largest glass handrail suppliers. [...] It was this kind of genuine innovation, which in a way arose from certain needs, and which is important for the end result. And then what was happening inside the product, it was like the supplier’s own thing. And in my opinion, it has been a particularly successful project, and I have also been specifying those railings multiple times myself”. (AR5).

Although the architects viewed the core of technical development to be on supplier's responsibility, the interface between technical development, and testing and validation was seen as the next important stage after the initial stages. Indeed, for architects it seems that the most favorable level of longitudinal customer involvement is that of described by Lagrosen (2005) and suggested by Gruner & Homburg (2000). As one of the architects described the purpose of involvement after initial prototypes:

"And then that kind of interface of testing and piloting / technical development. I think there it's again quite pivotal, because now it can be ... whatever it is, it can be printed or prototyped in some way, and thus designer's feedback could be valuable at that point". (AR1)

In practice, this means that designers should be involved after every iteration of technical development and prototyping. Furthermore, the involvement could be managed by including such decision-making GO/KILL criteria that forces designers' perspective to be accounted for after every iteration

The stage of technical development was seen especially important for taking aesthetics, details, and fittings into account. Although these aspects should obviously be considered already during the early stages, a tangible prototype is nevertheless a very familiar platform for designers and allows for more in-depth and real-life reviewing. As some of the architects reflected on the importance of this stage:

"Well, it would be nice to take part in that technical development work as ... as it's kind of ... the generation of ideas has been narrowed down and then it has started to be developed. Like kind of the detail level design... that it would then be such a product that would be suitable for use". (AR3)

"If it [the aesthetics of a product] is forgotten at some point, it will not end up in the finished product. But like the most important is certainly that technical development, that the aesthetics is taken into account there". (AR2)

"Of course, the details are such that there should already be some prototype and model, and then we will see how those products are attached, for example. Does it have hidden fastening systems? What kind of surface materials? So, this is then another moment [for involvement]". (AR5)

One of these architects in particular reflected upon a real-life example, where a founder of one of the largest locking manufacturers in Finland had toured in architect offices, presumably at this very interface of technical development and testing and validation.

"In fact, there have been those situations, like when iLOQ was born, it was the agent, or the founder, who toured in architect offices and presented the product.

And as it was still a bit raw in form he sought for some inspiration. [...] It was maximum of half an hour or an hour, so like a coffee break demonstration, but which of course always extends for longer than 15 minutes". (AR3)

This example thus provides us with a tangible tool for involving designers during the stage of development – and why not also during the initial stages. In addition, such face-to-face involvement does not explicitly have to happen at the architect's office, as successful trade representatives have been shown to exploit all the meetings with designers for feedback on existing products and for views on new product development (Emmitt & Yeomans 2008, p.166-167).

Furthermore, it is important to discuss how this specific locking innovation mentioned above was very revolutionary at least in Finnish construction industry, as it represented (and still does) a great advancement in digital locking solutions. Although it can only be speculated, the novel and even revolutionary nature of the innovation may have been in importance when overcoming the gatekeeper mechanism held by architects, as architects are seen more enthusiastic towards and motivated by such innovations. Indeed, another architect described a not-so-glamorous involvement compared to the one described above, that had not been especially motivating:

"Well sometime yes... something like, whatever they are some plastic carpet companies [laughs] or something [...]. Some new color scheme or something, so they have toured the [architects'] offices and asked for some comments on what shades of gray would be needed. That's what came to mind now". (AR4)

Just like the stage of development is easily blended in with the stage of testing and validation, the stage of testing and validation is easily blended in with the final launch stage. Especially in construction, these two latter stages go very much hand in hand as the final testing is usually carried out through actual construction projects, and which then leads to an eventual launch if being successful. And when it comes to the role of architects in these stages of testing and launch, architects felt their power and role to be limited. Instead, contractors were seen to have more significant role when deciding upon new product pilots, which thus supports the earlier observations made from contractor interviews.

"In the launch, I don't feel that the architect needs to be very prominently involved. [...] Like sometimes the architect has a big say in what products are used, sometimes it's limited. And that's why the implementing body in it... contractors should be present at that discussion as well". (AR2)

As it was with the stage of building a business case, most architects also view the launch stage as similarly driven by commercial motives and thus not worth being involved in. Rather architects prefer taking part in development as anonymous actors without commercial attachments, as an architect explains:

“Well, here’s the troublesome thing I’m trying to stay out of, because I personally feel that I’m not like... my role is not to [market] individual products as brands that way... and that’s why it’s always hoped that there will be enough suppliers/actors springing up to the market. Like we prefer to talk about those needs and materialities and qualities that we need of them”. (AR5)

As designers have been shown to utilize lists of favorable products (Emmitt & Yeomans 2018, p.153) and in general to favor products with well-established track record, this observation is somewhat problematic when trying get architects to adopt new innovations. Unfortunately, this research is not able to provide definite practices for overcoming this barrier other than conforming to previous recommendations on, for example utilizing designers as change agents (Emmitt & Yeomans 2008, p. 168) and building trustworthy relationships with designers in general (Sariola & Martinsuo 2016). Therefore, the subject of better overcoming these market barriers and achieving market adoption is recommended as a subject for future research.

Despite the rejective views on using architects to find suitable projects to support product launch, it was discovered in the previous chapter how the interviewed architects demonstrated abilities to contribute knowledge into developing successful marketing after-sales support of a new product. This includes especially contributing knowledge on data model objects and object libraries, designer’s toolboxes, marketing materials, and other online information provided.

Lastly, one of the interviewed CEO’s was particularly excited to talk about their one-time business-level collaborations with certain construction product and furniture manufacturers. Reasons for these development projects stemmed from a need to replace outdated solutions from architects’ perspective, which supports the findings by Vaquero Martín et al. (2016) that professional users are extrinsically driven to cooperate when there is a need to overcome unsuitability of existing technologies. Furthermore, these are good examples on how project-level cooperation can lead to a successful business-level cooperation:

“It has started from projects. This is perhaps the most typical for us. So the first one is done together with the dune and there it has been found that hey we have this and that and you have the kind that these could not be combined in some way. [...] In the other one it started from when we have been planning

kindergartens, schools and learning environments for a long time. So it led to the designers, [and] the project leader having discussions during a project with the product manufacturer that “these and these kind of products are lacking”, and then the idea came that if these should be further processed and further developed. And the other one went very concretely so that we were in touch with this company, from where we then went to get to know them. They opened this product development process of theirs for us. And then we thought that... we started to look if that would result some common interface”. (AR1)

These real-life examples thus show how such thoroughly cooperative NPD development projects are also possible between suppliers and architects. In addition, they further highlight the suitability of workshops for cooperative idea generation and scoping as the CEO further described the process in which they were involved in the supplier’s NPD process:

“We have held workshops... it all started together because it was like its own innovation project, where, of course, it was discussed what was being done for this project, how the procedures were agreed and then the workshops together. [...] They gathered comments from various stages of their process, and then it was further refined, and, in the end, it resulted concept-level plans from us for certain furniture, which they now consider on what should be done to them”. (AR1)

But regardless, it was finally noted how such comprehensive cooperation’s are still an unfortunate rarity between suppliers and designers (when also considering that these were the only such examples to emerge altogether).

“It’s pretty much an exception that ... usually at least 95% of cases go that way, that [supplier] says, that we have these and show them off like we have these coming and use if [needed]”. (AR1)

This observation also supports the finding by Sariola & Martinsuo (2016) who showed that only 38 percent of sampled designers had ever cooperated with suppliers beyond project boundaries.

4.4.3 Project clients and consultants

Clients and consultants are seen to have the hardest time finding a place in supplier’s NPD process. As it can be seen from Figure 9, clients and consultants found their input to have importance only during the early stages in terms of being a catalyst for innovation, and the again later when considering new product pilots at the stage of

testing and validation. For all the other stages, the possible role of clients and consultants in supplier's NPD was however seen practically non-existent.

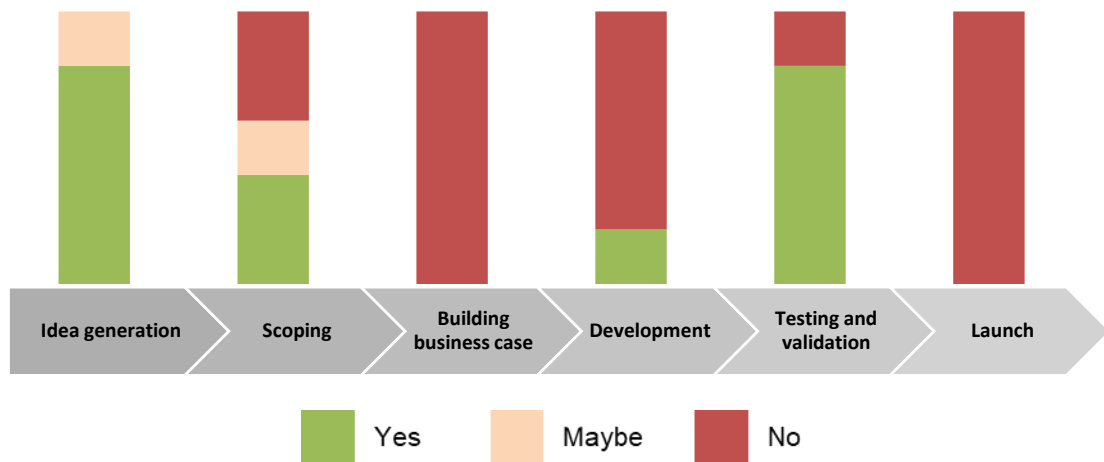


Figure 9: involving clients and consultants in supplier's NPD

Although the interviewed clients and consultants did not see themselves to be the best candidates for idea generation or scoping as individuals, they widely recognized the important role of clients as a catalyst for innovation. This is also supported by multiple earlier findings (Barlow 2000; Gann & Salter 2000; Seaden & Manseau 2001). As the one client explains, clients usually have or should have a significant role when considering innovation for future trends, but at the same time the more traditional project goals are nevertheless a significant driving force:

“But to answer the question, the role of the client/owner is the most important of all. Should be. And so, we want also that our responsibility concerns, our environmental goals come through in our construction projects. And... okay, the same goes for cost targets, efficiency targets”. (CL4)

To further discuss the role and perceptions of clients and consultations in construction innovation, one of the consultants highlighted the role of consultants especially when communicating between one-time clients and the the project network. Indeed, it was also argued by Bresnen (2010) and Tzortzopoulos et al. (2008) how most clients do not have coherent plans when it comes to construction innovation:

“We play a terribly large role in what kind of information we bring to clients. [...] to like all types of clients, like of course we have a lot of one-time clients; usually such limited housing liability companies¹⁾ that... may not have such a long-term plan or perhaps not even an interest in taking such long-term effects into account. [...] So justifying such things [not required by law] can then be a little more challenging for a one-time client. But then, of course, developer organizations are

already interested in piloting things and preparing for future changes, so... in that way they certainly differ quite a bit as customer groups". (CL3)

Although these aspects discussed above are not directly connected to supplier's NPD, it is important to understand the consultant's point of view when trying to find practices for accessing market input indirectly through consultants. Furthermore, the observation that consultants operate with a large number and variety of clients could be important in terms of getting comprehensive market input with the least amount of resources for initial stages of NPD. Indeed, as it was observed in previous chapter, consultants have a wide perspective to the industry and could thus provide ideas for new product development without the need for suppliers to wade through different types of clients separately.

However, out of all clients and consultants interviewed only one consultant demonstrated a higher level of willingness and capability to informally contribute to supplier's business-level NPD. This is suspected to result from this individual's long career in construction in multiple different roles and even as an entrepreneur, which has led to a vast network and general involvement within the industry. As this consultant describes his/her point of view towards possible involvement in general:

"So I have certainly been involved and participated, I have been involved in many things. After all, it's kind of like if you get involved and asked some opinion. So that's like, it's always worth answering, because it's... even if you don't get anything tangible at the moment, like a prize or a reward [...] you might come face to face with it somewhere later in life". (CL2)

Going back to the theme of customer involvement at specific stages of supplier's NPD, this consultant recalled how the most common form of informal involvement is asking personal opinions through trustworthy and personal relationships:

"Like "do you have a need...?" [laughs] That's probably the most common, but so... so, I mean, it should always be like short and concise, [...] like if you get involved without being in any project development group or anything like that. [...] But of course, you can always go golfing with friends". (CL2)

This observation further highlights the importance of finding the right individuals to involve, especially when considering consultants or even clients or end users. Indeed, when there are practically no possibilities for formal relationships between clients and supplier's, informal relationships between individuals quickly becomes the only option.

1) A special type of housing management solution. Exclusively, yet very commonly utilized in Finland.

Lastly regarding the early-stage involvement, it was also noted how there are risks involved when involving customers who are actually not customers in the sense of not representing either decision-making organizations, professional users, or end users. This risk is also somewhat relatable to avoiding conservative opinions within the industry:

“On the other hand, there is a danger that you will shoot down a good idea because you don't need it yourself. That is always the danger when participating in this stage of scoping ideas”. (CL2)

The building of business case was understandably not in the interest of any client or consultant due to their own businesses being far apart from that of supplier's. Practically only one consultant had any deeper views about this stage, which is probably due to this individual's role as a manager in cost estimations team. But nevertheless, the stage of building business case was seen solely a work of supplier's:

“If we say that it would replace something... like substitute another product that's usually used in that situation. So, then it would be good to think if there will be demand for it. But then again it is already here when scoping ideas where this should basically be done before going into building that business case. That [building the business case] I would consider to be something else”. (CL5)

Regarding technical development (or almost any other stage of NPD for that matter), there was again this one consultant who demonstrated willingness and capability to contribute. Thus, it seems once again that if a trustworthy relationship with a right person is being established, practically any opinions can be asked:

“Of course for technical development it is clear that opinions can always be given if asked. But [clients/consultants] may not be able to give it like “do it this way”, but rather we can say that most of the time it's needed like this and this”. (CL2)

But for other interviewees it seemed very distant idea to get involved in any hands-on product development activities.

“In technical development the real estate developer doesn't probably bring anything else than harm to your direction [laughs]”. (CL5)

Although one another consultant pondered that there well may be other colleagues with more experience (as with CL2) who would have been involved from his/her organization:

“[...] but to have actually taken an active part in the development of a product... would have to ask someone who has been in the house for longer time ... it could well be that there are them too.” (CL3)

For the stage of testing and validation, however, it seems there are more possibilities to have consultants and even clients involved through product pilots. For example, the one client interviewed explained how there are some of these space pilot projects carried out in their facilities from time to time, that also involve the end users of these spaces. Furthermore, these space pilots could act as a platform for gathering end user feedback on existing products, and therefore in fact be considered a part of new idea generation:

“Well, we do these kind of space pilots, and... like the aim is to find space solutions or some other space-related solutions. The fact that... yes there is testing and piloting [in the presented NPD process model] too, but could there be some precursors to that kind of experimental culture? Meaning that this idea generation stage could also involve experimentation, and then we could... we could willingly act as a test platform if we had some systems to test on a small scale”. (CL4)

Furthermore, one of the architects recognized similar mock-up space pilots frequently utilized in public school projects, that could similarly act as a potential platform to gather development proposals from existing products and to pilot completely new products:

“Well, some of those mock-up installations, such as the mock-up class at school projects, come from users and clients. [...] Since all the equipment in the classes, there may be 60 different classes, so then it is repeated. So then in that first one they are getting approved: heights and so on”. (AR3)

In fact, the target company was part of the ongoing project referred to by AR3, but so far these mock-up sites have not been systematically leveraged for the purposes of NPD and collecting end-user feedback. Rather they have been viewed as imperative procedures required by clients.

One consultant thought how they might have some influence towards other stakeholders in project networks when proposing new product pilots. An important predecessor, however, is that the product is already proven to meet industry requirements during the technical development.

“I would think that in technical development it has like... it is proved in a certain way that it meets the requirements and so. But that taking upon pilot projects, that is, the consultant does have these [opportunities] where he/she could bring it out on project planning meetings like: “Hey, there’s now a product like this, how about we take this? What do you think about it at this project?” (CL5)

However, another consultant approached these product pilots from much more risk averse point of view, which is understandable especially in more traditional project implementations. This observation supports the findings by Rose et al. (2019) that

reluctance to carry increased risks in case of product failures is perceived as a barrier to for construction innovation:

“Whose risk it is? And especially in these more traditional project implementations, like... like whose job it is... it is to like take the responsibility that the product really fits that project? And what kind of side effects can it actually have in a project if it doesn't work as intended or some challenges arise with it during installation or otherwise, so... to share that kind of risk can be quite troublesome”. (CL3)

To further discuss this risk aversion, Rose et al. (2019) found how clients consider the biggest barriers for innovation to result from suppliers' insufficient testing of new products. As it was also suggested by CL5 above to have proper testing before piloting, it seems this could decrease the possible risk averse behavior and greatly increase the probability of scoring a product pilot. And as construction consultants were already shown to possess vast knowledge on the whole industry including complying with regulations and standards, it would seem logical to seek aid from these consultants when figuring out the right level of testing before pilot project becomes topical.

Lastly, to highlight how far away clients and consultants are from product suppliers, no real-life examples of involvement in business-level NPD of suppliers emerged from interviews other than couple of examples from new product pilots. However, as it has already been shown, this one consultant was particularly enthusiastic about construction innovation and thus showcased possibilities for business-level involvement when suitable partners are recognized.

““Here would be a good business idea for someone who would bother to start developing”. I have even said it out loud. I should ask those employees of mine where I have again missed a good business idea. Of course, as a former entrepreneur I have been even forced to brainstorm them”. (CL2)

On the other hand, all the other clients and consultants interviewed were more rejective to the idea of being involved as individuals. For example, this one actual client clearly displayed the challenge of involving clients in supplier's NPD by being very outspoken and honest when asked about past experiences in supplier's NPD:

“Well doesn't come to mind. And if I have been invited, I may not have gone then. Like I don't see this as my own job though”. (CL4)

These views do not however, explicitly imply that these stakeholders would not care for business-level development at all. As for example, one consultant described how their organization and individuals are very happy to be involved in all types of business-level development projects that serve the common goals of society and construction:

“And then these public funded projects are absolutely such that [...] for example this development project of wood construction. Although there was not particularly a product being developed in it, then things like these that... serve the common goals of society are, of course, such that I do not see any contradiction in it.” (CL3)

And though it was observed how most of the consultants and clients were rejective to the idea of suppliers contacting clients and end users directly during construction projects, none of the interviewees saw barriers in doing so beyond project boundaries.

4.5 Framework for customer involvement in supplier’s NPD

The results presented and discussed within this chapter have been compressed into a generalized framework presented in Figure 10. The framework was designed in tandem with the process of data analysis and revised constantly as the researcher became more accustomed with the data and emerged results.

The basic structure of the framework is based on Figures 7, 8, and 9 that showcase the preferred NPD stages for involvement separately for each customer group (contractors, designers, and clients and consultants). The NPD process timeline with distinctive stages is presented at the bottom of the framework, and separate swim lane sections are placed above this timeline for each customer group. Finally, discussed customer involvement practices for supplier’s business-level NPD are placed on these swim lanes for each customer group. It is important to note that some of these practices can intersect across two adjacent NPD stages, even though NPD stages are usually separated by explicit decision-making gates with pre-defined GO/KILL criteria. This is because some of the explored practices and/or the knowledge obtained from customers can be seen beneficial in either one or both of the two adjacent stages. Thus, NPD managers are left with some decisions to make when implementing the framework on their NPD processes, although in most cases it is better if the involvement takes place earlier than later.

Possible opportunities for project-level NPD and cooperative business-level development throughout the NPD process lifecycle have been presented in the framework separately for each customer group with cross-sectional arrows. Although the opportunities for project-level NPD are very context dependent, these opportunities can be enhanced through, for example, collaborative project implementations and supplier’s higher technical flexibility/capability. For the business-level collaborations, the level of a relationship should be highly trustworthy and integrative, with cooperation happening within all stages through integrated NPD teams (Lagrosen 2005). This type of relationship and cooperation could even allow for customers being the primary innovator.

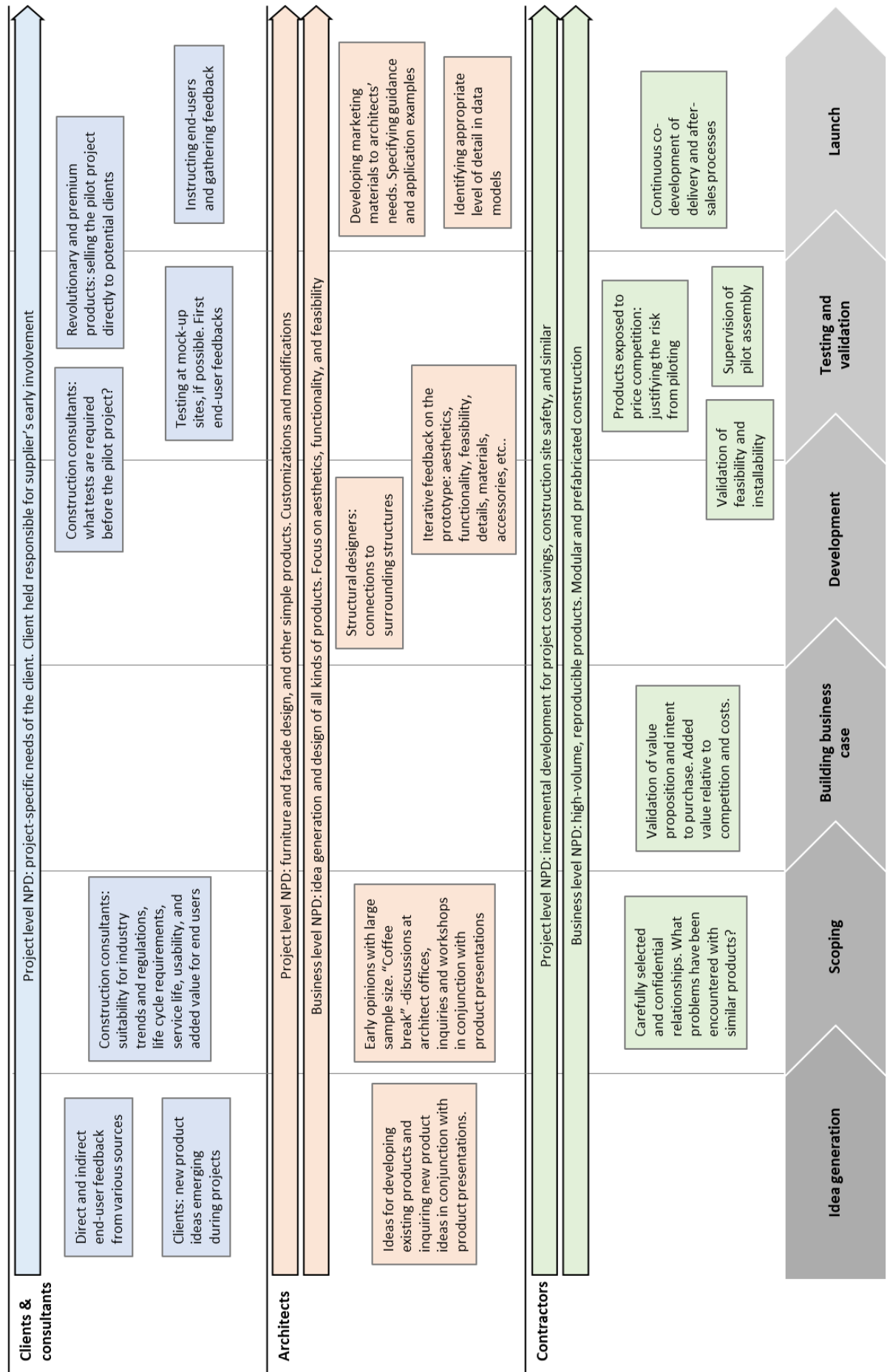


Figure 10: framework for customer involvement in construction product supplier's NPD

The framework is designed as a baseline tool for NPD managers working in companies that manufacture and/or supply all types of construction products. It is by no means a complete solution, but rather operates as a checklist for managers to account for different possibilities and pitfalls of customer involvement during an NPD process. The framework also does not take into account the different levels of customer involvement (CIS, CIC, CIN), that should be considered separately according to the type of innovation (low-tech, high-tech, radical, etc.) and the type of relationship in involvement (transactional, facilitative, integrative, formal, informal, etc.). Furthermore, it is important to remind about the unique nature of each individual NPD project, which brings its own limitations to any framework aimed for generalized implications. Thus, NPD managers should first consider how these results would adapt to their distinctive business, types of construction projects, and finally types of supplied products.

The results and the application of the framework to the target company's NPD process was discussed, evaluated, and approved during a designated seminar that was attended by most of the target company's officials from operational staff to the board of directors. Furthermore, the results from this research were also applied to refine other tools for new product development including portfolio management, market analysis, competitor analysis, and project documentation. Although these practical implementations would have been interesting to share, they were decided to be left out due to revealing too much business sensitive information.

5. CONCLUSIONS

This final chapter concludes the theoretical and managerial contributions of this research. Finally, some of the most critical limitations are considered and subjects for future research recommended upon these limitations.

The objective of this research was to design a comprehensive framework for involving contractors, designers, and construction project clients into construction product supplier's new product development. This objective can be deemed as fulfilled, as all three research questions were first answered and discussed in depth, and then applied to the designed framework. But as the visual framework does not give explicit answers to these research questions, these answers are concluded in Table 15.

Table 15: explicit answers to the research questions

| Research question | Contractors | Designers | Clients and consultants |
|--|--|--|--|
| Perceptions on construction innovation and involvement in supplier's new product development | <ul style="list-style-type: none"> • Willingness to improve the industry as a whole • Long-lasting, trustworthy relationships are valued with mutual benefits • Innovating is seen difficult during projects where standardized solutions are preferred, but innovation can be enhanced with collaborative project implementations | <ul style="list-style-type: none"> • Inherent interest in innovation and new knowledge • Innovating is seen difficult during projects • Involvement in supplier's business-level NPD is seen important/desirable • Involvement must be concise and purposeful • Transparency and neutrality are valued • Shunning away from commercial motives | <ul style="list-style-type: none"> • Willingness to react upon new trends and acute project needs • Innovating is seen difficult during projects where standardized solutions are preferred • Difficult to see a role in business-level NPD • Project-level innovation can be enhanced with collaborative project implementations and earlier supplier involvement |
| Knowledge contribution to supplier's new product development | <ul style="list-style-type: none"> • Value relative to costs • Feasibility, installability, and safety from an on-site perspective • Competing products and operating models | <ul style="list-style-type: none"> • Product aesthetics, fittings, and details • New product ideas • Feasibility, end-user functionality • Directed end-user feedback and needs • Product marketing and after-sales support | <ul style="list-style-type: none"> • Product life cycle assessment and requirements • Direct end-user feedback and needs • Construction industry as a whole, incl. regulations (consultants) • Value relative to costs |
| Timing and practices for involving customers into supplier's new product development | <ul style="list-style-type: none"> • Scoping: opinions from carefully selected and trustworthy relationships • Building business case: validating the value proposition through trustworthy relationships • Testing and validation: finding suitable pilot projects and testing on-site feasibility • Launch: continuous co-development of after-sales processes | <ul style="list-style-type: none"> • New product ideas from all opportunities • Scoping: early opinions and workshops with a large sample size • Development: connections to surrounding structures • Development/testing: iterative feedback on prototypes; involvement in workshops • Launch: optimizing marketing materials and tools for specifiers | <ul style="list-style-type: none"> • Leveraging cooperative projects and any client-driven ideas • Direct and indirect end-user feedback from various sources • Development/testing: what tests are required before piloting? Can it be tested in a mock-up? • Testing/launch: convincing and selling revolutionary/specialized pilot products directly to clients |

5.1 Theoretical contribution

This research was greatly inspired by studies carried out by Sariola & Martinsuo (2013; 2015; 2016; 2018) in Tampere University of Technology. The key findings from this research are linked to these previous studies in Table 16, which shows a logical progression in the overall contribution to literature regarding construction product supplier's role in construction innovation.

Table 16: linking the theoretical contribution to previous studies

| Research | Research focus | Empirical data | Key findings |
|--|--|--|--|
| Sariola (2013); Martinsuo & Sariola (2015) | Supplier's relationships with third parties (architects and structural designers) in construction project networks, and especially the influence of third parties on procurement. | 22 interviews of architects and structural designers | "The findings show the crucial role of third parties in the constructor's and customer's decision-making process, and various ways for suppliers to develop the relationship toward the third parties. The results offer important knowledge about the cooperation between construction component suppliers and third parties and means to increase the centrality of component suppliers in the project network". |
| Sariola & Martinsuo (2015) | Conceptual framework for enhanced relationships between suppliers and designers in project networks | Excerpts from the interviews by Sariola (2013) | "Cooperative practices needed for strengthening the relationships in project networks were identified. The framework on how such practices are associated with relationship strength between supplier and designers was developed. Propositions on strengthening the relationship between component suppliers and designers were stated". |
| Sariola & Martinsuo (2016) | Supplier's non-contractual relationships with designers | 89 survey answers from architects and structural designers | "The findings reveal the supplier's activeness and technical capability as precursors to trust, and supplier's technical capability and supplier-designer cooperation beyond project boundaries as precursors to commitment. The different precursors of trust and commitment imply alternative pathways for strengthening noncontractual relationships in construction projects, thereby deviating from activities in contractual relationships". |
| Sariola (2018) | Identifying practices for enhanced relationships between suppliers and contractors in project networks, and especially the use of suppliers' potential in construction innovation. | 18 interviews of contractors and their representatives | "The contractors perceive that the suppliers have innovation potential, and that they are often a source of construction innovation. The findings reveal business- and project-level practices for enhancing the contractor-supplier relationship and for overcoming barriers that hinder the suppliers' innovation potential". |
| Karppinen (2022) | Identifying practices for customer involvement in suppliers' new product development | 15 interviews of contractors, architects, clients, and consultants | The findings reveal tangible business- and project-level practices for attaining valuable market input from all customer stakeholders in construction project network during all stages of supplier's new product development process. |

The majority of the findings made in this research were built upon empirical observations and were found to support most of the previous research findings on promoting construction innovation. Furthermore, this research complements the unfortunately constricted research conducted from the point of view of construction product suppliers, and finally brings the previous and new findings together for a generalized framework. In addition, the empirical findings complement NPD literature in terms of applying well-established frameworks by Cooper (2001) into a tangible business project aimed for tangible results. Literature regarding customer involvement in NPD was mostly used to design the empirical component of the research, but also to validate the industry-specific findings against generalized literature. This research however does not significantly contribute into the generalized literature regarding customer involvement in NPD.

Although Bygballe & Ingemansson (2011) argued how Swedish and Norwegian construction industry perceive business-level R&D projects as of less in importance compared to continuous development within construction projects, observations made within this research cannot confirm this true for Finnish construction industry. First, it was shown how 14 out of all 15 interviewees thought innovating within projects is very difficult, and thus business-level NPD is necessary from supplier's perspective. And second, even though especially the interviewed clients and consultants found only little if no connection to supplier's business-level NPD, this does not mean these actors would not care about business-level development at all. Indeed, most of the interviewees recognized the importance of and the need for innovation and continuous development. The biggest limitations, however, seem to lie within the business models and processes that have not been able to readjust for cooperative innovation and the most recent trends.

5.2 Managerial implications

As the most significant finding, the research reveals tangible business- and project-level practices for attaining valuable market input from all customer stakeholders in construction project networks during all stages of supplier's new product development process. The findings further imply how innovating is seen challenging within projects, but also how project-level innovation can be promoted with more collaborative project implementations. Customer involvement at the business-level of supplier's NPD was however highlighted the most, with emphasis on, among others, identifying the lead users, building and leveraging trustworthy relationships, and exploiting every possible opportunity of informal involvement.

This research was aimed for designing a generalized framework for customer involvement in construction product supplier's NPD no matter the type of business or

types of products in development. For the target company of this research, the results were applied on a generalized NPD process based on the model by Cooper (2001) with specified checklists and GO/KILL criteria assigned for each process stage. But as it was presented in Table 1, the most notable stage-gate NPD process models all consist of very much similar stages. Thus, the results from this research should be very easy to fit with other NPD process models too.

For NPD management, it is always important to realize the project-based nature of NPD, and, for example, how different types of NPD projects can affect possibilities for customer involvement. For the target company, one significant factor was the level of outsourcing for some products being developed. Thus, it was left for the NPD project management team to judge how in-depth the process should or could be followed for different types of innovations when some being even fully outsourced solutions to resale. In addition, the one single process was made to fit all types of projects from incremental low-tech innovations all the way to radical high-tech innovations where similar room of judgment was left for NPD managers.

Furthermore, the results from this research were not only applied to create a tool for customer involvement in the target company's NPD, but to also refine a complete set of tools for new product development including portfolio management, market analysis, competitor analysis, and project documentation. Indeed, the findings from this research could also be applied on other aspects of NPD than just customer involvement. For example, the framework and results presented in this research should also provide relevant checklist topics for NPD managers to consider regardless of customer involvement breadth, such as lifecycle assessment, added value, aesthetics, on-site feasibility, regulations, and required testing. Indeed, some of these listed aspects were also included into the GO/KILL criteria built into the target company's model.

5.3 Limitations and future research

As there are no definitive truths in explorative research, endless amounts of limitations could be listed here too. But arguably the greatest limitation due to the exploratory approach and the limited time frame is not to allow for statistically rigorous evaluations of the emergent findings. Most importantly, even though these emergent findings were constructed within a tangible framework, there was no opportunity to validate how these proposed practices affect NPD performance when utilized on different types of development projects, and with different levels and breadth of customer involvement. Thus, further longitudinal research is proposed to quantify the qualitative findings made in this research.

One of the key shortcomings of this research concerns the innovation-oriented practices during the launch stage of supplier's NPD to promote market adoption, and especially the engagement of different customer groups at this stage. In retrospect, the nature of this stage and the endpoint of an NPD process were probably not defined clearly enough for the interviews, which may have resulted in limited findings. But on the other hand, the endpoint of an NPD process is not unambiguous either and, in any case, the line must be drawn somewhere. But nevertheless, it is suggested for further research to explore how suppliers can better promote the market adoption of new product and services. And speaking of services, it is also recommended to broaden the scope of supplier-driven development from only products to also services as they were excluded from this research.

Although project-level innovation was viewed challenging, and especially from supplier's point of view, multiple observations were made on how cooperative project implementations such as alliances could promote project-level innovation. It is thus recommended to further explore how these types of implementations can promote innovation in practice from the perspective of all stakeholders in construction project networks.

Finally, an interesting sidenote by two architect CEOs was made on how tile and flooring suppliers are contacting architects more actively compared to suppliers from other product segments. What makes this even more interesting is that the first ever product supplier to acquire architects for marketing operated in a similar product category of brick manufacturing. As Istock's competitors have apparently adopted the same method, it would thus be interesting to research if this movement has been a contributing factor for different product segments becoming more active towards architects than others.

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APPENDIX A: INTERVIEW QUESTIONS WITH SELECTED FOLLOW-UP QUESTIONS

1. Background and perceptions on innovation
 - 1.1. Please tell in brief, what is your background and current role within construction industry? What are your typical tasks?
 - 1.2. How do you feel about the role of [architects/contractors/clients] in the renewal and innovation of the construction industry?
 - 1.3. How do you feel about the role of construction product supplier in the renewal and innovation of the construction industry?
2. Communication and cooperation with construction product suppliers
 - 2.1. How much do you and the company you represent be in contact with construction product suppliers? How does the communication typically take place, with whom, and on whose initiative?
 - What type of information is being shared?
 - How the communication could be developed?
 - 2.2. Is there communication outside of construction project boundaries? What kind of communication has there been?
 - How the communication could be developed?
 - What this type of communication would require?
 - 2.3. Do you or does your company have any closer cooperation's with suppliers? What kind of cooperation has there been?
 - Has there been any cooperation outside of project boundaries?
 - How has the cooperation initiated?
3. Project-level NPD
 - 3.1. How often during construction projects does the need arise for solutions that cannot be found on the market?
 - How these situations are usually being handled? Describe the process as accurately as possible.
 - Have these problems usually been solved?
 - 3.2. Do you have experience in customer-driven innovation where you or the company you represent have designed a new type of product for a supplier to implement?
 - How has this type of cooperation succeeded?
 - What do you think it would take for such a cooperation to succeed?
 - What challenges and opportunities you see in this type of cooperation?
 - 3.3. If there has been a need for supplier's product development during a construction project, how have you or the company you represent been involved in this product development? How do you wish the involvement would occur?
 - Role in the involvement? (source of information, active participation, etc.)
 - The role of personal relationships?
 - Contractual or informal involvement?
 - Dedicated cross-organizational teams?
 - What type of compensation from the involvement?
4. Business-level NPD
 - 4.1. Do you find it easy or difficult to communicate your perspectives and needs to the supplier?

- How concrete are the problems and potential development ideas (i.e., tacitness)?
- 4.2. In what areas do you feel that [architects/contractors/clients] are the best “product experts”? What type of information and expertise could [architects/contractors/clients] provide for suppliers’ new product development projects?
- Consider, for example, situations where you feel that a product supplier has not understood aspects you believe are relevant.
- 4.3. Shown below is a typical phasing of a new product development project (shown also for questions 4.4. and 4.5.). At what stages do you feel that suppliers should especially pay attention to the perspectives of [architects/contractors/clients]?
- Do you recognize practical examples?
 - Considering the responses for questions 4.1. and 4.2., at what stages should these matters be taken into consideration?
 - Lastly, what opinions does the interviewee have about those stages that have not yet been discussed about?



- 4.4. Have you or the company you represent been involved in supplier's new product development in any of the described stages out of project boundaries? If not, could you imagine being involved out of project boundaries?
- The way of contacting?
 - Role in the involvement? (source of information, active participation, etc.)
 - The role of personal relationships?
 - Contractual or informal involvement?
 - Dedicated cross-organizational teams?
 - What type of compensation from the involvement?
- 4.5. What barriers do you see for the customer involvement in supplier's new product development out of project boundaries? How could these barriers be overcome?
5. Directions for development within construction industry
- 5.1. In what direction do you see construction industry developing in Finland, especially from the perspective of the target company's business? What challenges and opportunities does this create for innovation and product development?
- 5.2. How do you see Finnish construction product suppliers performing against foreign suppliers? What are the main competitive factors for Finnish construction product suppliers?
6. Closing the interview
- 6.1. What wishes do you have for product suppliers operating within the business segment of the target company? Considering, for example, technical solutions, service solutions, scope of deliveries, etc.?
- 6.2. Is there anything else you would like to mention?