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New Product Development Process for Parts Business

From New Product Idea to Market Launch

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TIIVISTELMÄ:
Varaosamyynti on tärkeä liiketoiminnan osa-alue teknologiayrityksille. Varaosat turvaavat laitteen käyttövarmuutta ja niillä voidaan päivittää uusia ominaisuuksia vanhoihin laitteisiin. Hinnan ja toimitusaikojen lisäksi tuoteinnovaatiot ovat tärkeitä kilpailutekijöitä teknologiateollisuudessa. Teknologiajohtajuuden kannalta on tärkeää, että yritys jatkuvasti kehittää tuotteittaan, ja sen lisäksi tuo markkinoille uusia innovaatioita. Uusien tuotteiden kehittämiseen viittaa englanninkielinen termi *New Product Development*, joka käsittää tuotteen kehittämisen tuoteideasta markkinajulkaisuun. Uusien tuotteiden kehittämisessä avaintekijät ovat selkeä tuotekehitysprosessi, dynaaminen tuotekehitystiimi, sekä asiakastarpeiden ymmärtäminen.

Tämä tutkielma on tapaustutkimus, jossa kohdeorganisaationa on Konecranes Port Servicen varaosayksikkö. Tutkimuksen empiirisessä osiossa käytetään sekä laadullista että määrällistä dataa. Kohdeorganisaatio myy satamanosturien varaosia ja kehittää jatkuvasti tuoteportfolioon uusia varaosatuotteitta ja -paketteja. Kohdeorganisaation käyttöön on esitelty yleinen Stage-Gate tuotekehitys prosessi tätä varten. Tutkielman tavoitteena on selvittää, miten nykyistä prosessia voisi kehittää entistä sopivammaksi varaosaliiketoimintaan ja täsmentää vastuualueet sekä työtehtävät prosessin eri vaiheiden sisällä. Kehitysideat kerätään laadullisella tutkimusmenetelmällä haastattelemalla tuotekehityksen parissa työskenteleviä henkilöitä kohdeorganisaatiosta. Lisäksi selvitetään määrällisen datan avulla aiempien tuotekehitysprojektien läpimenoaikoja sekä prosessin pullonkaulavaihe.

Tutkimuksen perusteella aiempien tuotekehitysprojektien läpimenoaika on ollut noin vuosi, vaihdellen projektin suuruudesta. Prosessin pullonkaulaksi löydettiin tekninen kehitysvaihe, joka keskimäärin kesti 192 päivää. Tutkielman jatkotutkimusideana on selvittää, miten tätä vaihetta voidaan nopeuttaa. Nykyiseen prosessiin saatiin useita kehitysideoita haastattelujen perusteella ja esitelty prosessi vastuualueineen esitellään työn lopussa.

AVAINSANAT: varaosamyynti, tuotekehitys, tuotekehitysprosessi

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ABSTRACT:
Spare part sales is an important business for engineering-driven companies. Spare parts ensure the equipment operation security and old new features can be updated to machines by spare part packages. In addition to price and delivery times, product innovations are important competitive factors in the technology industry. From the point of view of technological leadership, it is important that the company constantly develops its products, and in addition brings new innovations to the market. *New product development* refers to the development of new products starting from market opportunity identification until the new product is launched to the market including the post launch-review. The factors in successful new product development are well-defined process, dynamic cross-functional team as well as understanding of customer needs.

This thesis is an empirical case study research where the case organisation is a spare part organisation of Konecranes Port Service. Data is collected by mixed method meaning that both quantitative and qualitative data are used in the empirical part of the thesis. The case organisation works in spare part sales for port cranes, and constantly develops new spare part products and packages into their product portfolio. A general Stage-Gate new product development process has been introduced for the use of the case organisation. The aim of the thesis is to find out how the current process could be developed to be even more suitable for the spare part business, and to specify the areas of responsibility and tasks within the different stages of the process. Development ideas are collected using a qualitative research method by interviewing employees from the case organisation. In addition, the quantitative data is used to find out the lead times of previous new product development projects, as well as bottleneck from the previously used process, are clarified.

Based on the research results, the lead time of previous new product development projects has been about a year, varying with the size of the project. The bottleneck was found to be the develop-stage which on average took 192 days. Based on the results an idea for future research is to find out how this process stage could be accelerated. Several development ideas for the current process were obtained based on the interviews, and the recommended process with areas of responsibility will be presented in the last chapter of the thesis paper.

KEYWORDS: spare part business, new product development, new product development process

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1 Introduction

The spare parts business is an important are of business for engineering-driven companies, ensuring the continued maintenance and functionality of equipment (Kulshrestha et. al., 2024). Recent research has underscored the significant role spare part sales play in generating revenue, particularly in manufacturing and engineering sectors (Wagner & Lindemann, 2008). Since product and service innovation is one the primary driver of competitive advantages in technical equipment sales, it is important to develop innovative products continuously (Taifi & Passiante, 2012). Term *New product development* (NPD) is referring to developing new products for markets (Vinayak & Kodali, 2014). The effectiveness of new product development resets upon the well-defined NPD process, the efficiency of a cross-functional team, and comprehensive understanding of customer needs (Ulrich, 2015). New product development process gives guidelines for product management team to manage NPD projects and clarifies tasks and responsibilities during each stage of the process.

This thesis is an empirical case study research conducted for a spare part organisation of Konecranes Port Service. A general new product development process has been introduced for the case organisation whereas this research studies how this process could be developed to be even more suitable for parts business. The other topic is new product development lead times and process bottleneck. The data is collected by mixed method using both quantitative and qualitative data. The quantitative data is collected to find out the average lead time for previous new product development projects, while the qualitative data will be collected by interviewing different teams of the case organisation regarding the development ideas for the NPD process. The research questions are:

1. What has been the average lead time for previous NPD projects in the case organisation, and which stage of the process has been the bottleneck?
2. How the case organisation's NPD process could be developed to be more suitable for part business?

The first chapter of the thesis is a literature review of spare part business focused on engineer-driven companies. The key themes are spare part supply chain, procurement, spare part sales, spare part organisation and management. The next part of this chapter is the case organisation introduction.

The chapter 3. *New Product Development* introduces basics of new product development and different kind of new product development processes based on the literature and peer reviewed articles. First part of the chapter introduces new product development in general and the key perspectives of it. In addition, new product development time and tools are brought out in this section. After this, chapter 3. focuses on new product development process first paying attention on customer needs identification and product concept development. A linear model for new product development process and key activities of it are introduced together with figures, and finally Stage-Gate process for new product development is presented. In addition, new product development tasks and responsibilities are brought out in the last part of the chapter.

The chapter 4. introduces the research methodology used in this research. First the case study method is introduced based on the literature. Next part of this chapter presents mixed method, which means that research data is collected by both quantitative and qualitative data. Finally, the research process for this research paper is introduced. This thesis is a case study research made for a specific case organisation. Since quantitative and qualitative data is used, the data collection is made by mixed method.

The chapter 5. is the empirical case study in the case organisation. This chapter begins with current state analysis by introducing the current NPD process in the case organisation. This was made by interviewing an employee from case organisation product management. The next part of this chapter introduces the quantitative research results related to new product development lead times and process bottleneck. After this the qualitative interview results are presented and analysed.

The chapter 6. Discussions compares key literature findings to empirical research results and finally summarises the analyse by cause-and-effect diagram. The next chapter talks about research validity and reliability. Finally, conclusions and recommendations for the case organisation are introduced together with future research suggestions.

2 Spare Part Business and Case Organisation Introduction

Regarding Hu et al. (2018) *"Spare parts are common inventory stock items, which are needed to maintain equipment"*. Aftersales includes spare parts and upgrade kits, repair service, online support, documentation, and user training for customers (Szwejczewski et. al., 2015). Spare parts are used to support the repair and maintenance during the product lifecycle (Kulshrestha et. al., 2024). This chapter of the thesis introduces the basics of spare part business in engineering driven companies. The main topics are the spare part inventory and procurement, marketing and sales, and spare part management. The other part of this section introduces the case organisation of the empirical research.

2.1 Spare Part Business

Machines with lifetime up to 30 years consumes spare parts annually in the value of 2,5 percent of the purchase price (Hu et al., 2018). The bad availability of spare parts causes economic loss for industries with high-tech technologies implemented by mass and continuous production. This is why spare part business plays a crucial role in firms which sell technical equipment. The spare part sales might be even the most profitable function of the organisation (Wagner & Lindemann, 2008). According to Wagner and Lindeman after-sales business and spare part sales are about 25 percent of the company total revenues on average, and even 50 percent to the profit in manufacturing and engineering driven companies. From the economic point of view the importance of spare part business can be seen from the gross domestic product of the USA by being 8 percent of it. The increasing importance of spare parts sales makes it more important for companies to improve innovations and concepts in this area of business.

The article of Roda et al. (2014) named "*A review of multi-criteria classification of spare parts: From literature analysis to industrial evidences"* highlights the significant role of spare parts management in equipment-intensive companies (Roda et al., 2014). These companies might have challenges with high system availability, and this is why spare

parts are a valuable resource for the company. For example, the unavailability of spare parts can lead out of use downtimes for sold equipment which in turn has direct consequences on the company's profit. On the other hand, having a big stock of parts with high warehouse value creates costs and ties up capital. The management and investment in spare part inventories are closely related to equipment life cycle cost (Hu et al., 2018). In the spare part management, the equipment lifecycle process can be divided into three main phases called initial procurement phase, normal operation phase, and end-of-life phase.

Despite the fact that it is more common for spare part procurement and inventory to be integrated with primary product supply chain, it can also be an independent organisation. In engineering companies, it is quite common to use same suppliers for primary products and spare parts to reduce the supplier base and streamline processes. The spare parts distribution can be operated as with primary products, directly or indirectly. The case study made by Wagner and Lindemann shows that six out of seven companies prefer regional distribution centres instead of one central warehouse. With this kind of strategy customs delays can be avoided and the lead time for spare parts supplies is reduced. In addition, local distribution centres improve customer satisfaction by more customer specific service. (Wagner & Lindemann, 2008).

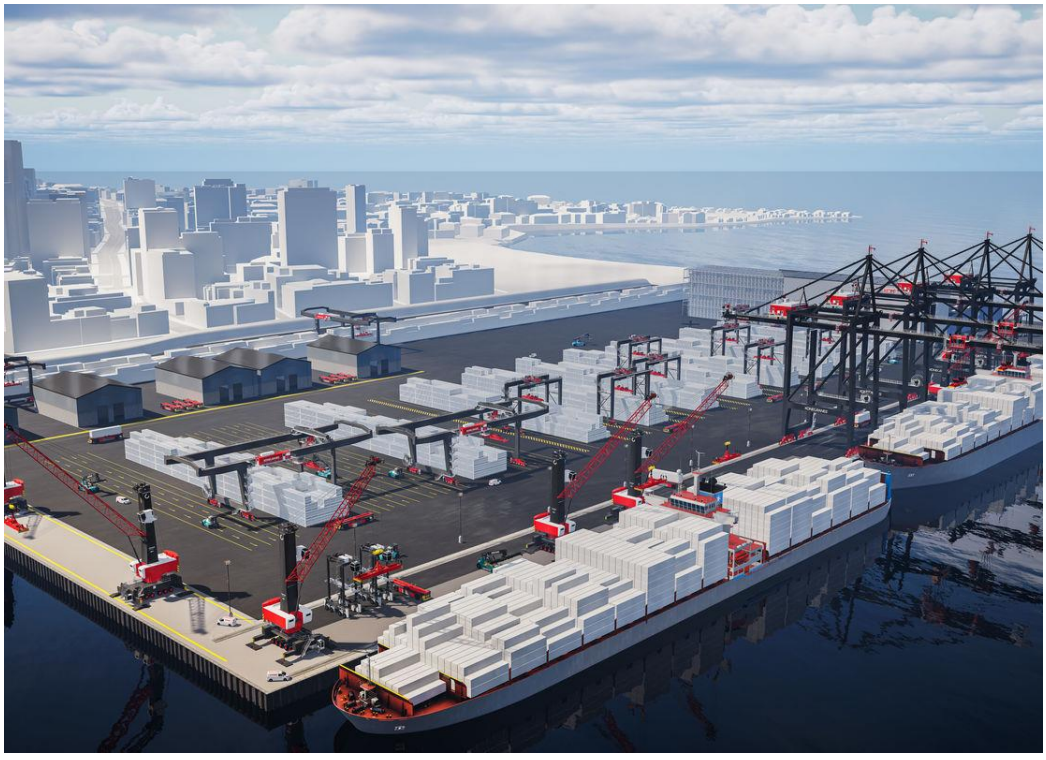
Developing aftersales business is important for companies to survive in markets. Active marketing and target customer validation can ensure this. The current trend to improve marketing for spare parts sales especially in business-to-business is operate sales and marketing via online stores where the customer's order is transferred directly to sales organisation's ERP-system, which starts the internal sales and order handling processes as well as logistics and distribution processes for the sold spare parts. From customer perspective this usually lower prices and cut delivery times, and for sales organisations it reduces sales costs. However, the order intake from online stores is quite low in many companies, and the reasons for this are usually in IT incompatibility between the customer and sales organisation. In conclusion, it is important for companies to develop

their online stores with customer related cooperation all the time. (Wagner & Lindemann, 2008)

During the recent decades, the increased market demands requires more flexibility and efficiency from the manufacturing companies where the machine availability is in crucial role (Peron & Sgarbossa, 2021). Efficient maintenance services and spare parts management are needed to run the production system. From the customer perspective long lead times for spare parts can reduce the operation efficiency and create downtime costs. This makes the forecasting and inventory management more and more important in spare part business. Additive Manufacturing is coming more popular in spare part management by allowing on-demand spare parts production which increases high inventory levels. Regarding spare part organisation's place in the organisation, in manufacturing industry it is usually integrated to some other business unit of the organisation, but it can also be an independent organisation (Wagner & Lindemann, 2008). Despite the fact, that separate accounting for spare parts does not exist in most of the companies, they can adopt management accounting practices focused on their spare parts business to ensure effective spare parts management. The key spare parts sales indicators are the order intake and sales, spare parts inventory turns, and sales profit.

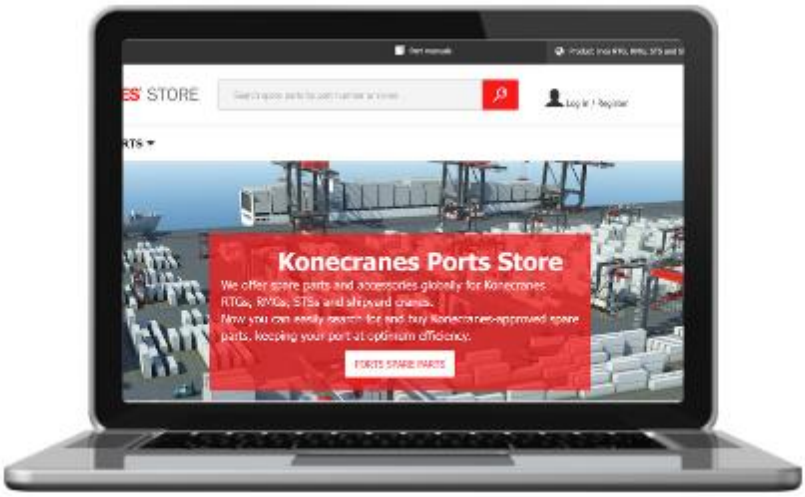
2.2 Case Organisation

Konecranes is one the biggest companies in crane manufacturing businesses operating in fifty countries and having almost 17 000 employees around the world. The central office locates at Hyvinkää Finland, where Konecranes also has manufacturing for crane components. Konecranes has two business areas: Industrial Service and Equipment, and Port Solutions. Industrial Equipment supply cranes for different industries from light lifting chain hoist cranes to heavy lifting process cranes, while industrial service provides crane and machine tool services. Port Solutions supply various lifting equipment for container terminals and shipyards which can be seen in Picture 1. Konecranes Port Service provides after-sales services such as maintenance, modernisation, and retrofits as well as spare parts for port cranes. This research is conducted for a spare part organisation of Port Service. (Konecranes, 2024)



Picture 1. Konecranes Port Solutions (Konecranes website, 2024)

The aftersales plays a vital role in Konecranes business. In their website Konecranes recommends using Konecranes-approved spare parts, which ensure that parts really fit and work properly in the crane. Picture 2. shows Konecranes Port Store where the customers can buy spare parts easily with the crane serial number or spare part number. The webstore also makes it easier to track your order. They highlight that replacing parts continuously improves crane's operation reliability and safety. Konecranes over 100 000 different parts in their spare part catalogue. (Konecranes, 2024)



Picture 2. Konecranes Ports Store (Konecranes website, 2024)

3 New Product Development

Products and services innovation is the primary driver of competitive advantage (Taifi & Passiante, 2012). New product development (NPD) is referring to developing new products for the markets (Vinayak & Kodali, 2014). Vinayak and Kodali state that new product development covers everything from market opportunity and customer needs identification, to creating, selling, and delivering products. Customer demands are constantly evolving, making it essential for companies to prioritize customer satisfaction (Kušar, et al., 2004). Success in the market depends on delivering products with the right features, quality, and price. Products that do not align with customer needs, arrive late, or are too expensive are unlikely to succeed. This chapter of the thesis is a literature review focusing to the new product development from different perspectives like new product development time and customer needs identification and presents different new product development processes.

Product innovation and creating new products is vital for companies' success and survival in nowadays business (Kahn, 2012). Companies need to identify the customers' needs and develop innovative products all while keeping costs low (Ulrich, 2015, p. 2). Product innovation is important for the product success which contributes to sustainable business success and growth opportunities (Vinayak & Kodali, 2014). While market innovation focuses to entering and exploiting to targeted markets, process innovation refers to involving new production methods and technology.

Manufacturing perspective and marketing perspective are the key approaches to new product development (Trott, 2021). Manufacturing perspective is focused how effectively the new product can be manufactured in production, while marketing perspective is more customer-centric approach which tries to understand customer needs and how the business can meet those. Competition between companies is typically evaluated using financial metrics like returns on capital (ROCE), profits and market share. In addition, non-financial measures like design and technological innovations are also used for this. The integration of technologies in product

development provides differentiation for organisations in the competitive environment (Boylan & Syntetos, 2010). The Figure 1. highlights the different perspectives of new product development which are marketing, research and development, design and engineering, economics, and production management.

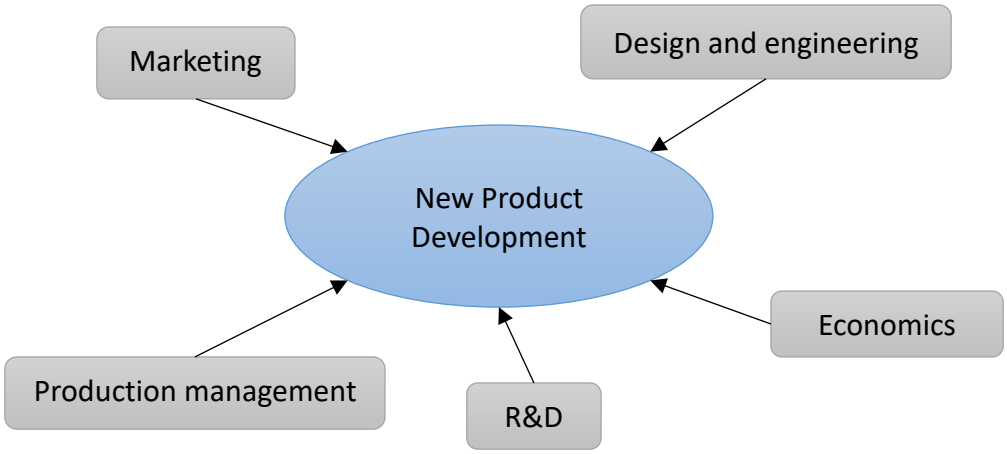


Figure 1. Different perspectives of new product development (Trott, 2021, p. 419)

Transitioning to concurrent engineering speeds up new product development for global market entry whereas regular team meetings help share information quickly, while assigning responsibilities avoids delays. Doing tasks at the same time cuts down development time. Tools like Quality Function Deployment and Failure Modes and Effects Analysis make processes smoother for faster results. This approach ensures that products come to market faster, meet customer needs efficiently and remain competitive. (Kušar, et al., 2004)

3.1 New Product Development Process

Product development management is critical decision making for product development process and organisation. Product development management consists of planning,

concept development, system-level design, detail design, testing and refinement as well as production ramp-up. It is important that there is a good integration between these distinct functions especially in the concept development stage of the product development process. Concept development consists of identifying customer needs, competitor analysis, setting specifications and concept testing. The effectiveness of new product development rests upon three main factors: a well-defined new product development process, the efficiency of a cross-functional team and comprehensive understanding of customer needs. New product development process requires good leadership and communication, and the team responsibilities should be clear. The Figure 2. describes the linear model of new product development, where the first steps are idea generation and screening, followed by concept testing and business analysis. After this the product development is started followed by test marketing and commercialisation. The last step in this model is monitoring and evaluation. (Ulrich, 2015)

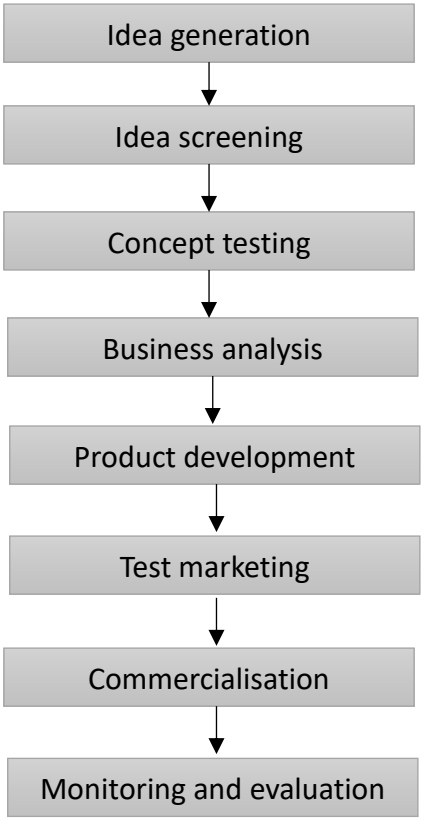


Figure 2. Linear NPD model (Trott, 2021, p. 434)

While addressing immediate customer needs is important, it is crucial to recognise customer needs throughout the product's entire life cycle, including after-sales services (Szwejczewski et. al., 2015). Interviews and conducting market research is good method for gathering customer feedback. After the data collection the raw data must be interpreted in terms of customer needs which requires a keen understanding of the customers' perspectives (Ulrich, 2015, p. 88). The raw data is organized into a hierarchy and the relative importance of the needs must be established. This enables the product development team to discover which requirements are essential for customer satisfaction and market success.

To succeed in finding market opportunities, it is crucial to explore a wide range of ideas from various sources (Ulrich, 2015). The synthesis of these customer needs and identified opportunities forms the basis for the creation of innovative, market-driven products that meet customer expectations. In the concept phase the product development team goes through a step-by-step process starting with ideation based on customer needs for the product. They need to clarify the problem with information gathered from various sources and reflect on the solutions. The second step is that they have choose the best ideas, which is called concept selection. Concept selection is a continuous group process consisting of two stages: concept screening and concept scoring. Concept screening helps to narrow down the choices and concept scoring uses more detailed rating system. This aids the team in making choices and maintains a record of the steps taken. The next stage is concept testing where the product is tested with the potential customers, and it is done in distinct stages of making the product. The complete process ensures that the team has chosen the right idea, works well together and the product improving continues based on the customer feedback. The Figure 3. presents new product concept and prototype testing. After the business opportunities are evaluated and market opportunities are explored the concept testing and screening begins. Consumer testing can be used to evaluate the product concept and test samples are produced in stage of the process. Based on the concept testing possible prototype

developments and further product testing are implemented before the market introduction.

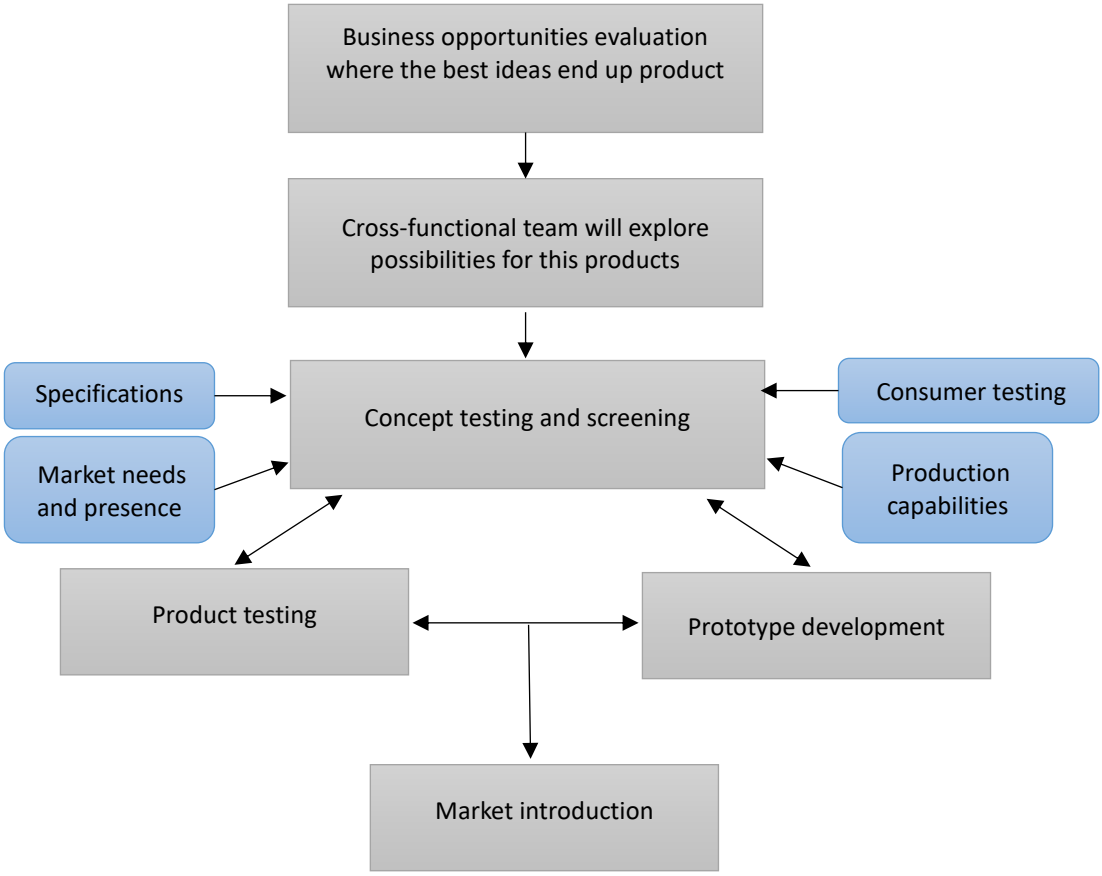


Figure 3. New product concept and prototype testing (Trott, 2021, p. 457)

Process for new product development ensures excellent product quality, coordination between teams, successful project planning and continuous improvement. The new product development process can be better understood as a series of activities linked each other shown in the Figure 4. The process starts with strategic planning by collecting new product ideas from R&D and market research. After the new product idea is approved the project team starts to generate business opportunities followed by product concept generation. The next stage is development of product prototypes which are tested from market and technical approach. The last step after market and technical

testing is market introduction, where the product is launched to markets. The screening and evaluation is a continual process which takes place at every stage of this process. (Trott, 2021)

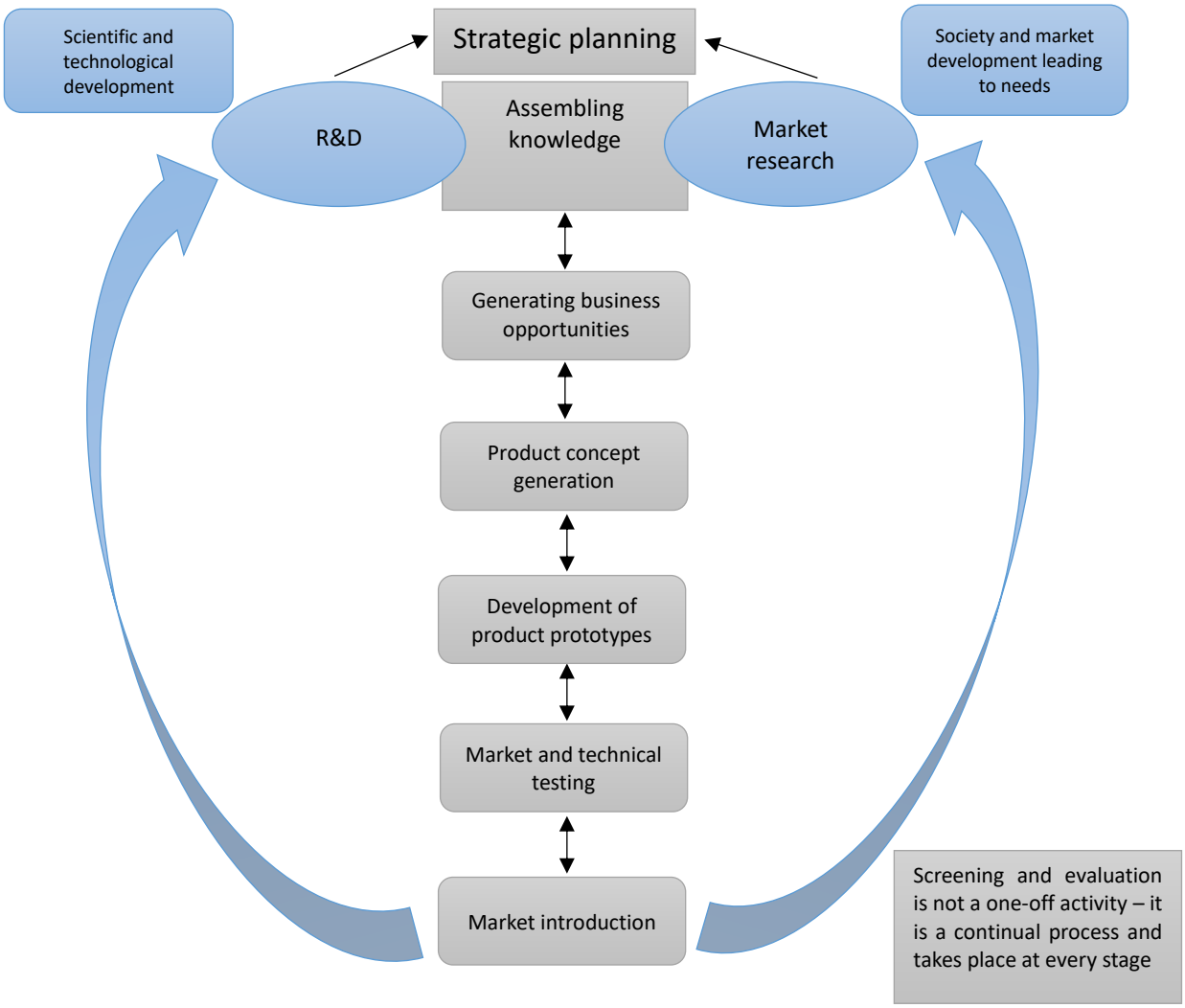


Figure 4. NPD process activities (Trott, 2021, p. 493)

3.2 Stage-Gate Process

Robert Cooper developed the Stage-Gate process, refining it through research, consulting, and multiple editions of "Winning at New Products" since 1988. The fifth

edition expands the model to cover new product types, integrate with other methodologies, and streamline for smaller projects. Cooper integrates ideas from Agile software development, lean manufacturing, Six Sigma, and design thinking to demonstrate the adaptability of Stage-Gate to diverse industries and project scopes. While traditional product development focused on perfection and long development cycles, modern practices prioritize speed, efficiency, and cost-effectiveness. Companies now emphasize being first to market rather than flawlessness. Cooper identifies five major changes driving the need for innovation: continual technological advancements, evolving customer needs, shorter product life cycles, increased globalization, and the dominance of the Internet. After years of refinement, Cooper presents a comprehensive view of the Stage-Gate process, addressing various product cases, working situations, and organizational structures in new product development. (Smith, 2018)

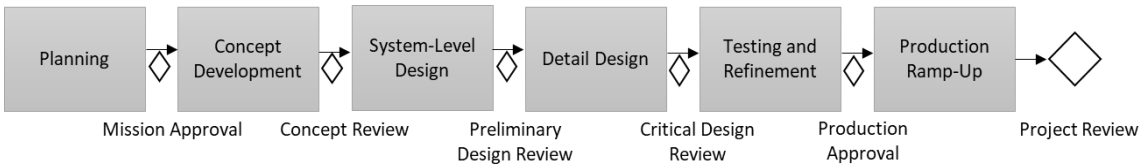


Figure 5. Stage-Gate NPD process (Ulrich and Eppinger, 2019, p. 23)

Ulrich and Eppinger (2019, p. 23) presents the Generic Product Development Stage-Gate product development process which can be seen in Figure 5. This process consist of six stages starting from planning followed by concept development where the market needs are identified, and the product concept is evaluated. The next stage is system-level design where the product architecture is defined, and production planning is started followed by detail design which consists of more specify design work and planning. The product prototypes can be evaluated in testing and refinement, after which the production ramp-up can begin. These phases guide the structured development for a new product and ensure that it meet customer needs. In addition, Ulrich and Eppinger (2019, p. 25) presents a table which shows the key tasks for each product development team. This table can be seen in Appendix 1.

4 Methodology

This research is an empirical case study research where the data is collected by mixed method. First section of this chapter introduces the basics of case study research method based on the literature. The next section presents mixed method data collection, and finally the research process for this empirical case study is introduced. Since the data is collected by mixed method, both quantitative and qualitative data is collected from the case organisation. In addition, interview questions for qualitative research part are presented in this chapter.

4.1 Case Study Research

Case study research is a useful and flexible way to do qualitative research that looks at real-life events in their natural setting. Case studies come in two main types: single case studies and multiple case studies. Single case studies focus on a single person, thing, or event, while multiple case studies look at several cases that share a theme or research question Case studies use a variety of methods to gather data, such as interviews, observations, and the study of artefacts and papers. Researchers talk to key stakeholders and participants in-depth to get their ideas. Case studies are criticized to be open for subjectivity and researcher bias because the researcher's interpretation is a big part of the analysis. In addition, case studies are often thought to not be generalizable because they only look at one or two specific cases. This makes it hard to apply the results to larger groups of people. There are many things that need to be carefully thought through when planning a case study. Researchers need to be truly clear about their research question and goals, in addition they have to figure out the best ways to collect data and analyse it for their study goals. Setting up measures of reliability and validity is a key part of making the study more dependable. (Schell, 1992)

Regarding research methods, it is imperative to ensure the robustness and reliability of gathered data. Internal consistency, test-retest reliability, face validity, and construct

validity are the four most important tests in this search. The first test, internal consistency, checks how well various parts of a measurement tool constantly measure the same thing. An important level of internal consistency means that the data is dependable since different things should not give different results. With the second test, test-retest reliability, can be seen how consistent the readings are over time. It is especially important to make sure that the same test would give the same results. The third test, face validity, looks at how an instrument looks on the outside. It is a subjective evaluation of how well a measuring tool seems to measure what it is supposed to measure. Finally, the fourth test, construct validity, looks into the more in-depth parts of a measuring tool. (Golafshani, 2003)

4.2 Mixed Method

Mixed method research combines quantitative and qualitative data collection (Matović & Ovesni, 2021). It provides a multiple approach to look into complicated research questions. This integration does not happen only during the analysis part, instead it happens at every stage of the research process. By using both qualitative and quantitative methods together, it provides a better understanding for a research problem or question (Fabregues & Molina-Azorin, 2016). Researchers who use the mixed method must carefully plan and conduct their studies to make sure that the collection and analysis of both qualitative and quantitative data fit together.

The level of integration determines the quality of mixed method research (Matović & Ovesni, 2021). Integration can range from methods working together without any problems to methods running at the same time. To rate this quality, you have to look at the purpose of the study and the choice of mixed method models. The quality of interaction is also affected by the techniques used, both those that are specific to mixed method and those that are taken from quantitative and qualitative methods. There are several things to think about when judging the quality of mixed-methods study (Fabregues & Molina-Azorin, 2016). First, it should be judged by its own set of quality

standards, taking into account how this method is different. When you critically evaluate mixed method research, you have to look at how well it integrates several types of data, how well it produces mixed-methods research questions, and how well it uses clear steps that connect quantitative and qualitative aspects (Matović & Ovesni, 2021).

4.3 Research Process

This thesis is an empirical case study research. The empirical research is conducted for the case organisation introduced in chapter 2. Since the used data collection method is mixed, both quantitative and qualitative data are collected from the case organisation. The quantitative data is collected by Excel sheet questionnaire sent for case organisation product managers. The idea is collecting data of ten previous new product development projects conducted in the case organisation and find out results related project lead time, and process stage lead time. They have to fill the date when each process stage started in their project, which are anonymised for example as Product A. After they have responded the dates to forms, lead times can be calculated. The idea is to compare the quantitative data and qualitative data results and see how these support each other. The questionnaire form for quantitative data can be seen next page at Table 1.

Table 1. Questionnaire for product managers for quantitative data

Process stage starting date	Concept	Proposal	Proof	Develop	Prepare to market	Handover
Project A	e.g. 01.01.2022					
Project B						
Project C						
Project D						
Project E						
Project F						
Project G						
Project H						
Project I						
Project J						

The next part of the empirical research is the qualitative data research which is conducted by interviewing case organisation product managers who also dealt with quantitative research, sales and business line managers, and sourcing specialist. The idea is to get perspective from all the key employees who are related to new product development in the case organisation. There are six interview questions for both product managers and sales and business line, and three for sourcing. Interview questions for all these three groups are specified questions. Three product managers will be interviewed together in group interview, and since the fourth is working in different location, that interview will be organised separately. Other respondents will be interviewed separately. After both quantitative and qualitative data is collected, results from both method will be compared to literature findings and recommendations for the case organisation are done by these discussions. The validity and reliability of research results are discussed in chapter 7. Interview questions can be seen below in Table 2. and Table 3., and the Finnish versions are presented in Appendices.

Table 2. Interview Questions for Product Management

1.	Have you used the current NPD process in your projects? Have the process been different in some stages?
2.	How do you collect new product ideas?
3.	Who makes approvals between process stages?
4.	What is the bottleneck of the process?
5.	Do you have development ideas for current process? Are both stages 3. and 4. needed?
6.	What kind of information product manager gives for marketing to create marketing materials?
7.	What happens after the market launch? Do you have idea for on-going post launch review?

Table 3. Interview Questions for Sales and Marketing

1.	Have you used the current NPD process in your projects? Have the process been different in some stages?
2.	Do you get new product ideas from the customer site? To whom do you forward these ideas?
3.	Are you aware of product concepting and approvals between process stages?
4.	What are the advantages specific NPD process?
5.	Do you get all the needed information from the product manager to develop the marketing materials? What kind of information is needed?
6.	What kind is the handover process, and who are the participants?
7.	How do you follow up sales and feedback after the market launch? How is the customer feedback handled?

5 Empirical Research

This part of the research is the empirical study conducted in the case organisation. Both quantitative and qualitative data are used for data collection. First part of this chapter is a current state analysis, which introduces the new product development process introduced earlier for the case organisation. The analysis of the current state was made based on an interview with the case organization's product management. The next part is the quantitative research where five product managers filled a timetable form regarding ten previous new product development process made in the case organisation. *The idea was to find out the average lead for new product development process, as well as the bottle neck stage from the current process.* This data can be compared to qualitative research results, which are made by interviewing nine employees from three different teams of the case organisation. Finally, the validity and reliability of the research results are evaluated.

5.1 Current State Analysis

The current NPD process introduced for the organisation can be seen in the Figure 6. The first phase in the process is new product ideation which consists of four different stage: idea pool, concept, proposal, and proof. The new product ideas are collected from the ideal pool which consists of a number of internal and external sources. However, in spare part business most product ideas comes from suppliers, internal workshops, and customer site. After this the new product concept is created in the concept stage, where the business model canvas, simple functional descriptions and first high-level calculations are created. As this model is based on stage-gate process, the concept is approved by product management, sales, and business line. In the proposal stage, the full business case with development plan, variants and customer validation is created. Some NPD concepts will be confirmed by business line top management before the development stage which depends on the size of the project, and how much external resources are needed in the development. The optional proof stage is for unusual cases

only, where some product concepts are practically evaluated at the customer site or in the own product development.

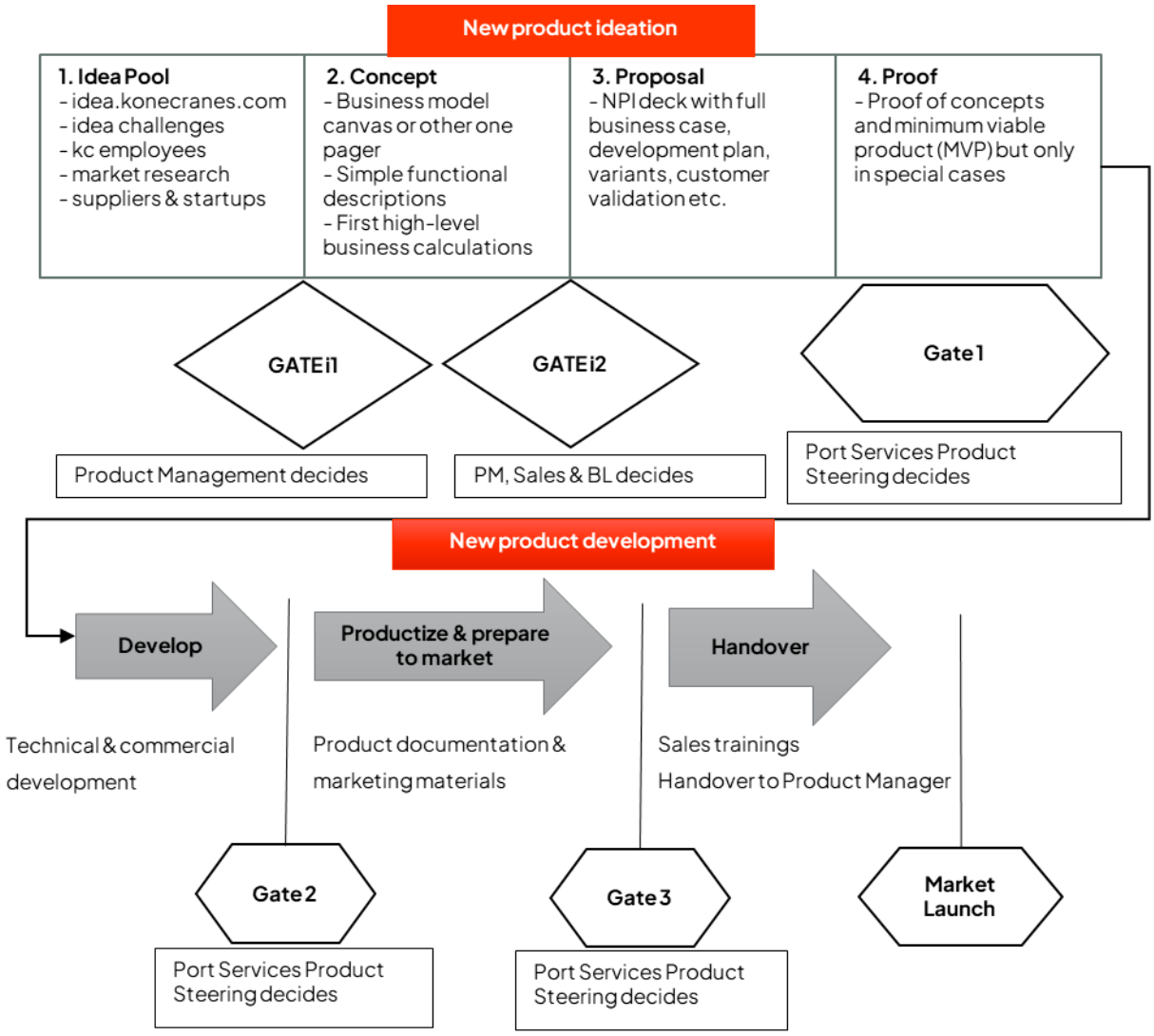


Figure 6. Current NPD process in case organisation

The first step of the development phase is technical and commercial development. All the product data and marketing materials are prepared in this stage. After this the product manager gives the needed information for the marketing team to create the marketing materials. The last stage is handover where the sales team and frontlines should be trained to be familiar with the new product. Finally, the marketing campaign

starts, and the new product will be launched to the markets. Naturally it is very project based how straight-forward this is process is used. However, the idea is to give guidelines for product management team to conduct these projects.

5.2 Quantitative Research: Project Lead Times

The quantitative data for this research was collected by sending a table questionnaire for five product managers who have been working with new product development projects in the case organisation. Data from ten different NPD projects brought out the average lead time for new product development process, as well as the process stage lead times. Based on the value and scope of the project these were separated to high-value and standard projects. Project manager had the fill a questionnaire where they put the starting date for each process stage.

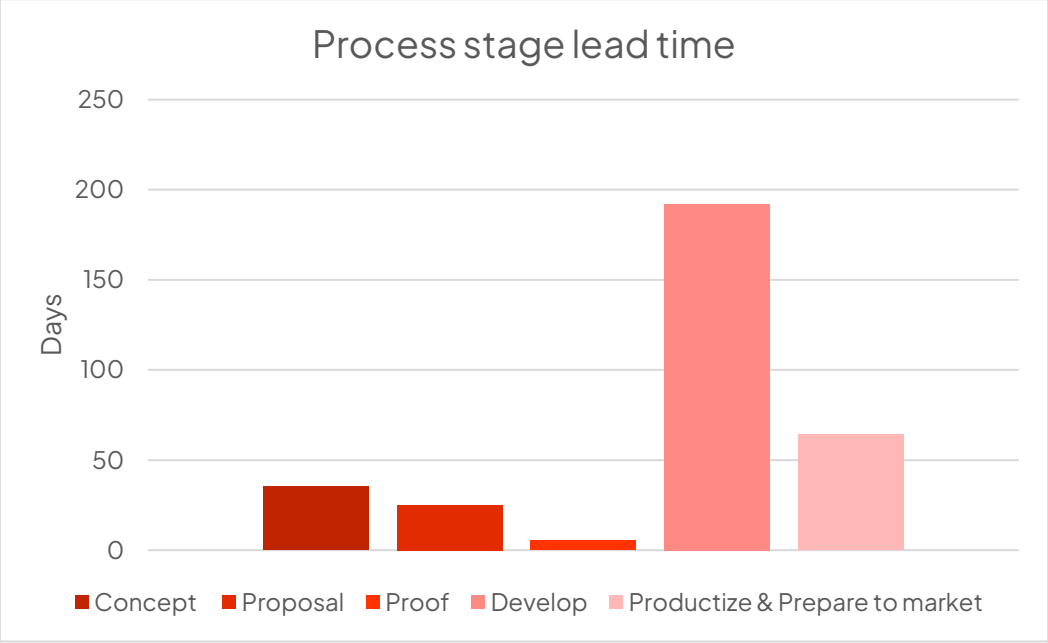


Figure 7. Process Stage Lead Time

The main goals was to find out the bottleneck stage of the new product development process, and project lead times in total. Based on the data, the Figure 7. shows that the bottleneck stage was *Develop,* which on average took 192 days while prepare to market took about 64 days and proposal 25 days.

The average lead time for these projects was 12 months, divided 21 months for high-value projects and 7 months for standard NPD projects. The fastest project lead time was

three months while the longest took 33 months. The lead times for these projects can be seen in Figure 8. and Figure 9.

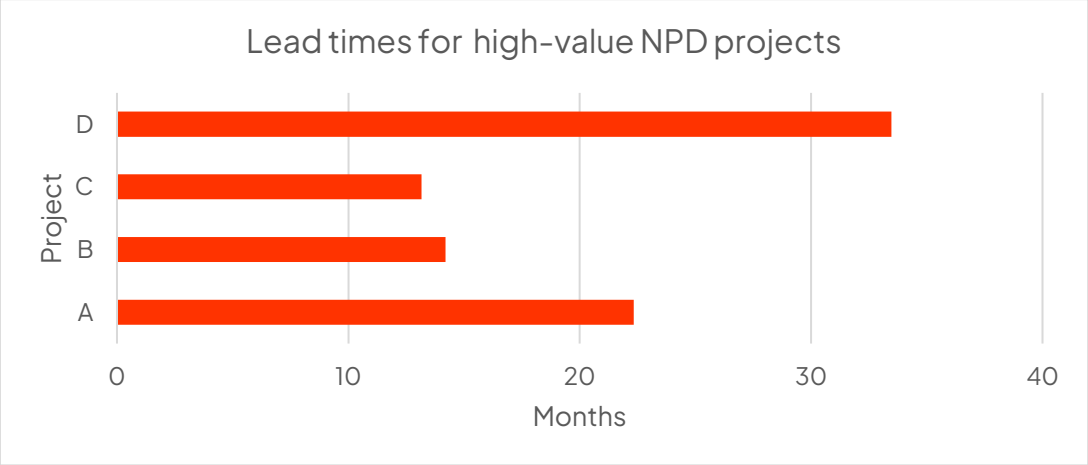


Figure 8. Lead times for high-value NPD projects

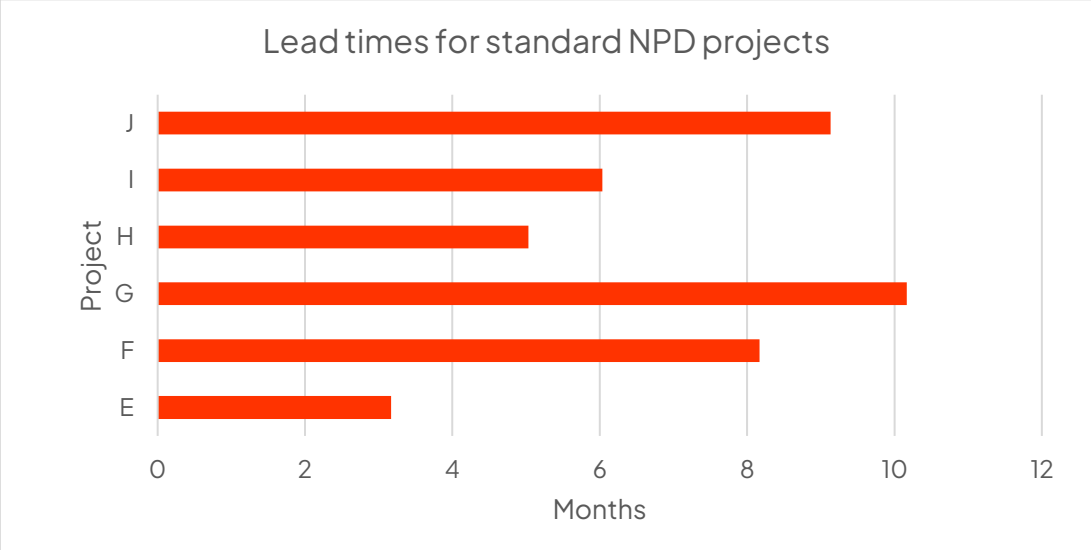


Figure 9. Lead times for standard NPD projects

5.3 Qualitative Research: Interview Results

This section introduces the interview results. The first interviews were for product management where four case organisation product managers were interviewed. The next interviews were organised for sales and marketing where sales manager, business line manager and marketing manager were interviewed. The last interview was organised for sourcing specialist. Interview questions are introduced in chapter 4.

5.3.1 Product Management

Four product managers from the case organisation were interviewed for this thesis. Product managers A, B and C were interviewed together in group interview organised in the case organisation's office in February 2024. Product manager D was interviewed separately via online interview. All of them have been working with the previous new product development projects in the case organisation.

The first interview question for product managers asked them to describe the process they have used in their previous NPD projects and is it similar than process which is introduced for case organisation lately. Product manager A described that the common process for new product development is quite individual, and project based. Product Manager C stated that during the past few years not so many projects has gone directly through all the process stages, and many of them still may be in the concept or proposal stage. The role of case organisation is more product item data based than technical development in their new product development projects. Product Manager B highlights the importance of cooperation within project team members in NPD projects and states the case organisation needs some kind of external support in most of their projects.

The second questions asked where they get the new product ideas. All the product managers stated that usually ideas come outside of the product management team. Product manager C added that suppliers and customer site are the main external sources

for new product ideas. Product manager A noted that most common reason for new product development projects are End-Of-Life products, referring products that will no longer be available from the supplier. In cases like this, the sourcing and procurement contacts the product manager, who start to work on to find replacement products. However, Product manager A stated that the idea is to sell the obsolete products out of stock before implementation of the replacements. Product manager C added that other source for new product idea in spare part business is the main equipment organisation. Innovations for new equipment should be taken into account in aftersales and spare parts. Product manager B also noted that new product ideas should be considered more proactively with main equipment organisation, and product planning, discussing about the latest innovations for main equipment, and how these ideas could be used in the spare part products. Product manager B stated that new product concepts can be created also in internal workshops, when then purpose is to replace an old product with better replacement based technical features or environmental effects.

The third question asked their knowledge about the Stage-Gate system in NPD process, and do they always know where to get approval before moving to next stage in the process. Product manager A stated that approvals are mostly used in the high-value NPD projects. Product manager C added that the presented Stage-Gate process could be good for their organisation. The fourth question asked, what has been the bottle neck stage in the previous projects based on their experience. All the product managers stated that the bottle neck has been the develop-stage, which supports the data shown in the previous chapter. The reason for this is that in this stage they usually need some kind of external technical support.

The fifth question was asking are both stages proposal and proof needed in part business, or could they be included in one stage, and which kind of development ideas they have for the case organisation new product development in general. Product manager C highlighted the importance of approval gate between proposal and develop stages. He noted that the first stages should not take too much time especially in standard projects.

Product manager A stated that projects related to End-Of-Life products are usually quite linear and the gates between the stages are more for follow-up gates than approvals. All the product managers noted that the proof of concepts is very seldom used in part business, and it could be included into proposal stage.

The question six asked them to describe what kind of information product manager should give for the marketing manager when project is moving to prepare to market stage. Product Manager B told that they usually have meetings with marketing manager to talk about the needed information. He told that technical details and product pictures are the key materials that product manager gives for marketing manager. He said that this part of the process is not very straight-forward, since there are a lot of information moving across different teams. He added that product manager has responsibility to deliver all the needed information for marketing.

The last question asked what happens after the product is launched to the markets, and do they have idea for on-going post launch review done after the market launch. Product manager C noted that the frequent problem has been that this part of the process has been forgotten. Project manager A added that usually the project is thought to be completely finished after the market launch. Product manager C stated that there should more sales training for sales and frontlines organised by product manager before the market launch. However, they highlight that the responsibility of collecting customer feedback is in the sales team. Product manager B supported that after the marketing materials have been published, there could be a meeting where the product manager introduces the new product with technical details and features for salespeople.

In the end of the interview, product managers gave open comments related to new product development in the case organisation. Product manager A said that main problem is the lack of people working with these projects. Regarding project management Product manager B and C considered that Jira tracker would be useful tool for case organisation product management.

Product manager D stated that his previous NPD project started from the internal workshop, where they created the new product concept together with product management team. He highlighted the importance of effective communication between product management, sales, and marketing during the new product development process. In addition, he added that customer feedback is important for new product development since customers usually have very practical experience of the machines itself.

5.3.2 Sales and Marketing

The next interviews were organised for Sales manager A, Business line manager B and Marketing manager C. Especially sales manager and marketing manager have a significant role in new product development projects, but also the role of business line is important since they work directly in the customer interface together with sales. They were all interviewed separately via online interviews.

The first question asked their experience of NPD projects in the case organisation. Sales manager A stated that the process in previous NPD projects has been remarkably similar than the process introduced for the case organisation. However, it has usually been quite simply and straight forward. He told that often the decision of productising is made in the preliminary stages of the process when the market opportunities are considered. The one key problem has been the lack of resources, which may have caused that project has not been finished at all. He stated in certain projects some of the approval stages are left out and sales together with business line have made the decisions themselves to move forward. Usually, external resources are not needed in cases like these. However, when there is a need for external resources, then approval from top management is needed. Business line manager B stated she has been only as in a follow up role in previous NPD projects, and not participated to development work itself. Marketing manager C has been participated in several NPD projects in the case organisation and she stated that in the stage when marketing site is involved, the product is more or less

ready in a technical point of view. The role of marketing manager is to create the marketing materials for new product based on the information given by product manager. She added that marketing team is also part of the market launch stage as well, highlighting that most spare part launches are medium level product launches. Compared to first level product launches marketing materials for spare parts usually does not include for example marketing video. The core of marketing actions in spare part launches consists of email campaigns sent to the target customers. After the market launch a follow up is evaluated by sales team and frontlines. Marketing manager C described that in business like this it usually takes about one year to reach target customers for the new product.

The second question asked do they get new product ideas from the customer site. Business line manager B stated that most of the ideas come from the suppliers, or own product development team. She said that ideas from customer site could be collected more proactively for example via store or business reviews organised by frontlines. She added that product ideas should be also collected more from frontlines. She highlighted that communication should be improved in general, especially between main equipment design team and aftersales. She described that the role of sales is to bring the possible product ideas from the customer site, and product managers are responsible of productising these. Sales manager A said that new product ideas are coming weekly, and they have a lot of ideas of which they have not even been discussed yet with the product management team. He described that the process has been very solution-oriented, meaning that if customer wants an offer for some new solution or product, these will be offered to them. Related to new product ideas Marketing manager C stated that marketing is not so much involved in discussions related to new product ideas. However, she thought that ideas usually comes from internal sources and customers as well.

The third question asked their experience about the product concepting and approvals between the process stages. Sales Manager A said that is very case by case related question. If the own product management team can find solution itself without external

support, then there is no need for approvals from the top management. He added that there is corporation stage process for how to move on if external resources are needed. Business line manager B agreed this by stating that it is very project related manner.

The fourth questions asked what the advantages of detailed process for new product development are, and general development ideas for case organisation new product development. Sales manager A stated that it is always good that there are some kind of process. However, the disadvantage may be the extra stages which does not bring more value for the projects and just cause more lead time. He noted that process like this is a good follow up tool for project managers to know how the project is moving forward. He stated that this kind of defined process is needed to support NPD projects and in the cases when new employee starts to work in product management the defined process gives guidelines how to move forward. However, he reminded that the process must be enough flexible. Business line manager B also thought that in general it is good to have clear process for new product development with various stages and gates. She stated that a defined process improves communication and information sharing during the projects. Marketing manager C supported that the stage gate-based NPD process works well for part business. Sales manager C noted that in between gate 2. and gate 3. there should be inventory planning, meaning that before going to markets and publishing a new product in store, the data must be organised and for example the items of spare part kit must be available and priced with reasonable delivery time in Ports store.

The fifth question was marketing based question by asking what kind of information the product manager should give for marketing to develop the marketing materials for the new product. Sales manager A stated that the given information should be incredibly detailed in technical point of view, and why the customer should consider this new product, for example is it replacing some old product. Also, it should be described is it do it your self-product or does it need some kind of installation from service organisation. Marketing Manager C stated that product manager should give all the technical details and features to marketing manager to create the marketing materials. In addition,

marketing manager would also require technical sales arguments from product manager to highlight the benefits of the new product and value propositions for the customer. When customers are exploring the new product from sales organisation marketing materials they consider should they buy this. She stated that in spare part business customers are mostly familiar with the industry and know the main equipment in very specifically, so they just want so to see whether it matches their requirements. To sum up, marketing wants to know the benefits of the new product, and how it works for the customer. In addition, useful product pictures for marketing makes the materials more interesting.

The sixth question asked the participants to describe the handover process. Sales manager A stated that sales trainings between sales and frontlines plays a crucial role in NPD projects before the market launch. Also, Marketing manager C highlighted that frontlines and sales team should be trained to be familiar with the new product using internal sales trainings organised by product management team some weeks before the market launch. She stated that sales and frontlines should be remarkably familiar with the new product to be ready to answer customer's questions. In addition, marketing materials should be introduced in these trainings. Marketing manager C reminded that it is necessarily to inform of the market launch schedule for frontlines enough early. Also, Sales manager A stated, that all the team members are not always informed enough early about the market launch.

The last question asked how they follow up sales and collect feedback from customer site after the market launch. Sales manager A described that feedback follow up is partly automated process. However, he highlighted the importance of communication between sales and marketing when customer feedback is collected. Marketing manager C noted that ideally marketing should be involving in customer feedback collection. However, the marketing team is such a small team that they cannot manage that part, which causes the customer feedback should be collected by sales and frontlines who work in the customer interface. She added that this kind of information should be

collected and saved into one place, where product managers, sales, frontlines and marketings could all see the customer feedback. For example, marketing could improve their marketing message or materials if based on this feedback. The last point that Marketing manager C brought out was that before the product is launched to the markets, marketing needs to check how to make the marketing materials more customer thinking, to ensure for the customers that the new product is worth of buying, instead thinking only fact-based features.

5.3.3 Sourcing

The last interview was arranged for a sourcing specialist of the case organisation. The first question asked him to describe the cooperation between sourcing and suppliers when product catalogues are updated and replacement products for obsolete items are considered. He stated that when we are talking about commercial products, key account managers from suppliers are quite active to follow up their product portfolio with case organisation's sourcing specialist. Usually, these suppliers have a web portal as an information channel for this kind of updates. He stated that it is bigger challenge how the information is shared inside the case organisation. During these discussions with suppliers, they update frame agreements where they pay attention to End-Of-Life products. He stated that in aftersales business ongoing data follow up for product portfolio plays a crucial role. In cases of End-Of-Life products there is six months' time to find out the replacement product. However, in spare part business the huge amount of different items it makes it sometimes more challenging to follow up the End-Of-Life information for all the active items in product portfolio.

The second question for sourcing specialist asked how sourcing department engages in new products development projects, and what kind of a role they have? He stated that in new product ideation stage the communication between sourcing and product management is incredibly important, since usually the first input for a new product idea comes from suppliers. He highlighted that sourcing is responsible to track End-Of-Life

products with suppliers, and then share this information with product management. Sourcing specialist stated that in the case organisation's previous NPD projects the new product development process has been usually very straight forward. He stated that in addition to idea pool, sourcing is also needed in proposal stage before the development itself, when the sourcing specialist can check all the needed details with suppliers. He also considered that End-Of-Life management should be initiative-taking, meaning that actions to find replacement products would be started soon after the supplier gives information regarding product End-Of-Life. To sum up, the sourcing should be involved in two stages: idea pool and proposal.

Lastly, sourcing specialist was asked to describe how does the communication between sourcing and product management works in new product ideation stage? He stated that information should flow between the product management and sourcing in both directions. He noted told that they have had continually active communication with product data management highlighting the importance of transparent communication which can be done by modern sales tools. When the sourcing specialist gets an information for product from the supplier, he forwards it to product manager who can consider whether is potential to productise in their own business. Supplier manager told that he has been using Jira in his own projects and brought out that it has been a valuable tool for tracking and improves transparency in reporting.

6 Discussions

The background for this case study research was to find out a suitable new product development process for spare part organisation of Konecranes Port Service. In addition, the lead times for previous NPD projects were studied based on the quantitative data collected from the case organisation product managers. A new product development process has been introduced for the case organisation use, but the idea was to find out how this process could be developed and specify tasks inside the stages for each project team members. Development ideas were collected from interviews organised for product managers, sales and marketing and sourcing.

The quantitative data was collected from ten different NPD projects which were separated to high-value and standard projects based on the business case value and workforce used for projects. In general, the average lead time for projects was 12 months from product idea to market launch, meaning 21 months for high-value projects and 7 months for standards projects. The other manner data brought out was the bottleneck stage of the new product development process. The data showed that bottleneck stage in the previous ten projects has been the develop-stage which an average took more than six months where prepare to market took two months. There is a huge variation between in both project lead times and project stage lead times, which naturally are very project based, but the variation can also be result of that project team members have not had a clear task list and responsibilities listed for each stage. Naturally, some projects need more workforce and external resources than others.

Based on the literature the key factors to reduce new product development time are regular team meetings which helps to share information quickly to other project members, and assigned responsibilities avoids delays. In addition, doing tasks same time can reduce development time, however the idea in the stage gate model is to finish one stage before the next one can begin. Naturally tasks inside the same stage can be done same time, like in prepare to market stage the marketing manager can work on the marketing materials while the product managers finishes all the product documentation

related to new product. On the other hand, the marketing materials cannot be finished before all the technical development for the product has been finished. Tools like quality *Function Deployment, Failure Models* and *Effects Analysis* were recommend in the literature, while the main tool recommended in the interviews was Jira Tracker which can be used for project management and tracking. The one key problem has been the lack workforce among NPD projects, however there is a new position in the case organisation which is focused on new product development, and this will affect positively on project lead times in future projects.

Based on the interviews, new product development projects in the case organisation are quite project based and individual. From a technical point of view, case organisation's new product development projects focuses mostly on product item data creation and product documentation. Collaboration within different teams are important for project success. Decision-making in new product development projects involves considering market opportunities in preliminary stages of the project. The role of marketing department is to create marketing materials based on the information given by product manager. The role of sales and business line is to bring the latest ideas from customer site to product manager, sell the new product to customers and collect customer feedback. New product ideas primarily come from external sources like suppliers and customer site, but also internally from main equipment manufacturing innovations and product management team internal workshops. Initiative-taking collaboration with main equipment organisation is emphasized to integrate innovations into spare parts business.

In general, all the respondents were noting that stage gate based new product development process would be good for case organisation use. The need of approval between the stages rely on project's value and need for external resources. As showed by quantitative data, product managers also agreed in the interviews that develop stage takes most of the time in NPD projects. The interviews pointed out that it would be particularly important that before customer roll-out all product data should be finished including to pricing and inventory. It has been clear for all the team members that

product manager needs to give all the technical details and features of the new product for marketing manager to create the marketing materials. In addition, marketing would also like to get the main sales arguments from the product manager to tell for the customer why they should consider buying this product. Interview brought out that one key problem in the previous projects has been the lack post-launch review with customer feedback collection. The customer feedback should be collected by sales and business line since they are working in the customer interface. However, product managers should be involved in this by controlling the feedback collection.

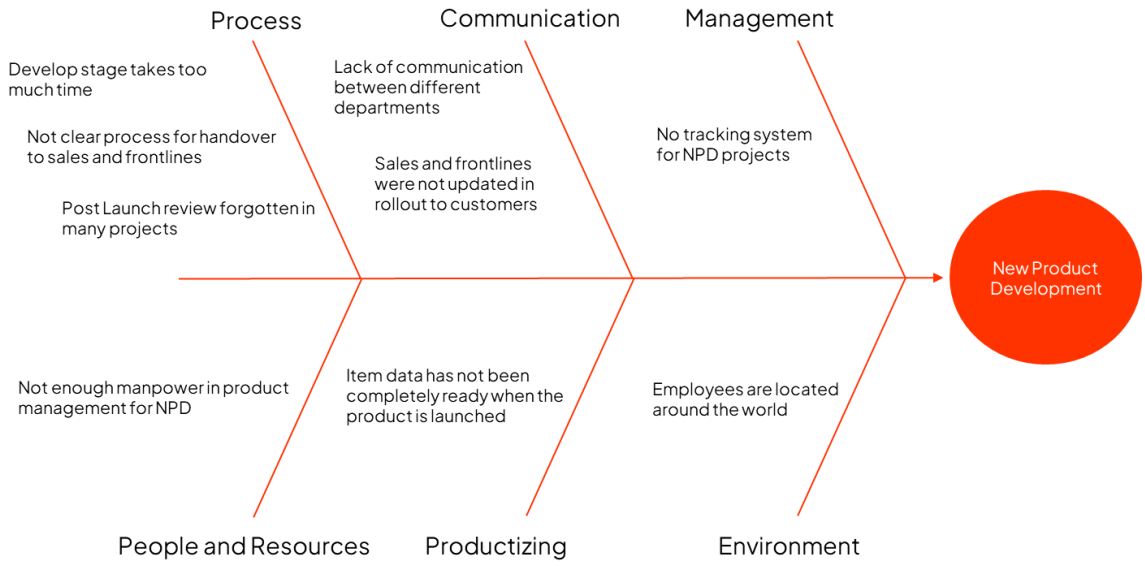


Figure 10. Cause-and-Effect diagram

The cause-and-effect diagram in Figure 10. brings out the key factors affecting on case organisation's new product development based on these interview results. There are six different causes mentioned: process, communication, management, people and resources, productising, and environment. *Process* brings out the issues of NPD process which effects on case organisation new product development in general. As interviews and quantitative data pointed out the develop stage is the bottle neck which has a big effect on case organisations total NPD lead time. As well the last stage handover to sales needs to be described more specific related to tasks and responsibilities inside the stage.

The third point was that post launch review was forgotten in many projects, meaning that any feedback has not been collected of the new product after the market launch.

The second cause *communication* noted two issues which effects on the performance of case organisation new product development. The first one was the lack of communication in general. More communication would be especially needed in the last stage between all the team members. In addition, more product ideas could be adopted from main equipment innovations. The interviews results also pointed out that situations where sales and frontlines are not informed of the market launch schedule should be avoided. Regarding *management*, based on the interviews the lack of project tracking might have been one reason for long lead times in NPD projects. The use of Jira tracker was recommended to improve project tracking and management.

Regarding *people and recourses*, the interviews for product management noted that the lack of workforce has delayed NPD projects, especially in develop-stage. However, as mentioned earlier the case organisation has a new position focused on new product development which will solve this problem. The last two causes are *productising* and *environment*, where productising is referring to item data and inventory management whereas environment relates to global working environment. In global organisation where people are located around the world, this must be taken into account when sales trainings and meetings are organised.

7 Validity and Reliability

Litwin (1995) states that *"Validity is in important measure of survey instrument's accuracy."* Regarding reliability, the book describes that *"Reliability is a statistical measure of how reproducible the survey instrument's data are."* Reliability refers to the consistency or stability of measurements across repeated trials and indicates the extent to which a measuring procedure yields the same results when applied multiple times (Carmines et. al., 1979). Carmines states that reliability ensures that measurements are dependable and consistent, regardless of their absolute accuracy. Validity refers to the extent to which a measuring instruments accurately measures what it is intended to measure. It concerns the relationship between the concept being measures and indicator used. A measure is considered valid if it effectively captures the intended theoretical concept and not something else. Even a reliable measure may lack validity if it consistently measures something other than the intended concept.

Regarding the validity and reliability of the literature review of this thesis, the use of various books and mostly peer-reviewed articles from several databases improves both validity and reliability. Most of the literature used for this thesis is released during the last decade which ensures that information is up to date. However, the total amount of references used could have been more, which would have increased the validity and reliability more.

Regarding the empirical research, the main limitation was the small sample sized used for both quantitative and qualitative data collection. However, all employees who are related to this topic in the case organisation engaged in this research, which improves the validity and reliability of interview results. The quantitative data was collected by sending questionnaire for product managers regarding their previous projects lead times. Dates were collected in months, not exact days which in turn might decrease the validity of results. All the interviewed employees are professional people from different positions of the case organisation, and all the interviews were recorded to ensure the validity and reliability of interview results. Taken these factors into account the empirical

research result can be considered to be valid and reliable beyond the case organisation target group.

8 Conclusions

Spare part business has a significant role in equipment maintenance and profitability for engineering driven companies. Literature highlights the familiar challenges in spare part business to be inventory balancing, efficient distribution strategies, and the shift towards online sales and marketing. Product innovation is the primary driver of competitive advantage, and that is why new product development is important for engineer-driven companies. The success factors for efficient new product development are well defined NPD process, communication in cross-functional product development team as well as comprehensive understanding of customer needs. Literature present different kind of processes for new product development. The Stage-Gate NPD process introduced in the literature is quite similar compared to process introduced for the case organisation, which aligns with empirical findings, emphasizing the need for approval between stages based on the project value and resource requirements.

This case study research studied new product development lead time in case organisation based on quantitative data collected. The other research question was focused how the case organisation's NPD process could be developed to be more suitable for spare part business based on the interview results and comparing these to literature findings. Empirical research results support on literature by underscoring the important roles of marketing and sales in new product development, including gathering feedback and creating the marketing materials. Literature and empirical research recommend tools like Jira Tracker for project management to improve communication and track progress. The recommendations for case organisation are introduced in the next part of this chapter. Finally, the future research suggestions are presented.

8.1 Recommendations for Case Organisation

This chapter introduces the recommended process for new product ideation and development. The complete process can be seen in Appendix 4. Based on the interview results, sourcing specialist is responsible to forward End-Of-Life product information from suppliers to product manager while sales and business line brings the new product ideas from the customer site to the idea pool. Product manager is responsible to consider the potential product ideas and create the product concept. The concept is reviewed by sales and business line in Gate i2, where they can give consultation regarding for example target customer validation. The concept is presented by business model canvas where the first high-level business calculations are introduced together with simple description of the new product. The case organisation already has a template for business model canvas which should be used for this. More specific numbers with full business case and customer validation are done in the proposal stage. As a difference for the earlier introduced process, the proof-of-concept stage is included into proposal in the recommended process. The Figure 11. below describes the recommended new product ideation process followed by the new product development.

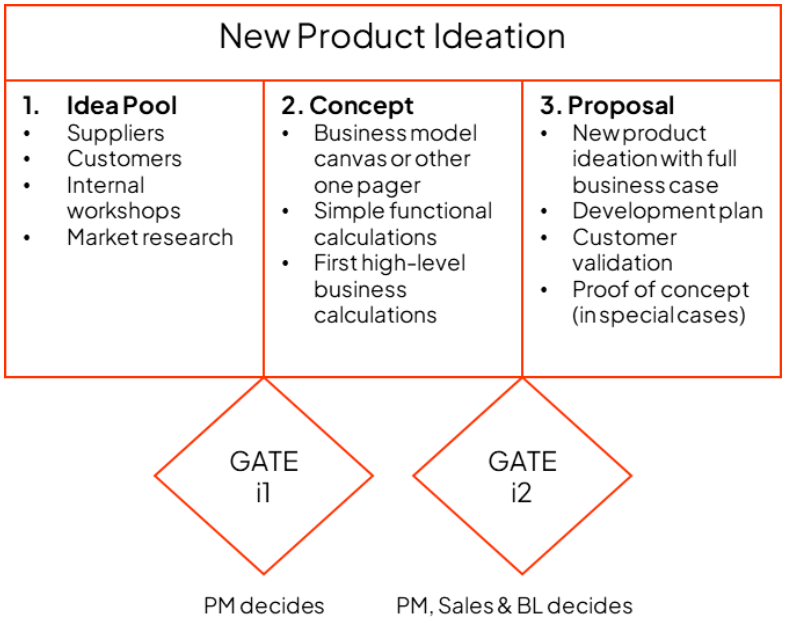


Figure 11. Recommended process for new product ideation

After the product concept is approved by Product steering in Gate 1, technical and commercial development for the new product can begin. All the item data should be finished in this stage. The next stage is prepare to market where marketing materials are created and product documentation including compliance issues should be finished. Product steering gives an approvals to move on next stages. The last stage in the recommended process is handover to sales and frontlines whereas in the introduced process it was called handover to product manager. In this stage the salespeople including sales managers, business line, and frontlines will be trained to be familiar with the new product before the market launch. Since the case organisation has frontlines around the world, these trainings should be arranged for example in three different time slots. After the market launch, business line together with sales will collect the customer feedback and forward it to product management. Product manager is responsible that feedback is collected, and the possible developments are done based on the post launch review. The new product development process is describes in Figure 12.

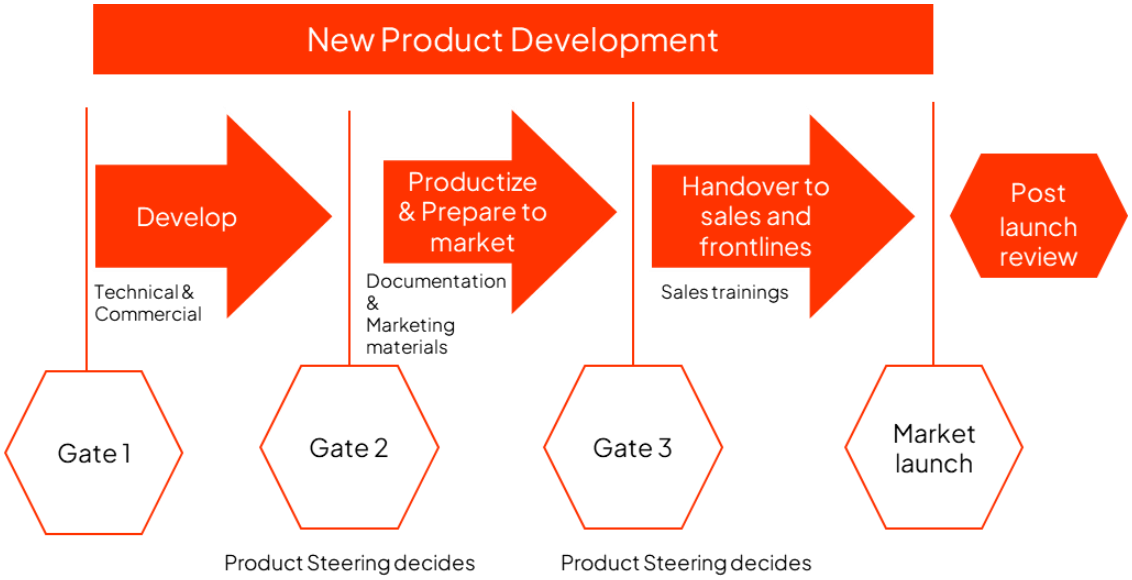


Figure 12. Recommended process for new product development

Based the literature recommendations and interview results Table 4. and Table 5. clarifies the tasks and for each stage and team member. On the left side of the table can be seen the process stage and the primary goal of it. Then all the team members are listed on top of the table, and their tasks can be seen from the column below. Table 1. shows the tasks for the product manager and sourcing. The role of product steering is more related to approval gates. Table 2. is for sales, business line and marketing. Appendix 5. presents the RACI table to show the responsibilities for each stage and members. RACI shows who is responsible, accountable, consulted and informed in each stage of the process.

Table 4. NPD process tasks 1

	Primary goal	Product Manager	Manager of Product Management / Product Steering Group	Sourcing
Idea Pool	Find a new product idea	Consider the potential product ideas for productising	Gives an approval to move on next stage in the process	Brings the new product ideas from the suppliers to the product manager, especially end-of-life time products
Concept	Create a product concept with business model canvas	• Create a business model canvas or other one pager • Do the simple functional and first high level business calculations	Review the product concept	
Proposal	Finish the product concept with full business case	• Create the full business case with numbers, target customers and development plan. In special cases proof of concept can be done by testing the product idea e.g. at the customer site. • Identify trade compliance issues	Gives an approval to move on Develop-stage	Verify supply chain readiness
Develop	Finish the technical and commercial development for the product	• Do the technical development for the product including item data and sales pricing • Prepare technical detail information and sales arguments for marketing	Gives an approval to move on Prepare to market	
Prepare to market	Product is ready for customer roll-out	• Finish the product documentation • Inventory management to make sure good availability for the new product	Gives an approval to move on Handover-stage	
Handover to Sales and Frontlines	Salespeople and frontlines know the new product with details and are ready to sell it	• Organise technical training for sales and frontlines to get familiar with the product	Gives an approval for Market launch	
Market Launch	Product will be launched to the markets			
Post launch review	Collect feedback of the new product from the customer site, and do the possible development work	• Control the customer feedback collection made by sales and business line	Follow up the customer feedback	

Table 5. NPD process tasks 2

	Primary goal	Sales Manager	BL Manager	Marketing Manager
Idea Pool	Find a new product idea	Bring customers' new product ideas to product management	Bring customers' new product ideas to product management	
Concept	Create a product concept with business model canvas	Comment on the product concept	Comment on the product concept	
Proposal	Finish the product concept with full business case	Participate in target customer validation	Participate in target customer validation	
Develop	Finish the technical and commercial development for the product			
Prepare to market	Product is ready for customer roll-out			Prepare the marketing materials based on the technical details and sales arguments given by product manager
Handover to Sales and Frontlines	Salespeople and frontlines are familiar with the new product with technical details	Get familiar with the new product to be ready to sell it. Sales trainings are organised by product manager.	Get familiar with the new product to be ready to sell it. Sales trainings are organised by product manager.	Send the marketing materials to the customer site
Market Launch	Product will be launched to the markets			Do the market launch
Post launch review	Collect feedback of the new product from the customer site, and do the possible development work	Collect customer feedback of the new product and forward it to product manager	Collect customer feedback of the new product and forward it to product manager	

8.2 Ideas for future research

The idea in this research was to find out the lead times for the new product development projects of the case organisation, and which stage of the process has been the bottleneck. Based on the quantitative data this bottleneck stage has been *the develop-stage*. The idea for future research could be why this stage takes so much time compared to other stages, and how the lead time for that stage could be reduced. The other key factor which came out from the interviews was the lack of customer feedback collection made by post-launch review. Other idea for future research could be how to develop customer feedback collection, and how this feedback should be collected and managed.

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Appendices

Appendix 1. NPD functions (Ulrich and Eppinger, 2019, p. 25)

Rally point phase	0. Project Registration	1. Concept Definition	2. Feasibility and Planning	3. Preliminary design	4. Final Design	5. Product Verification	6. Process Verification	7. Launch	8. Post-Launch Assessment
Primary goal	Define project and business unit needs	Develop project concept and charter	Create product description	Create preliminary detailed design	Detail and optimize design	Demonstrate product performance	Demonstrate process performance	Launch product	Identify lessons learned
Marketing and Sales	Identify customers and market size	- Capture voice of the customer - Analyse customer needs - Document customers needs	- Develop marketing and sales plan - Create phase-in and phase-out plans	Review concepts with customers		Initialize fields trials	- Complete field trials - Finalise training plans	- Finalise pricing and sales forecasts - Complete sales and service training	- Solicit customer feedback and satisfaction ratings - Measure sales vs. forecast - Complete phase-in and phase out
Engineering	Identify project risks	- Identify critical-to-quality specs - Develop and select concepts - Update project risks	- Create functional specification and performance metrics - Review concept selection - Define product architecture - Access technical failures modes	- Conduct a preliminary design review - Build test alpha prototypes - Access product failure models	- Freeze hardware and software design - Complete engineering documentation - Draft technical documentation - Secure beta prototypes	-Finalise design documentation - Complete beta prototype and field testing - Apply for regulatory approvals	Obtain regulatory approvals	Finalise product metrics	
Quality Assurance			Create preliminary test plan		Test beta prototypes for business	Complete quality assurance testing	Conduct process verification process		
Manufacturing				- Begin manufacturing process development - Conduct a preliminary manufacturing process review	- Finalise bill of materials (BOM) -Develop manufacturing control plans	Update manufacturing control plans	- Run manufacturing pilots - Finalise manufacturing control plans		Register obsolete and scrap products

Rally point phase	0. Project Registration	1. Concept Definition	2. Feasibility and Planning	3.Preliminary Dy design	4. Final Design	5. Product Verification	6. Process Verification	7. Launch	8. Post-Launch Assessment
Purchasing				Create a supplier participation matrix Access suppliers for certification	Identify long lead time items		Verify supply chain readiness		
Legal		Search patents	Identify trade compliance issues	Identify potential patents	Prepare patent applications	Assure trade compliance			
Financial	Prepare preliminary business case	Refine business case	Complete financial package						Monitor return on investment
Project Management	Identify project timing, resources, capital	- Access team capabilities - Identify development team members	Plan integrated product development schedule	- Update RP1-2 deliverables - Prepare RP3 checklist & submit for approval	- Update RP1-3 deliverables - Prepare RP4 checklist & submit for approval	- Update RP1-4 deliverables - Prepare RP5 checklist & submit for approval	- Update RP1-5 deliverables - Prepare RP6 checklist & submit for approval	- Finalise all deliverables - Finalise launch plans and documentation -Update RP1-6 deliverables - Prepare RP7 checklist & submit for approval	- Document best practices - Prepare RP8 checklist & submit for approval

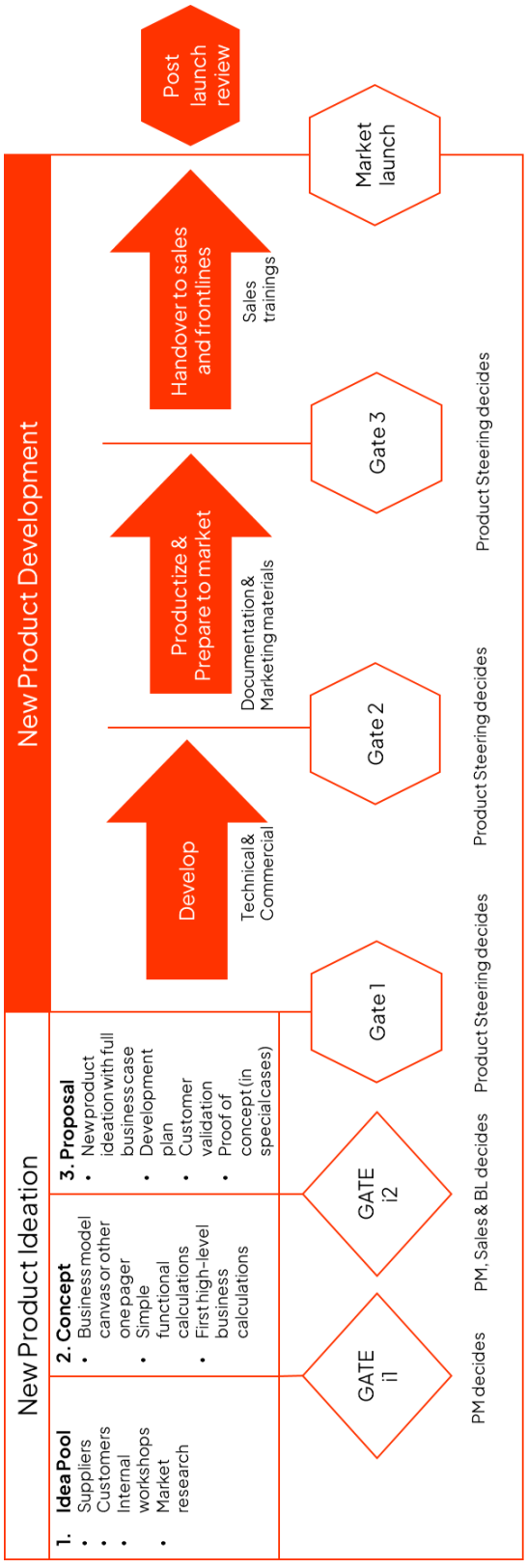
Appendix 2. Tuotepäälliköiden haastattelukysymykset

1.	Kuvailkaa aiemmissa projekteissanne käyttämäänne tuotekehitysprosessia? Miten se mahdollisesti eroaa esitellystä prosessista?
2.	Mistä eri kanavista uusia tuoteideoita tulee?
3.	Miten eri prosessivaiheet hyväksytetään ennen siirtymistä seuraavaan?
4.	Mikä nykyisen prosessin vaiheista on pullonkaula?
5.	Onko teillä yleisiä kehitysideoita prosessiin? Tarvitaanko sekä vaihetta kolme että neljä?
6.	Mitkä tietoja tuotepäällikön tulee antaa markkinoinnille markkinointimateriaalin luomista varten?
7.	Mitä tapahtuu markkinajulkaisun jälkeen? Onko olemassa prosessia palautteen keräämiseen asiakkailta?

Appendix 3. Myynnin ja markkinoinnin haastattelukysymykset

1.	Kuvailkaa aiempien projektien tuotekehitysprosessia? Miten se mahdollisesti eroaa esitellystä prosessista?
2.	Tuleeko asiakkailta tuoteideoita ja kenelle välitätte ideat?
3.	Miten eri prosessivaiheet hyväksytetään ennen siirtymistä seuraavaan?
4.	Mitä hyötyä tuotekehitysprosessista on tuotehallinnolle?
5.	Mitä tietoja tarvitaan tuotepäälliköltä markkinointimateriaalien luomiseen?
6.	Miten *handover* toimii prosessin lopussa, ja ketkä ovat tämän osapuolet?
7.	Miten seuraatte tuotteiden myyntiä ja asiakaspalautetta markkinajulkaisun jälkeen, onko tähän olemassa prosessia?

Appendix 4. Recommended New Product Ideation and Development Process



Appendix 5. RACI

	Product Manager	Manager of Product Management / Product Steering Group	Sales Manager	BL Manager	Marketing Manager	Sourcing
Idea Pool	Responsible	Accountable	Consulted	Informed	Informed	Consulted
Concept	Responsible	Accountable	Consulted	Consulted	Informed	Informed
Proposal	Responsible	Accountable	Informed	Informed	Informed	Consulted
Develop	Responsible	Accountable	Informed	Informed	Informed	Informed
Prepare to market	Consulted	Accountable	Informed	Informed	Responsible	Informed
Handover to Sales and Frontlines	Responsible	Accountable	Consulted	Consulted	Consulted	Informed
Market Launch	Responsible	Accountable	Informed	Informed	Informed	Informed