Kalle Savolainen

Strategic product backlog prioritization method for agile portfolio development

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Author: Kalle Savolainen
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ABSTRACT:

The product backlog is a central component of the scrum framework for conducting agile product development. The product backlog is a compiled list of all the development activities that are going to be completed, and it is the responsibility of the product owner to update, refine and prioritize this backlog so that maximum value is delivered in as short of a time frame as possible. This thesis explores the current best practices in product backlog prioritization in an effort to create a prioritization method for scenarios where the definition of value must be broad. The definition must account for the product backlog including a wide variety of different kinds of items aimed at developing products, services, and systems. As scrum is an agile methodology for product development the prioritization method should also adhere to the principles of agile. The thesis utilizes decision analysis and current best practices for the creation of the method followed by qualitative research in the form of interviews with product owners from ABB's Smart Power division to find out how well the method is suited for real world applications and how it should be improved. This approach aligns with a grounded theory approach and as such the data collection and analysis follows this approach. This thesis is centered around the following three questions. What are the parameters that a product owner should consider when defining the business value of product backlog items? How much weight should each parameter have in the decision-making process? How should the parameters be utilized in order to acquire the relative priority of each item? This thesis finds answers to these questions by creating a prioritization method, that accounts for a wide variety of parameters in the definition of the business value of product backlog items, by utilizing the above-mentioned research methods. The overall framework of the method as well as the individual processes that act as its components are the key findings of this thesis and can either be used together or separately. The framework of the method and its components are mainly aimed at organizations utilizing scrum in the development of physical products and services to complement these products. Furthermore, certain components could be utilized in companies outside the manufacturing industry, in organizations using other agile methodologies in product development or even in other decision-making scenarios where activities need to be prioritized. While many methods for product backlog prioritization exist, there was a clear need in the organization, and in the field of product ownership, for a new kind of method that would concretely support decision-making. This thesis combines existing product backlog prioritization models with typical decision-support tools to create a novel, systematic, solution for product backlog item prioritization.

KEYWORDS: Prioritization, Business value, Product development, Agile methods, Product backlog

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Tiivistelmä:
Product backlog eli tuotteen kehitysjono on keskeinen osa ketterän tuotekehityksen viitekehystä nimeltä scrum. Tuotteen kehitysjonoon on listattu kaikki ne aktiviteetit, jotka tuotteen kehitystiimi aikoo suorittaa. Kehitysjonon päivittäminen, jalostaminen ja priorisointi kuuluvat tuotteen omistajan tehtäviin. Näiden tehtävien tavoitteena on saavuttaa maksimaalinen arvontuotanto niin lyhyessä ajassa kuin mahdollista. Tässä tutkielmassa selvitetään tämänhetkisiä parhaita käytäntöjä kehitysjonon priorisointiin tavoitteena luoda priorisointimetodi, joka toimisi niissä tapauksissa, joissa arvon määritelmän tulee olla laaja. Määritelmän tulee ottaa huomioon, että kehitysjonossa saattaa olla useita erilaisia aktiviteettejä, jotka liittyvät tuotteiden, palveluiden ja järjestelmien kehitykseen. Koska scrum on ketterään kehitykseen pohjautuva viitekehys, tulee myös priorisointimetodin seurata ketterän kehityksen periaatteita. Tässä tutkielmassa luodaan priorisointimetodi päätösanalyysiin sekä parhaisiin käytäntöihin pohjautuen, ja selvitetään metodin toimivuutta ja vaadittavia parannuksia kvalitatiivisten haastattelujen perusteella. Haastateltavina toimi ABB:n Smart Power divisioonan tuotteen omistajia. Tämä lähestymistapa on yhtenevä grounded theory -tutkimusmenetelmän kanssa, minkä vuoksi tutkimusdatan keräys ja analyysi on suoritettu kyseisen metodin mukaisesti. Tämä tutkielma rakentuu kolmen tutkimuskysymyksen ympärille. Mitä parametrejä tuotteen omistajan tulisi ottaa huomioon eri aktiviteettien arvon arvioinnissa? Kuinka paljon jokaisella parametrillä tulisi olla painoarvoa päätöksentekoprosessissa? Kuinka näitä parametrejä tulisi käyttää aktiviteettien keskinäisen järjestyksen selvittämiseen? Tämä tutkielma löytää vastaukset näihin kysymyksiin edellä mainittuja tutkimusmenetelmiä hyödyntäen. Näin tutkielma luo priorisointimetodin, joka pohjautuu arvon mittaamiseen sellaisen määritelmän mukaan, joka ottaa laajasti huomioon eri parametrejä. Priorisointimetodin viitekehys sekä sen yksittäiset osat toimivat tämän tutkielman tärkeimpinä löydöksinä ja niitä voidaan käyttää joko yhdessä tai erikseen. Tutkielman esittämä priorisointimetodi on tarkoitettu niille yrityksille, jotka käyttävät scrum-viitekehystä tuotekehityksessään ja pääsääntöisesti keskittyvät fyysisten tuotteiden valmistukseen sekä niitä täydentävien palveluiden kehitykseen. Tämän lisäksi jotain osia metodista voitaisiin käyttää myös teollisuussektorin ulkopuolella muita ketterän kehityksen viitekehyksiä käyttävissä yrityksissä tai jopa muissa päätöksentekotilanteissa, joissa aktiviteetteja pitää asettaa tärkeysjärjestykseen. Vaikka monia tuotteen kehitysjonon priorisointimetodeja on jo olemassa, sekä organisaatiossa että tuotejohdon kirjallisuudessa oli selkeä tarve uudenlaiselle menetelmälle, joka konkreettisesti tukisi päätöksentekijöitä. Tämä tutkielma yhdistää olemassa olevia tuotteen kehitysjonon priorisoinnin malleja tyypillisten päätöksenteon tukimallien kanssa luoden uudenlaisen ja systemaattisen ratkaisun tuotteen kehitysjonon priorisointiin.

AVAINSANAT: Priorisointi, Liikearvo, Tuotekehitys, Ketterät metodit, Tuotteen kehitysjono

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1 Introduction

In recent years, many organizations have made the switch from utilizing traditional waterfall methods in their product development, to utilizing agile methodologies. One of the most prevalent agile methods is scrum. Scrum is a framework that aims to enable teams and organizations to generate innovative solutions to complex problems. The product backlog is one of the most important artifacts in the scrum framework. It contains a list of all the planned development activities a team is going to complete. The creators of the scrum framework Schwaber & Sutherland (2020) discuss the importance of ordering the items in the product backlog or in other words prioritizing the product backlog items. They mention that it is a necessary part of the refining process each item must undergo for them to be applicable for selection in an event known as sprint planning. It is during this sprint planning when the developers choose the items they wish to complete during the next development cycle. Schwaber & Sutherland (2020) mention that it is the responsibility of the product owner to help the developers understand the possible trade-offs included in the selection process. Therefore, it is important for the product owner to be able to prioritize the backlog in a way that captures the value associated with each item so that they can effectively communicate the value perspective to the development team.

1.1 Background of the thesis and identified research gap

This thesis was commissioned by the Smart Power division of ABB. The division recently made the switch to utilizing scrum in its portfolio development. During this transition, development teams that are focused on solutions for certain industries were also created to work in tandem with teams focused on developing products. In addition, certain teams took over the responsibilities of simultaneously developing products and solutions for certain industries. These changes called for a method of weighing both product- and service-related incremental development activities on an objective scale so that development activities could be prioritized in a way that maximizes value generation. This

was the reason behind the decision to re-evaluate how value should be measured so that a wide variety of parameters, both tangible and intangible, would replace the traditional financial centric view of value. The aforementioned also act as the reasoning for the decision of creating a prioritization method that would provide support and structure in the process of weighing the increments against one another.

In literature the same gap exists. While multiple models for product backlog prioritization have been created, a systematic process that is guided by strategic decisions, and utilizes a variety of variables when measuring value is needed. McGreal & Jocham (2018) mention that in product ownership there are no universal solutions and tools, but rather organizations, and product owners, have to find processes that suit their particular needs through empiricism. Due to this the solution should allow for modifiability and adjustability so that each product owner can use it in practice. Schwartz (2016) describes business value as a context-based aggregate of quantifiable and unquantifiable aspects that should also be approached empirically in order to generate a vision of what it should be for each context.

The research gap for this thesis is then that currently there is no solution in the organization or key field literature that generates an estimation of the business value of product backlog items based on a wide range of parameters and then incorporates this evaluation into a strategy guided product backlog prioritization process. A process that allows the user to adjust the weights each parameter has on the decision-making process, and that can be continuously improved so that it supports the adoption of the agile principles.

1.2 Study objectives and research questions

The purpose of this thesis is to evaluate the literature available in the field of agile product development, the scrum framework for conducting agile product development, product ownership and management, as well as product backlog prioritization in order

to create a method for strategically evaluating the internal priority of various kinds of product backlog items. The method should focus on evaluating the value generated by these items in a way that recognizes that business value is a somewhat abstract concept that includes multiple tangible and intangible aspects. As the purpose of agile is to approach big problems by breaking them down into smaller more manageable increments and to continuously improve the final product in cycles, the prioritization method should be modular and modifiable. This ensures that as more knowledge is gained the method may be continuously improved and it will continue to evolve to meet the needs of the people utilizing it.

The objectives of this thesis were formed as follows:

- To review existing literature on the current best practices for backlog prioritization.

- To define the key business value prioritization parameters present in the literature.

- To define the sections of and build the framework for the process of evaluating the business value.

- To carry out qualitative research in the form of interviews to validate the proposed framework and expand on the pool of possible parameters.

- To define the parameters of the framework for the creation of the prioritization method.

The research questions this thesis answers are formed on the basis of the objectives and read as follows:

RQ1: *What are the parameters that a product owner should take into account when defining the value of product backlog items?*
RQ2: *How much weight should each parameter have in the decision-making process?*
RQ3: *How should the parameters be utilized in order to acquire the relative priority of each item?*

1.3 Scope and structure

The scope of this thesis is limited to creating the structure of the product backlog prioritization method as well as an initial version of the individual components of the method. Their creation was entirely based on theory presented in key field literature. The structure and components were discussed with professionals within the organization to validate the structure of the model and to gather feedback on how the method could be improved so that it better reflects reality. These suggestions of improvement are analyzed, and the method is adjusted accordingly. Additionally, a description of the process of carrying out prioritization using the method is provided. Further rounds of qualitative research, and therefore further cycles of improvement of the method, were left outside the scope of the thesis.

In chapter 2, the topics of agile and its application in the development of physical products are explored to create an understanding of the typical problems that occur in these cases. Scrum, which is a method of applying the agile principles into practice, and the product backlog, which is an important artifact in the scrum framework, are discussed in chapter 2.1. As the product backlog is at the center of the prioritization method an understanding of it and its typical contents is crucial.

As the product owner is the person responsible for upkeeping the product backlog, their role and responsibilities are discussed in chapter 2.2 to create an understanding of what is needed from both the product owner, and the organization for the product owner to

be successful in their role. This understanding is helpful in understanding certain aspects of the prioritization method and what it needs to account for.

As the purpose of the prioritization method is to measure multiple aspects and weigh them against one another in the decision-making process, methods for accomplishing that are discussed in chapter 2.3. Mainly the approach of utilizing a scorecard, and how one could be created are discussed. Current best practices used for prioritizing product backlogs are also covered in chapter 2.4. How the business value of the different backlog items could be measured in a way that accommodates the fulfillment of the requirements of the prioritization method are discussed in chapter 2.5. The findings of chapter 2 are summarized in chapter 2.6 together with a presentation of the gaps answered by the empirical portion of the thesis.

The methods used to conduct the research in this thesis are discussed in chapter 3. Decision support methods, qualitative research, and the data collection and analysis methods utilized in the research are all covered. Decision support methods were utilized for the creation of the theoretical method for prioritization. This initial draft was then adjusted based on feedback from qualitative interviews that were carried out for the purpose of conducting research in line with the grounded theory approach.

The results of the qualitative research and the implications of these findings on the prioritization method are covered in chapter 4. The current practices of the participants with regards to product backlog prioritization and their opinions on what is currently being overlooked in the process are explored first. The current strategy creation process and its linkage to the process of prioritizing a backlog is also discussed. The issues the product owners currently face due to the products being physical are also presented. Feedback on the method proposed on the basis of theory was also collected and this feedback is presented as well.

The analysis of these results is approached from three perspectives. The validity of the method based on the opinions of the interviewees is discussed and an analysis of the suggested improvements is presented. The chapter also includes a look into the aspects the product owners saw as something that should be considered in the process, but that were not considered in the method presented to them. The adjusted form of the prioritization method, its components, and how to implement it are also discussed in chapter 4.

The key findings of this thesis are presented in chapter 5. These are the proposed prioritization method, and the proposal of how business value could be broken down into measurable aspects. The managerial implications and the limitations of the findings of this thesis are also discussed and suggestions of how the topic could be researched further are made.

2 Literature review

This chapter acts as a view into the current prevailing theories around the topic. These theories are analyzed from a theoretical point of view and this analysis forms the theoretical foundation for the prioritization method proposed in this thesis. The themes of agile, and product ownership are discussed to create a better understanding of the problem this thesis attempts to solve. As agile is typically thought to be an approach suitable for software focused companies, and the organization that commissioned this thesis is more focused on hardware-based products, the point of focus in this thesis is on agile and its adaptation for hardware development. The topic of scrum is also discussed under the theme of agile as it is the way of adapting agile into practice that the organization has adopted.

The main focus of this chapter however is the topic of backlog prioritization in order to create an understanding of what the current best practices and processes are, and what factors and parameters are typically used when scoring various types of product backlog items. As a part of the identified problem for this thesis is that there is currently no conclusive understanding of the set of parameters that should be used, and how, in the product backlog prioritization process, the creation of a wide base of parameters that could be used in the process is paramount for the creation of a successful solution. How these parameters should be incorporated into the prioritization process in a way that allows the strategy to play a key part in the process is also discussed.

2.1 Agile principles

Published in 2001, the Manifesto for Agile Software Development includes four simple statements that act as an outline for the principles of agile. These four statements are written as follows “individuals and interactions over processes and tools, working software over comprehensive documentation, customer collaboration over contract negotiation, and responding to change over following a plan” (Beck et. al., 2001). An

organization founded by the authors of the manifesto, the Agile Alliance (n.d.), describes agile as a philosophy, rather than a ready to use framework for product or service development.

2.1.1 Agile development and physical products

As mentioned, agile principles were originally intended to be used by software developers for software development projects (Beck et. al., 2001). This means that, when a company typically involved in the production of physical products wants to adopt agile principles into their product development process, a slightly different approach is needed. Schuh et. al. (2018) discuss the challenges of adopting agile in organizations that manufacture physical products. They suggest that an approach of decomposing the agile principles in order to capture the desired effect of adopting the agile approach should be followed by these companies. This way they could create agile development processes for physical products.

Schuch et. al. (2017) discuss the importance of iterative prototyping early in the development process in order to reach a high level of product maturity so that additional costs in the ramp-up phase of the process can be avoided. These costs are typically the cause of the product not meeting the requirements of the market, which leads to last-minute changes, which in turn have major implications for the technical design of the product. Cooper & Sommer (2018) discuss the difficulties physical product manufacturing companies adopting agile have faced and list the difficulties of translating physical products into increments as especially detrimental for the process of prototyping. This is caused by the fact that often creating a physical prototype is very time consuming, and resource heavy, when compared to a non-physical one. It is also more difficult for companies producing physical products to gather feedback from customers on their prototypes as the customers often need to physically get their hands on the prototype in order to test it (Cooper & Sommer 2018).

But since prototyping in the early stages of the product development process is so crucial to avoid costs later on in the process, manufacturing companies adopting agile need to look towards producing something tangible between a concept and a prototype. These items can take the form of animations, simulations, technical design documents and crude models (Cooper & Sommer 2018). The creation of these is easier to split into iterations and can even be managed in a single sprint. Gathering feedback on them is also much simpler as most of the items listed above can be sent to the customers and other stakeholders via e-mail.

Atzberger & Paetzold (2019) also found the constraints of physicality to be among the leading causes of difficulties in adopting agile in the manufacturing sector. The same difficulties of producing prototypes, and breaking the products into increments aside, they also identified the likes of dependence of external suppliers, tool creation, certification acquirement and more as the constraints that physicality brings to agile development. What is interesting about their findings however is that out of the 25 identified difficulties only 9 arose from the constraints imposed by physicality and the rest of them dealt with issues stemming from the people applying agile into hardware development. Atzberger & Paetzold (2019) identified 8 difficulties in the mindset of the people, as well as 5 difficulties in scaling agile and 3 difficulties in team distribution that are issues centered around organizational stiffness. These findings together with the workarounds presented by Cooper & Sommer (2018) show us that it is not the methodology being applied that creates most of the issues for agile in the development of physical products, but rather the people applying it.

2.1.2 Scrum as an agile framework

Scrum is a framework that is often used to apply agile principles into practice. According to the creators of scrum, Schwaber & Sutherland (2020), it was first introduced in the 1990s as a method for solving complex problems. Scrum is a structured method for applying lean thinking and empiricism through an iterative approach to product

development. Each scrum team consists of a product owner, a scrum master, and several developers who through a pre-specified schedule of events plan and control short periods of development activities called sprints (Schwaber & Sutherland, 2020).

As mentioned, each scrum team consists of a product owner, a scrum master, and several developers. The developers are a cross-functional set of individuals who plan out and execute the workload for each sprint and create the increments that ultimately lead to a finished product. The scrum master guides, coaches, and enables the development team while simultaneously acting as a bridge between the product owner and the development team, and facilitating, supporting, and coaching the product owner so that they can effectively carry out their responsibilities. The product owner acts as a line of communication between the rest of the team and stakeholders. Their main responsibility is to manage the product backlog, through creating, removing, and ordering the backlog items so that the needs of the stakeholders are met by the increments that are created by the development team (Schwaber & Sutherland, 2020).

Schwaber & Sutherland (2020) write about the various so-called artifacts that are used when applying scrum into practice. These artifacts are items that include the necessary information to understand the work being done and its value and include the product backlog, the sprint backlog, and the increment. Each of these artifacts is tied to a measurable commitment and for the product backlog that is the product goal. For the purposes of this thesis only the product backlog is elaborated on.

2.1.3 The product backlog

The product backlog is defined by Schwaber & Sutherland (2020) as the list of items that acts as the source of the work to be completed by the scrum team to improve the product. They also discuss the refinement of the product backlog, an activity during which the items receive more precise definitions so that they may be completed during the sprint. Another important consideration raised by the authors is that it is the developers,

not the product owner, who are responsible for sizing the backlog items. According to Ries (2018, pp. 29–31) the backlog is also a document that constantly evolves throughout the development process. This means that as the understanding of the requirements of the stakeholders changes the product backlog and its prioritized order must also change. Simultaneously Ries (2018 pp. 29–31) emphasizes the importance of defining the core components of what a working solution needs early in the development process. This helps ensure that the end product meets the most crucial needs of the stakeholders and is ready to enter the market as soon as possible.

As mentioned, the product backlog is the list of items that acts as the source of the work to be completed by the scrum team to improve the product. This means that typically a wide variety of various kinds of development activities can be found in each product backlog. Below in table 1 three classification systems for product backlog items can be seen.

McGreal & Jocham (2018)	Rubin (2012)	Lacey (2015)
Feature Requests	Features	Stories
Experiments	Changes	Taxes
New Capabilities	Defects	Spikes
Defects	Technical improvements	Technical debt
User stories	Knowledge acquisition	Other circumstantial categories
Nonfunctional requirements		

Table 1 Three systems for classifying product backlog items.

The first category for backlog items McGreal & Jocham (2018) discuss is the category of feature requests. This category is meant for all the items that are related to requests that come from various stakeholders. The second category for backlog items is experiments. These include all items focused on creating new functionalities that are released to test the markets. New capabilities, defects, use cases and user stories also have categories of their own. The final category for backlog items presented by McGreal & Jocham (2018) is nonfunctional requirements. These refer to the qualities of a system and include the likes of scalability, maintainability, availability, accessibility, performance, cost, legal and

compliance and more. The key difference between functional and nonfunctional requirements is that while functional requirements may exist on their own, nonfunctional requirements exist due to the system existing. These nonfunctional requirements are important to emphasize in the development as they describe what the system should be and therefore play a major role in the design of the product. To adopt these into the product backlog they may be captured as backlog items such as user stories, as acceptance criteria for existing backlog items or if they concern multiple backlog items, they may be adopted into the definition of done (McGreal & Jocham, 2018).

Rubin (2012) describes five classifications for backlog items. These are features, changes, defects, technical improvements, and knowledge acquisition. Rubin (2012) also explains that the features, which include all customer requests similar to the functional requirements presented by McGreal & Jocham (2018), are the ones that are often introduced into the backlog under the name of user stories.

Another classification system comes from Lacey (2015) who divides backlog items into stories, taxes, spikes, and technical debt. Stories are the items that deliver actual value. Taxes are items that are items mandated by the corporation, laws, or regulations and in effect are items that are necessary but that no-one likes to complete. Spikes are items that are experiments meant to explore new ground. Items classified as technical debt are work needed to avoid necessary changes to a system later in its lifecycle. In addition to these Lacey (2015) mentions circumstance dependent categories such as bugs or outages that can be used by teams at their discretion.

2.2 Successful product ownership

When describing what an effective product owner looks like, McGreal & Jocham (2018) use the term entrepreneur. They describe five types of product owners, and how each of them functions in the role of a product owner. An entrepreneur in their words is someone who is invested in the development process and sees the return of investment as if

the money invested was theirs. In their words an entrepreneurial mindset is essential for success as a product owner, as both a technical understanding of the product as well as an understanding of the business side are equally important for success.

Furthermore McGreal & Jocham (2018) split all product owners into two contrasting categories, a receiving, and an initializing product owner. According to them a receiving product owner receives key performance indicators from the upper levels of management. This often limits the proactiveness of the product owner and turns them into a more complacent product owner akin to a project manager. An initializing product owner on the other hand has the freedom to do what they deem necessary to achieve the product vision. The downside to this type of product owner is that they often lack a true connection with the development team as their time is spent attempting to spread the vision especially to the higher levels of management. McGreal & Jocham (2018) also state that the reality for most product owners is that they fall somewhere between an initializing and a receiving product owner and that a product owner should tailor their approach to fit their personality and the organization through trial and error. This idea is also shared by Due Kadenic et. al. (2023) who explain that the theoretical definition of a product owner is typically so wide that it is unreasonable to expect it to be filled in by one person. This leads to product owners discovering a suitable approach to their work environment. This discussion also ties into the difficulties, which can impact the successfulness of a product owner, centered around organizational stiffness and the mindset of the people adopting agile mentioned by Atzberger & Paetzold (2019). This means that it is not enough for a product owner to adapt to their operating environment, but they must also be drivers of change within their organizations to achieve success in their role. This is due to the fact that the inability for a product owner to make the decisions necessary to drive the vision of the product severely limits their effectiveness in that role (McGreal & Jocham, 2018).

When describing the skills and traits required in order to be a successful product owner McGreal & Jocham (2018) summarize through the acronym CRACK. The first c of the

acronym stands for collaborative, the r for representative, the a for authorized, the second c for committed, and the k for knowledgeable. Through this acronym they state that a successful product owner should be a committed part of the team and a representative for the stakeholders while being empowered to make decisions about all product related decisions, committed to the product and the role, and continuously learning as much as possible about the product and the market.

When describing the method for measuring the successfulness of a product owner McGreal & Jocham (2018) raise the idea of three Vs: vision, value, and validation. Vision is what guides the direction of the development of the product and acts as a common goal for the stakeholders. Value is a contextual understanding of what the stakeholders of the product ultimately want. For some stakeholders it may be monetary, for others it may be a practical benefit to their day-to-day lives. For this reason, it is the role of the product owner to understand what value means for each of the stakeholders involved. Validation for a product owner is all about gathering feedback from stakeholders including the customers to understand if the direction of the product development is correct. For the product owner to be successful they claim that the vision of the product should be clear and known by both the developers and the stakeholders of the product. The vision should also be reflected in the product backlog and aligned with the sprint, and release plans. When measuring the value, a product owner should look at how they measure it and how often, if the return on investment is being maximized, if the developers and stakeholders are being kept happy, and what the split in investments between innovation centered and maintenance centered projects is. To measure validation the product owner should evaluate if the product is being regularly validated by the stakeholders and customers, if the direction of the product development is adjusted accordingly and if the products meet the quality requirements at launch (McGreal & Jocham, 2018).

It is also evident that the difficulties mentioned in chapter 2.1.1 mean that in order for a product owner to be successful in the manufacturing sector some of the aspects for

successful product ownership discussed above are more important than others. The difficulties in incrementalizing a physical product place a requirement for the product owner to be very knowledgeable on the technology of the product to fully understand its components. Another requirement placed on successful product ownership by the product being a physical one is that the product owner has to know and understand what alternatives to a working prototype the customers can and cannot use to test the technical specifications of the product in the early phases of the development process. An expert understanding of the certification processes and external suppliers, both current and potential future, are also needed in order to deal with the constraints of physicality discussed by Atzberger & Paetzold (2019) and Cooper & Sommer (2018).

2.3 Methods for weighing multiple aspects in decision-making

When weighing multiple aspects in decision-making the most common approach is to adopt some kind of scorecard. The benefits of this approach, as discussed by Lawson et. al. (2007), are that a variety of measures can be tracked simultaneously, and that it creates alignment between organizational goals, such as strategy, and the day-to-day operations of the employees. This means that the core purpose of the scorecard is to help in evaluating the performance of the business model (Lawson et. al., 2007). And as was discussed in chapter 2.2 the product owner has to have a vision that not only reflects the objectives of the organizational strategy, but that guides all development being done, much like a business model. Therefore, the adoption of a scorecard into evaluating the relative business value of backlog items would be an easy way to track progress against the goals the product owner has envisioned for their backlog.

It is important to note however that as Charlesworth (2013) mentions the subjective part of the decision-making process should be kept as simple and transparent as possible. For the subjective part of the decision Charlesworth (2013) suggests using a tool known as the objectives hierarchy. This tool enables the decision-maker to understand the objectives of various stakeholders and the defining meanings of success. In this tool a primary

objective must be selected first. Next a set of fundamental objectives are listed. These objectives can be created by thinking about how the primary objective can be reached. Next a list of means objectives are listed. These objectives are contributing factors to reaching the fundamental objectives. A representation of this hierarchy can be seen below in figure 2. The arrows "how?" and "why?" can be used to figure out where in the hierarchy a particular objective lands. If the objective answers the question of "how?" it should go down in the hierarchy and vice versa (Charlesworth, 2013).

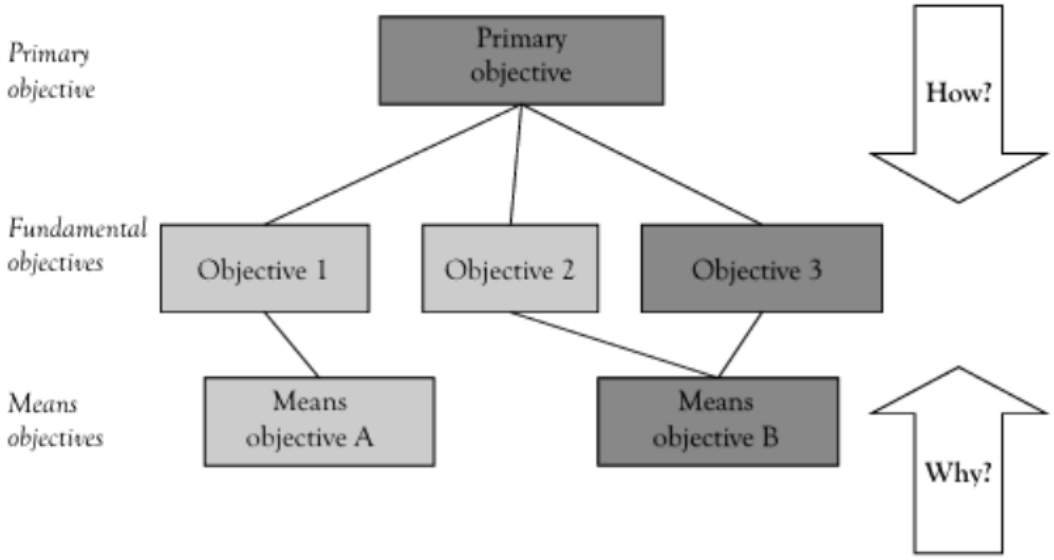

Figure 1 Objectives hierarchy construction (Charlesworth, 2013, pp.20).

2.3.1 The balanced scorecard

The balanced scorecard is a framework that allows the management to translate vision and strategy into something measurable. The balanced scorecard approach allows these to be translated by utilizing four perspectives of what brings value to an organization. These four perspectives are financial, customer, internal business process, and learning and growth. These four perspectives should however not be viewed as an absolute truth but rather a template that individuals and organizations can mold to suit their needs. The key purpose of the balanced scorecard is to look at these perspectives and to score

items from each perspective so that each of these perspectives is considered to be equally valuable. The purpose of having multiple perspectives present is to ensure that both short- and long-term objectives are accounted for and the drivers of reaching those objectives are measured (Kaplan & Norton, 1996).

The approach of utilizing a scorecard then aligns with the approach for decision analysis recommended by Charlesworth (2013) and the objectives hierarchy tool. Further support for the approach of a scorecard comes from Parnell et. al. (2013, pp. 60) who state that combining the performance scores of multiple objectives is typically done by mapping each score first before combining them into a single score. This is in line with the scorecard approach.

2.3.2 The weighted scorecard

A slightly different approach to scoring items based on the same principles is to use a weighted scorecard. This approach, according to ProductPlan (2022), is an important tool in the field of product management. The tool works very similar to the balanced scorecard by allowing the user to score an item across various metrics to reach a more comprehensive view of value generation rather than simply looking at traditional financial measures. The difference between the two comes from the fact that while a balanced scorecard views each perspective as equally valuable, the weighted scorecard allows the user to decide which of the criteria are the most important in the decision-making process. This also allows for the relative weight of the categories in the decision-making process to fluctuate over time (ProductPlan, 2022).

The steps for creating a weighted scorecard are straightforward. The user should first determine the list of items to be evaluated by the scorecard. The user should next compile the list of criteria they want to use to weigh the items and then determine the relative weight of each criterion. The last step is to choose a scale to score the items on, and

to go through the process of scoring the items according to the criteria they have chosen. This results in the user having a score for each item (ProductPlan, 2022).

2.4 Current best practices in backlog prioritization

As discussed, the product backlog is a list of all the work to be done on a product in order to improve it. For the value received from completing backlog items to be maximized the items must be prioritized in some manner. Below in table 2 some common models for backlog prioritization are summarized.

Creator(s):	Name of model	Summary of the model:
McGreal & Jocham	4-dimensional model	4-dimensions: Costs/Size, Risks, Dependencies and Business value. Dependencies evaluated separately, others measured on scales and used in the calculation of the order rank
Lacey	Big Wall Method	Uses two axes, value and size, to divide items into four quadrants: small low value, small high value, large high value, and large low value. Items are then arranged so that value is maximized, and size minimized. Useful for new product backlogs
Clegg	MoSCoW	Features are divided into four categories. must have, should have, could have, and won't have to determine their priority in the product backlog. Backlog items are then ordered according to the ranking of the features based on the categories.
Kano	Kano model	Features are divided into three categories. Basic needs, performance needs, and features which delight. Backlog items are then ordered according to the ranking of the features based on the categories.

Table 2 Summary of best practices for product backlog prioritization.

McGreal & Jocham (2018) present four aspects to consider when prioritizing backlog items. They are business value, risks, cost or size, and dependencies. The dependencies are fairly straightforward as this aspect has to only be considered to ensure that there

are no product backlog items that must be completed before completing another item. The cost or size of an item is similarly straightforward. This dimension simply measures the effort, or the cost, needed to complete a particular item. Risk analysis is a staple of all sound business planning as is the case with backlog items. The risks are also a dimension of backlog prioritization that are fairly straightforward. The risks, both technical and business, associated with each item must be understood and evaluated in the prioritization process. The only aspect that is not so straightforward is the business value. Especially in cases where each item cannot be associated with a direct and foreseeable financial benefit, weighing the business value of items against one another is very difficult. For example, attempting to measure the increase in customer satisfaction or future opportunities caused by one item against the cost savings or the actualization of the strategy caused by another. In these cases, McGreal & Jocham (2018) suggest the use of the vision for a product to be used as a guideline. What this means is that it is up to the product owner to define the meaning of business value.

McGreal & Jocham (2018) also provide a simple formula to be used for weighing the business value, risks and cost or size of each item against one another. By summing the risk and business value and dividing the sum by the size or cost, the ordering rank of a particular item is reached. The reason why dependencies are not included in the formula is that they act more as a gate that blocks the completion of certain items before others have been completed. It is important to note that as McGreal & Jocham (2018) mention the prioritization of a backlog does not have a single universal solution, but rather good and bad solutions and that empiricism is necessary in order to achieve better outcomes.

There are multiple other models for backlog prioritization as well. The big wall method presented by Lacey (2015) is an example of this. The model is meant mainly to be used with new backlogs as new backlogs typically lack both the estimation of the size of the items and the items are not in a prioritized order. Lacey (2015) does however point out that even when the backlog items are either prioritized or estimated, the big wall method can be used to complete the remaining activity. In the method all the scrum

team members and stakeholders gather to discuss the size and value of the items, which are written in the form of user stories, and place them on a large board so that the horizontal axis is reserved for size or cost estimations and the vertical axis is reserved for value estimations. After completing this the items are broken into four quadrants, small low value, small high value, large high value, and large low value. The items are then prioritized so that the large low value items are placed at the bottom, the small low value items next and the large high value items after that with the small high value items being placed at the top (Lacey, 2015).

Ashmore & Runyan (2014) discuss two common prioritization methods for system requirements often used to prioritize backlog items. The first of these is the so called MoSCoW method. In the MoSCoW method features of the product are divided into four categories: must have, should have, could have, and won't have. These determine their priority in the product backlog. The must have and won't have categories are self-explanatory. The should have category refers to features the customer does not need but expects, and the could have category refers to features that are optional and not expected by the customer, but that could add to the user experience.

The Kano model is another example of a common prioritization method presented by Ashmore & Runyan (2014). In this method features are divided into three categories. Basic needs, performance needs, and features which delight. The basic needs are often the features that cause satisfaction and dissatisfaction in the eyes of the customer, and the performance needs mainly revolve around user experience. The delight category on the other hand are the features that set the product apart from competition by providing excitement that the customers did not expect. When utilizing the Kano model, over iterations, the delighting features typically evolve into performance needs and performance needs evolve into basic needs as the customer grows to expect those features to be present.

As was discussed during chapter 2.1.2 during the process of refining the items of the backlog, according to Schwaber & Sutherland (2020), receive more precise definitions. However, as Rubin (2012) mentions typically not all of the items in the backlog are given very precise definitions. Typically, only the items that are going to be implemented next receive definitions of great detail. In addition, only the portion of the backlog that currently sits at the top must be completely prioritized, while the items deemed to be of lower priority do not require as much effort in their prioritization.

This of course means that there has to be some level of initial prioritization of the items so that the product owner is able to decide which items belong at the top of the backlog and should therefore be prioritized against one another to see what the most important items are. This is where something known as a product roadmap comes in. The product roadmap typically consists of a schedule for the release of the increments produced by the scrum team. The releases could be scheduled, for example quarterly, and each release should have a well-defined desired outcome against which progress can be measured. This release schedule stemming from the roadmap can then be utilized by the product owner to complete a preliminary round of prioritization as the increments that are going to be released next should obviously be of a higher priority, and therefore need a high effort prioritization process to determine the ranking order of each item within the next release (Rubin, 2012).

As is evident currently there are many solutions for backlog prioritization and as was mentioned by McGreal & Jocham (2018) there is no universal answer but rather each organization, and product owner, has to find a method that suits their particular needs through trial and error. As the identified research gap for this thesis is that currently there is no solution, with which both products and solutions can be scored in a systematic manner, using a wide range of parameters, the most prudent approach is to adopt the model presented by McGreal & Jocham (2018) where the cost or size, risks, dependencies, and business value are weighted.

The strength of the model is in that a wide variety of parameters can, and should, be considered for the measurement of business value. This of course requires the business value of each item to be translated into a single number. This can be achieved by creating a weighted scorecard that considers the relevant parameters and their significance in the decision-making process. Another strength of the model is that it can be integrated into the two-stage model discussed by Rubin (2012) where the items are first prioritized according to the roadmap and then the high effort accurate prioritization is carried out within the backlog items scheduled for the next release. This avoids the need for a resource heavy process in which the product owner has to go through each backlog item, which is an evident downside to such a model, and can only consider the internal order of the items deemed to be, by the roadmap, the priority for the next release. Further proof for the adoption of this model is provided in chapter 3.1 where the accounting for risk in the decision-making process is discussed.

2.5 Parameters for measuring the business value of backlog items

Schwartz (2016) describes the issues with attempting to capture the essence of business value. As business value is a complicated concept to approach, a multitude of parameters measuring the vision, stakeholder interests, and other sometimes unquantifiable measures of value must be weighed against one another to create a holistic view of what business value means in each particular context. In fact, Schwartz (2016) goes as far as to say that each organization must discover what business value means in their context. In this chapter a way to capture business value stemming from the principles of agile is discussed in order to create an overview of the various aspects that could be considered.

As discussed in Chapter 2.3 Charlesworth (2013) emphasizes the use of the objectives hierarchy tool to decide the attributes that should be scored. Schuh et. al. (2018) list sixteen metrics and whether a company should maximize or minimize their performance on these metrics to successfully apply agile principles into practice. The metrics companies should maximize their performance on are customer satisfaction, target orientation,

profitability, productivity, reaction rate, relation to reality, motivation of people, organizational knowledge, local knowledge, share of knowledge, and personal independency. The metrics Schuh et. al. (2018) believe agile organizations should minimize their performance on are complexity, uncertainty, misdeterminations, execution errors, and overload of people.

These sixteen metrics were derived from the agile manifesto and act similar to fundamental objectives in the objectives hierarchy tool when the primary objective is to be successful in the application of agile into practice. Below, in figure 2, is an expression of these objectives in the objectives hierarchy. As can be seen from the figure the list of things to consider is quite high. Many of the metrics also complement one another or act as antonyms for one another. And as Charlesworth (2013) cautions against using an overly complicated process for decision analysis, some grouping of the metrics is in order. Also, as can be seen, means objectives are not presented in the figure. In chapter 3.1 decision analysis as a field of study is discussed in further detail and there the justification for leaving them out is presented.

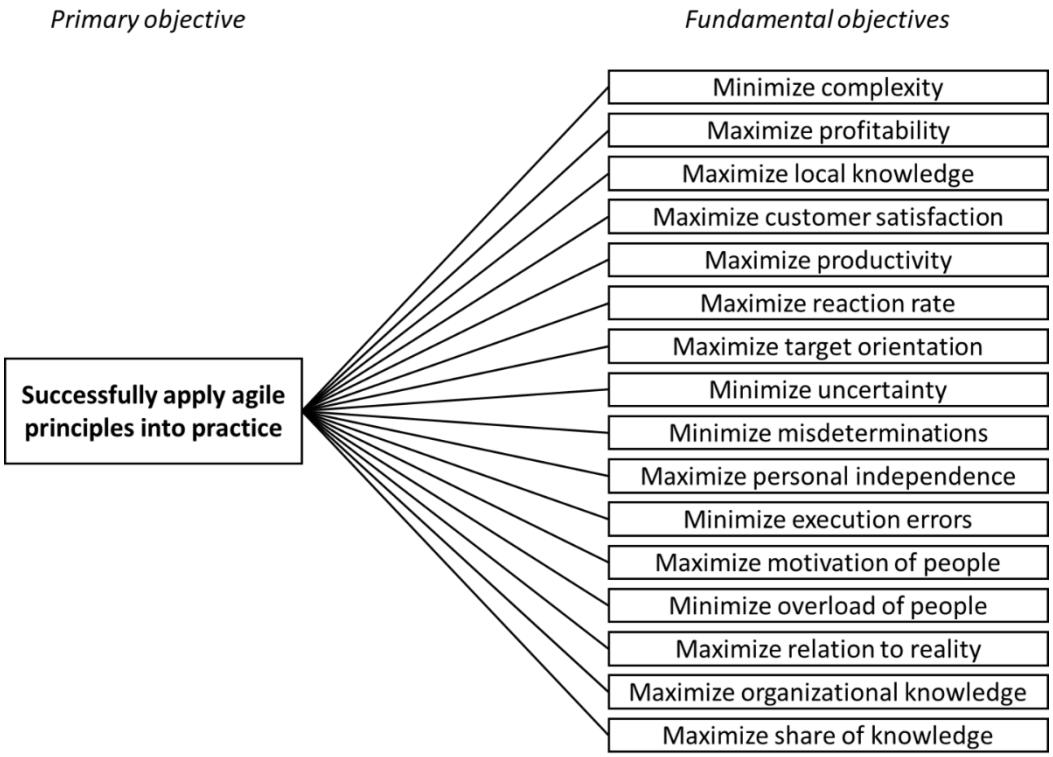

Figure 2 Objectives hierarchy for agile principles (Source: the author).

As discussed in chapter 2.1.1 manufacturing companies can avoid the resource heavy and difficult process of getting prototypes into the hands of their stakeholders for feedback by adopting what Cooper & Sommer (2018) refer to as protocepts or pretotypes. These items and their prioritization are also something that should be considered as through the process of prototyping costly redesign efforts later in the development process may be avoided (Schuch et. al. 2017). This ties into the idea of removing uncertainty and misdeterminations as well as generating organizational and local knowledge being relevant for measuring the business value of backlog items as mentioned above. This also ensures that the items that are experimental but do not necessarily have any other apparent reward are appropriately accounted for in the prioritization. Another reason for the necessity for their inclusion into the product backlog comes from the definitions of different classifications for items in the backlog. Classifications such as knowledge acquisition in the classifications presented by Rubin (2012) or spikes in the classifications presented by Lacey (2015). Since generating new organizational and local knowledge and sharing it, increasing a products relation to reality, removing uncertainty as well as

avoiding misdeterminations, are essentially all components of the same thing, they can be bundled into one group of measures the term knowledge acquisition accurately depicts. Therefore, when evaluating the business value of backlog items, it is relevant to measure knowledge acquisition.

McGreal & Jocham (2018) discuss three Vs: vision, value, and validation, which are essential for successful product ownership. Out of these value and vision align with the metrics of customer satisfaction and target orientation presented by Schuh et. al. (2018) respectively. As mentioned in chapter 2.2 value in this context is defined by McGreal & Jocham (2018) to be a measure of what the customer ultimately wants and as such it is almost identical with the definition of customer satisfaction by the American Society for Quality (n.d.) who state that to satisfy customers a company has to find out what the customer actually wants. But as these parameters are ultimately needed to evaluate the business value of the items the name customer satisfaction, bolstered by the definition of value by McGreal & Jocham (2018), should be utilized to avoid confusion.

Vision on the other hand according to McGreal & Jocham (2018) is what acts as a guideline for all development activities and as such acts similar to the metric of target orientation. While the measures presented for measuring this vision by McGreal & Jocham (2018) are not relevant for measuring target orientation, what is relevant is that it should be evident that all the items in the backlog are oriented towards a common goal. Rubin (2012) explains that this vision should also be reflected in the product roadmap, and as such an appropriate definition for measuring target orientation would be to measure whether or not the product backlog accurately reflects the product roadmap, which has been formed based on the product vision. The measure of reaction rate mentioned by Schuh et. al. (2018) is also related to the measurement of target orientation and vision. This is due to the fact that by maximizing the reaction rate a company may ensure that the roadmap accurately depicts the market at any given moment by swiftly reacting to changes in it. In terms of the parameters associated with target orientation, a way to

introduce reaction rate into the mix would be by measuring how well the targets meet the demands of the market.

Backlog items classified as defects were discussed by both McGreal & Jocham (2018) as well as Rubin (2012). While the definitions slightly differ the overarching idea is that defects are unintended issues, which have emerged from a previous release. Lacey (2015) also proposes the addition of bugs or outages into the product backlog which fall into the same category of activities. This definition and the metric of minimizing execution errors discussed by Schuh et. al. (2018) mean that when evaluating the business value of backlog items, it is important to consider that sometimes even with the necessary levels of knowledge, errors happen in the execution of items. This importance is caused by the fact that these errors can be detrimental to customer satisfaction and therefore business value. This is similar to the cost of delay, which acts as a financial measurement.

Measuring the maximization of profitability is slightly different in the context of backlog items. According to Schwartz (2016) the product owner should only be focused on the profitability of the particular item when evaluating their priority. Schwartz (2016) continues by stating that the measure of ROI, or return of investment, is the most commonly used to measure the profitability for backlog items. But as ROI typically weighs the profits against the costs of an item, when applying the model of McGreal & Jocham (2018) where business value and risks are weighed against costs, other alternatives must be used. Some alternatives to ROI mentioned by Schwartz (2016) are net present value, or NPV, profitability index, internal rate of return, and payback period. Each of the aforementioned are common financial indicators used in business and act as examples of the tools available for product owners and organizations to choose from. What is evident is that some kind of measurement of the profits gained by completing each item in the backlog is necessary for their effective prioritization as without it the backlog would not meet the requirement of maximizing the profitability discussed by Schuh et. al. (2018). However, Schwartz (2016) also mentions that these financial evaluations should not be held above everything else as prioritization parameters and that they only have a limited

usefulness for product owners in their decision-making process. One alternative Schwartz (2016) presents is the cost of delay. The cost of delay measures the financial impact of not completing an item as soon as possible and captures the idea behind the use of the ROI but as a negative figure instead of a positive one.

Complexity can be understood to refer to multiple aspects of business. In this context to understand how to measure if a backlog item reduces complexity, it is easier to turn the problem upside-down and attempt to understand how to measure if an item adds to simplicity. But as Bodell (2016) points out it is very difficult to understand what adding simplicity truly means. Bodell (2016) presents a definition for something that is truly simplified as something that is minimal, understandable, repeatable, and accessible. With minimal Bodell (2016) refers to something that is stripped of all unnecessary features but is still capable of meeting its requirements. With the term understandable Bodell (2016) refers to something that a person who is not an expert in the matter can understand and points out that understandability is likely to also increase trust among the customers. According to Bodell (2016) when something is repeatable it is easily scalable, modifiable, and replicable. This means that the user does not have to learn how to use a system from the start each time a feature is added, or a modification is made. Accessibility is increased when barriers of entry are removed. In other words, adding transparency and availability increases accessibility (Bodell, 2016). If then a product, system or service has large amounts of complexity it might not be minimal, which means it has features it does not need, which in turn affects profitability. Or it might not be understandable, repeatable, or accessible, all of which can lead to the deterioration of customer satisfaction. What this means in the context of business value parameters of product backlog items is then that there is a need to evaluate the items on whether they add to or subtract from complexity. These parameters could be introduced under customer satisfaction and profitability as discussed above, or they could be kept as a separate entity that factors into the calculation of the business value of a product backlog item.

Regulatory compliance is one aspect that should be considered in the process of prioritizing backlog items even if it does not affect business value directly. Lacey (2015) discussed items such as these and called them taxes. These items could include the likes of acquiring a specific certification or modifying the system to suit changes in regulations. Items that are necessitated by stakeholders and as such are mandatory for the team to complete, but that do not necessarily create any form of apparent business value (Lacey, 2015). In the model presented by McGreal & Jocham (2018) they discussed the use of dependencies as an element of prioritization. Listing all the items that depend on the completion of these so-called taxes as being dependent on their completion is one way to ensure that these tax items are appropriately prioritized.

The motivation of people, personal independence, and the overload of people are all measures mentioned by Schuh et. al. (2018) that an organization should measure their performance on, to be successful in their application of agile. As these measures are focused on the people and the organization applying the principles and do not directly affect the business value of a backlog item, introducing them as parameters seems at first futile. There is, however, a case to be made for the introduction of employee satisfaction as a factor to consider because as Wangenheim et. al. (2007) mention employee morale and satisfaction are correlated with customer satisfaction even in positions where there is no direct interaction with the employees and customers. Furthermore, Bellet et. al. (2019) found that there is a direct link between employee satisfaction and productivity. They concluded that happy employees are 13% more productive than unhappy ones. Due to this it would be beneficial to consider employee satisfaction when prioritizing the product backlog either as its own entity or as a part of customer satisfaction.

As stated, the decision analysis method should be kept as simple as possible and so the fundamental objectives presented in figure 2 should be formed into groups. These groups take the form of the parameters presented above. This is simply one way to achieve the simplification of the metrics listed by Schuh et. al. (2018). A revised

objectives hierarchy with the completed grouping can be seen below in figure 3. In this figure the fundamental objectives of figure 2 have been replaced with the tentative grouping discussed in this chapter. As was discussed earlier in this chapter, the means objectives are not discussed in further detail as they should not be included in the decision-making process for reasons explained in chapter 3.1. This exclusion, however, only extends to cases where the objectives listed in figure 3 are used to calculate value with a mathematical function. This means that organizations are free to explore the fundamental objectives listed in figure 3 and find means objectives to guide their day-to-day activities in case they were to apply this set of parameters outside of the scope of a backlog item prioritization decision-making process.

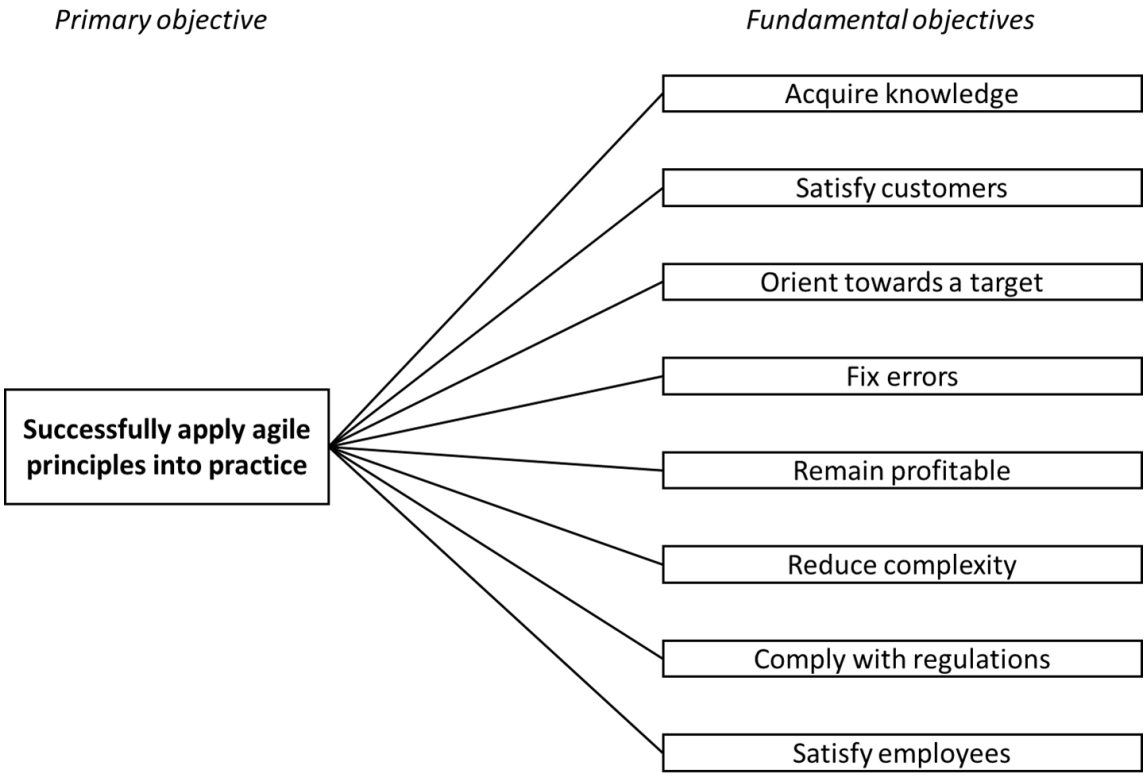

Figure 3 Simplified objectives hierarchy (Source: the author).

Through the use of the aforementioned parameters in the prioritization process of product backlog items, a company applying agile principles should in theory be able to maximize or minimize their performance on the measures described by Schuh et. al. (2018).

And by doing so the company should be successful in their application of the principles of agile. They would also be taking into account the vision, stakeholder interests, and other both quantifiable and unquantifiable measures of value thus generating a description of business value for each product backlog item. The exact metrics used in the process to measure these parameters, as well as the inclusion or exclusion of these parameters, should be considered on a case-by-case basis, because as was discussed in the beginning of this chapter Schwartz (2016) describes business value as being contextual.

2.6 Summary of the reviewed literature and identified gaps

To summarize, the findings of this literature review are that the agile principles place certain requirements on product owners working in the manufacturing sector, the role of a product owner requires certain characteristics and approaches to be used by the individual to be successful in their role, and decision-making processes in scenarios where multiple aspects must be weighed against one another require a specific approach. Also, while many models exist for product backlog prioritization, the one by McGreal & Jocham (2018) works better in the context of this decision-making problem than the other common models and should therefore be favored. Furthermore, this model should be utilized in conjunction with the ideas by Rubin (2012). An approach for generating a list of parameters that could be used for measuring business value was used to create a wide-ranging definition of business value that captures the essentials of finding success with the agile approach.

The research gap presented in chapter 1.1 was that there is currently no systematic method of prioritization that is guided by strategy, and that approaches business value from a wide perspective that includes a variety of different aspects. This gap is therefore partially filled by the findings of this literature review. By utilizing the approaches detailed in chapters 2.3, 2.4, and 2.5 under the assumptions of what are the necessary aspects of a successful product owner detailed in chapter 2.2 and supported by the

discussions of the constraints caused by physical products detailed in chapter 2.1.1 a theoretical method for prioritizing the product backlog can be created.

However, as the method is entirely based on theory, research into its validity was necessary in order to modify it in a way that better suits reality. The methods used for this research and its findings are presented in chapters 3 and 4. For this portion of the thesis the gaps in research could then be formulated as a three-pronged approach for Validate the prioritization method and adjusting it where necessary. These three prongs are formed as follows:

- There is a need for an understanding of how prioritization works in day-to-day practice.

- There is a need for an understanding of how business value, strategy, and the constraints of physicality might affect the prioritization process.

- There is a need for an understanding of how the proposed method and its components are viewed by industry professionals.

3 Research methods

This chapter discusses the methods utilized to conduct research into the topic. An overview of the selected research method and the justification for utilizing it is presented together with an overview of the methods for data collection and analysis. The research is normative, meaning it focuses on how things should be in the future, and theoretical in nature. It also aims to support managers in their decision-making process and so decision support methods were chosen. The decision support methods primarily apply for the creation of the first draft of the prioritization process that then in accordance with the grounded theory method was validated and improved to better suit reality. Below in figure 4 the process of conducting research and which method relates to which step of the process can be seen.

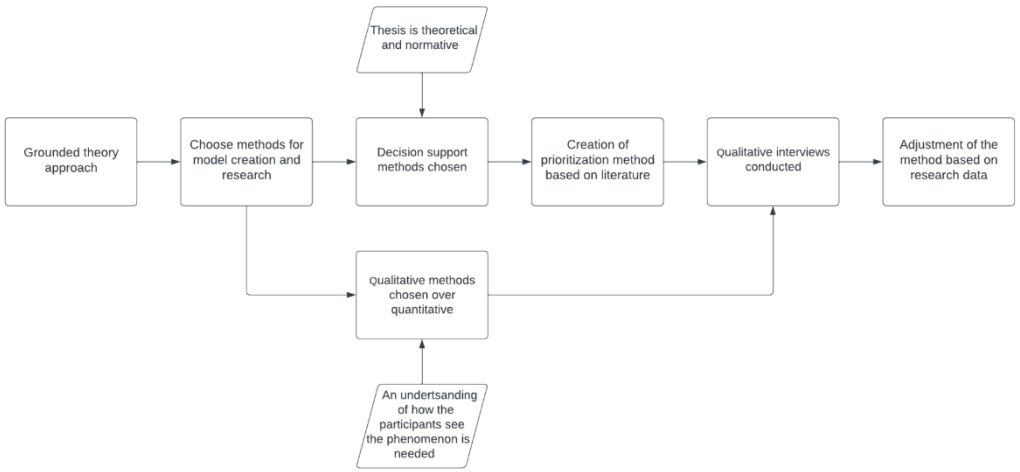

Figure 4 A flowchart of the research process (Source: the author).

In the figure the steps taken in the process as well as some of the inputs that influenced the methodology decisions can be seen. The methods themselves are discussed in further detail in chapters 3.2, 3.3, and 3.4. The grounded theory approach is a form of qualitative research and is based on a theory emerging from data that in the case of this thesis was the literary material presented in chapter 2. The approach and the reasoning behind its choice are discussed in further detail in chapters 3.1 and 3.3. The figure also

explains what the decision support methods were used for and how the theory-based method was adjusted based on the results of qualitative interviews.

3.1 Current challenges at the company

The questions faced by the Smart Power division of ABB in relation to product backlog prioritization align with the research gap identified in chapter 2.6. The division switched to utilizing scrum in its portfolio and product development and during the transition the responsibilities of certain teams were restructured. The transition caused a need for a prioritization method that the product owners could use to weigh product, system, and service development related backlog items on an objective scale.

The method should allow for the measurement of a wide variety of relevant parameters in order to acknowledge that items may not always have an immediately apparent financial benefit associated with them. The thesis was commissioned with the objective of generating a theoretical method for prioritization that would accomplish this purpose.

As the switch was made less than a year before this research was conducted it was the opinion of the company that the solution should be based almost entirely on available literature and then reviewed for applicability and usability through the opinions and experiences of the product owners rather than being built around the experiences and opinions of the product owners and only then cross-checked for theoretical support. This decision was made due to there being a need for a theory-based robust support framework for the prioritization process rather than a summarization of the existing views and assumptions of the product owners within the organization. Due to this the initial draft of the method was built from the findings from literature on decision-support methods and product ownership.

3.2 Decision support methods

Decision support methods cover a wide range of approaches for systematically aiding people in the decision-making process. One of these approaches is decision analysis. The objectives hierarchy presented by Charlesworth (2013) is an example of decision analysis in practice. Charlesworth (2013) explains that decision analysis is important in situations where there is ambiguity around the objectives that a team or an individual wants to reach, and where uncertainty is a factor. Decision analysis helps in clarifying objectives and removing uncertainty in decision-making. Charlesworth (2013) does however point out that good decisions do not always guarantee good outcomes as luck is always a factor in business, instead good decisions improve the odds of attaining good outcomes. These good decisions according to Charlesworth (2013) are also directly correlated with good financial results in business.

The objectives hierarchy is a widely used tool in decision analysis with regards to cases where there are multiple objectives. Parnell et. al. (2013, pp. 47–62) describe the types of objectives in the hierarchy in further detail. The fundamental objectives are the ultimate goals a decision-maker wants to reach in order to fulfill the primary objective, whereas the means objectives are only valued as they contribute to reaching the fundamental objectives. Parnell et. al. (2013, pp. 47–62) also note that in multiple objective decision analysis it is best practice to leave the means objectives out of the equation to simplify it and to ensure there is no double counting of value. This exclusion of the means objectives only applies in cases where the fundamental objectives act as parameters for a mathematical calculation of value, which is the case in this thesis (Parnell et. al., 2013, pp. 47–62). This acts as the justification to leave the evaluation of means objectives out of the decision-making process for product backlog item prioritization presented in this thesis.

As for the models for backlog prioritization presented in chapter 2.4, only one of them assesses risk. As Parnell et. al. (2013 pp. 47–62) explain, one of the ways to divide decision analysis models is to assess whether they assess risk as a separate entity or together

with the different metrics of value. This is illustrated below in figure 5. In the figure we can see two alternatives. In alternative 1 the performance scores of multiple objectives being combined into one single value metric through the decision makers trade-off preferences before weighing against the risk to create an output of a utility function. In alternative 2 everything is combined at once into a single utility function. Parnell et. al. (2013, pp. 47–62) discuss these approaches and claim that most decision analysis models utilize the first approach as it is far easier to implement. Therefore, a prioritization model that assesses risk as a separate entity should be favored. One of these models is the four-dimensional model presented by McGreal & Jocham (2018).

The reasons presented in this chapter, as well as the reasons presented in chapters 2.3, 2.4, and 2.5 where the aspects of the prioritization method were discussed, act as the justification for the selected approach. The approach consists of utilizing a weighted scorecard for the measurement of the business value parameters identified by utilizing the objectives hierarchy tool, and then calculating the rank score of the items with the four-dimensional model of McGreal & Jocham (2018). The approach was specifically selected for the high effort prioritization that the backlog items the two-stage prioritization model of Rubin (2012) dictates. This approach is in line with the ideas discussed by Charlesworth (2013) and Parnell et. al. (2013, pp. 47–62) regarding the simplification and systematization of decision-making in scenarios where the decision-maker attempts to reach multiple objectives simultaneously.

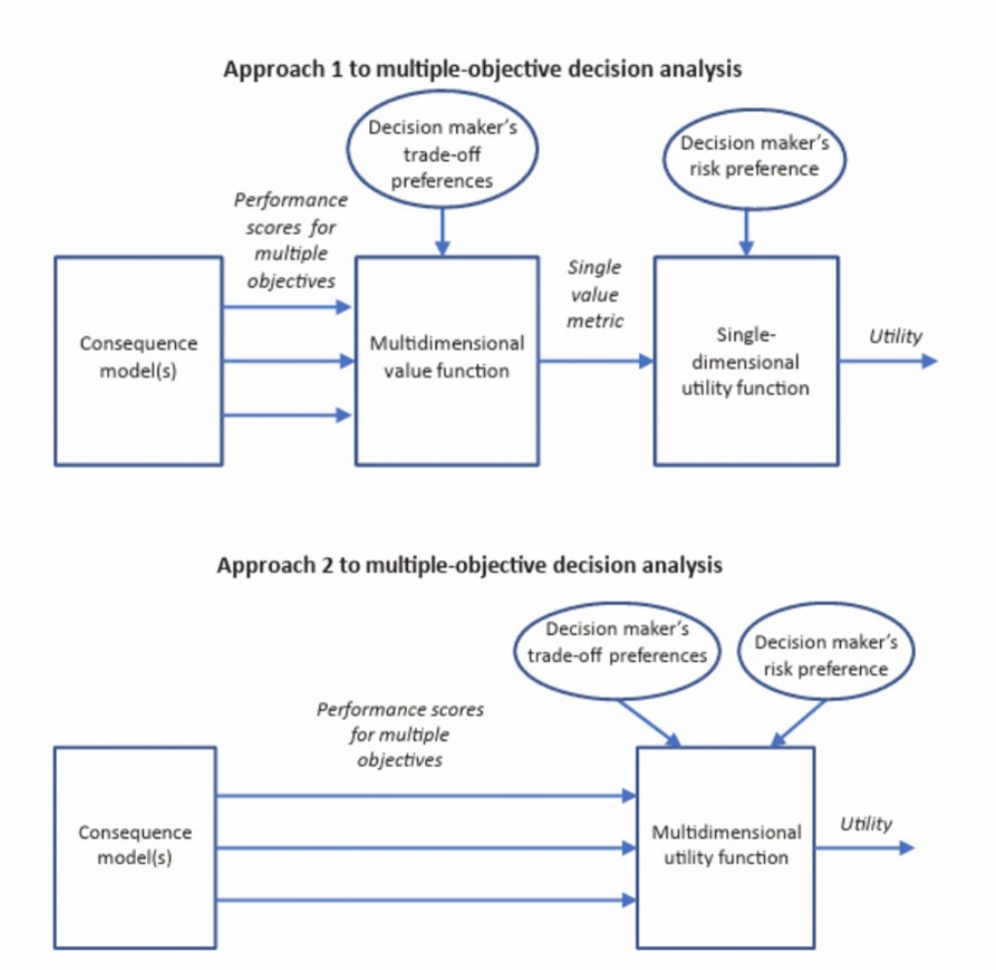

Figure 5 Two approaches to multiple objective decision analysis (Parnell et. al. 2013, pp. 59).

3.3 Qualitative research

The purpose of conducting qualitative research is to understand the subjective experiences of people. As Merriam et. al. (2015) mention the purpose of qualitative research is to understand how the participants of the research see the studied phenomenon in their individual context. The reason for choosing qualitative methods over quantitative comes from the definition of business value as contextual, meaning it varies from one context to the next, so a qualitative understanding of how its definition varies in each context is needed. Additionally, as expressed in chapter 2.2 McGreal & Jocham (2018) and Due Kadenic et. al. (2023) believe that each product owner has to find approaches

that work for them specifically rather than utilizing universally applicable tools. This means that the prioritization method must allow context-based modifications. For the method to account for these, an understanding of how different product owners view the key aspects of the proposed method in their contexts is necessary.

The purpose of this thesis is to create a theoretical look into how backlog prioritization could be completed and so the approach of grounded theory is the most appropriate for carrying out the qualitative research. Grossoehme (2015) states that in cases where there is no existing hypothesis that could be tested the grounded theory approach should be favored. It is clear that in the case of this thesis no prior method such as the one this thesis proposes existed prior. The end product of grounded theory should be a substantive theory, meaning a theory that includes specificity so that it may be applied into practice (Merriam et. al., 2015). This specificity of course creates a limitation to the applicability of the theory as it can only be applied in specific contexts rather than generally.

3.4 Data collection and analysis

In qualitative research the researcher is the primary instrument for data collection and analysis. The process of carrying out grounded theory research is for the researcher to start gathering data from available sources and to choose what data is needed to develop the theory further as it starts to emerge from the data (Merriam et. al., 2015). Grossoehme (2015) states that the nature of grounded theory research dictates that the sample size should be defined so that saturation is reached. This means that the sample size should be limited so that the researcher can be convinced that by utilizing a larger sample size no new information would be learned.

Seven product owners were chosen as participants as an understanding of backlog prioritization in their specific context and the possibility of applying the emerging theory into their context was needed. These product owners were all employed by ABB at the

time of the interviews and while their professional backgrounds vary, they had the same amount of experience in the role of product owner at the company. It is also important to note that the amount of products, services, and systems being developed by the team of each product owner varied with some product owners mainly focusing on one or two of them depending on their context. The choice of participants was limited to seven due to there being seven agile teams, and therefore product owners, within the relevant chapter of the specific agile unit to which the question of broadening the view of business value in product backlog prioritization was relevant. While more product owners are employed by the division, their product backlogs mainly concern the development of products, and all of them have the same amount of experience in the role as the participants. This is why the decision was made that by increasing the sample size no new information would be learned, and so saturation would be reached with a small sample size. A summarization of the participants can be seen below in table 3. In the table information on the interviews and the participants can be seen.

Participant	Main responsibility of team:	Other responsibilities:	Time of interview
A	System development	Service development	12/23
B	Product development	Product care, Service development	12/23
C	Product development	Product care	12/23
D	Product development	Product care, Service development	1/24
E	System development	Product development, Product care, Service Development	1/24
F	System development	Service development	1/24
G	System development	Service development	2/24

Table 3 Information on the interviews.

The interviews took the form of semi-structured, approximately hour-long, one-on-one discussions with each product owner that also included time reserved to discuss the method for backlog prioritization emerging from the literature. The reasoning for the use of the semi-structured approach is based on the fact that the semi-structured approach allows for in-depth answers from the participants on their experiences. This aligns with the thoughts of Galletta et. al. (2013, pp. 47–57) who state that a semi-

structured interview should contain open-ended questions the participants can answer freely allowing for the researcher to delve more deeply into the subjects the participants discuss. The interviews should then move to more direct questions that aim to find qualitative data that more concretely supports the research. The proposed structure by Galletta et. al. (2013, pp. 47–57) also includes a third section where the participant is asked about their earlier statements to clarify them. This structure was followed in the conducted interviews.

The initial questions asked from the interviewees can be seen in appendix 1. However, most of the discussion was based on asking unscripted follow-up questions from the interviewees based on their answers to the initial questions. This was done in order to create a deeper understanding of their thoughts around the subjects. The participants were also asked whether they had any additional comments, questions or concerns, and certain statements were followed up on by the researcher to clarify certain statements.

One key aspect of the grounded theory approach is the data analysis. The data analysis is conducted using the constant comparative method in which the gathered data is grouped and analyzed based on similarities and differences to better understand what new information is needed to further define the theory (Merriam et. al., 2015). Grossoehme (2015) further states that the findings of the interviews should be analyzed in light of findings from literature and then gather feedback on the model from the participants.

As stated in the case of this thesis, the company wanted a solution stemming from theory, and as such, the findings of the literature review were used to create an initial draft of the prioritization method. However, during the interviews the participants were first asked about their thoughts on the subject matters per the identified gaps in research. These answers were then used to lead the discussions around the theoretical method. Even though all of the qualitative data was collected during the same session, the format proposed by Grossoehme (2015) was followed.

4 Results and analysis

In this chapter the results of the interviews are presented together with an analysis of the implications of the results. Furthermore, an analysis of the necessary adjustments and additions to the theoretical model, that emerged from the literature review, are discussed. These adjustments are also presented together with a description of the process for implementing the prioritization method in practice.

4.1 Results of the interviews

As stated, the interviews were carried out by discussing the current best practices in backlog prioritization and business value measurement with seven product owners employed by ABB. They were also asked to provide feedback on the prioritization method that emerged from literature.

4.1.1 Current methods used for backlog prioritization

The overall consensus amongst the interviewees was that the process of transitioning from waterfall to agile was still somewhat underway and that their agile teams were still mostly finishing legacy projects. What this means is that by the time of the interviews most of the interviewees had not yet put that much thought into their backlog prioritization processes. Some interviewees held recurring meetings with internal stakeholders to discuss the prioritization, others were evaluating big picture project priority and for the most part following an internal gate-model in project completion. Below in table 4 an overview of the data can be seen.

Theme:	Description:	Supporting quotes:
Common model usage	Models like MoSCoW or Kano were not used by the participants	"I have not used any methods such as these"

		"I have heard of them but do not use them"
Current methods	Mostly based on project level business case analysis	"Typically, I look at the business case" "We look at the business case and evaluate what suits our strategy best" "We meet with stakeholders to discuss priorities" “We try to follow market trends and initiatives in or prioritization” “We consider all these things (value, size, risks and dependencies) but do not use the model”
Common factors accounted for	Common: size and dependencies Less common: risks and business value	"We have a lot of external and internal commitments and have to work around them" "We have to look at the business case and evaluate how to deliver value as fast as possible" "We have to follow the critical path to avoid bottlenecks in development"
Considerations for the future	As legacy projects are finished new ways of prioritizing the backlog are needed	“Currently we have to work around handover projects from the old organization that are not agile” “Soon we will be able to prioritize items according to the mission and strategy of our team”

Table 4 Answers to the current state of prioritization.

As can be seen from the table none of the interviewees had utilized the MoSCoW or Kano methods for prioritization and only one had been doing a free form analysis that followed the model presented by McGreal & Jocham (2018) where the cost or size, risks, dependencies, and business value are considered. Most of the product owners covered one or more of these aspects when discussing how they prioritize their backlog. Out of them the most common factors to appear were the size of the items and possible

dependencies. The business value was mainly discussed at the project level but that is covered in more detail in chapter 4.1.2. The risk associated with items rarely appeared in the discussions and when it did it was approached more from a project level financial risk point of view rather than the business and technical risks associated with an increment point of view the model necessitates.

At the time of the interviews, most of the interviewees seemed to be at a point where the older projects being completed by the teams to ensure business continuity were starting to give way to new, more agile, projects. With these new agile centric projects more tailored to fulfill each agile team's mission, the interviewees were looking for new ways of approaching backlog prioritization.

4.1.2 Business value in backlog prioritization

As stated, the interviewees mainly used business value as a prioritization parameter at the project level but most of them did not use it at the backlog item level. This business value evaluation typically came in the form of a business case and was therefore focused primarily on the financial aspects of business value. Most of the participants did, however, note that this evaluation trickled down into item level evaluations. These answers can be seen in table 5 below.

Do you currently measure the business value of product backlog items?

Participant:	Answer:	Explanation:
A	Yes	Business case and financial metrics
B	Yes	Mainly typical financial metrics
C	Yes	No particular method, loose definition of business value and business case where applicable
D	Yes	Business case and financial metrics
E	Yes	Mainly typical financial metrics
F	No	Currently not measuring the value of individual items but did evaluate at project level
G	Yes	Business case and financial metrics

Table 5 Answers to business value measuring.

As the business value was primarily evaluated at the project level, the business value of the increments that make up these projects seemed to be something that was not systematically evaluated but more on the basis of gut feeling. What is important to note however is that on some level all of the product owners did use business value on some level when prioritizing their backlog.

As for the participant who answered that they do not currently measure business value of the backlog items, they too measured project level value. It is also important to note that even though their initial answer to the question was no later in the interview the participant did raise market visibility as something they did measure as a part of evaluating the business value of product backlog items.

4.1.3 Parameters currently used for business value measurement

As mentioned, when evaluating the business value of backlog items, the product owners mainly evaluated the financial metrics associated with the project the items were a part of as well as the overall business model. However, there were some aspects that were measured at the item level. These aspects can be seen presented in figure 6 below.

One aspect that was frequently raised as something that is evaluated when measuring the business value of backlog items was their urgency. This was raised as a contributing factor to ensuring business continuity through an evaluation of the cost of delay of the item.

On the topic of business continuity, another important factor raised was the necessity to push items related to projects started prior to the change to agile, above items more accurately reflecting the new objectives of the teams. This, however, seemed to be only a temporary problem in the minds of the interviewees as with time these projects are

set to be completed and replaced with new projects that more accurately reflect the new organization.

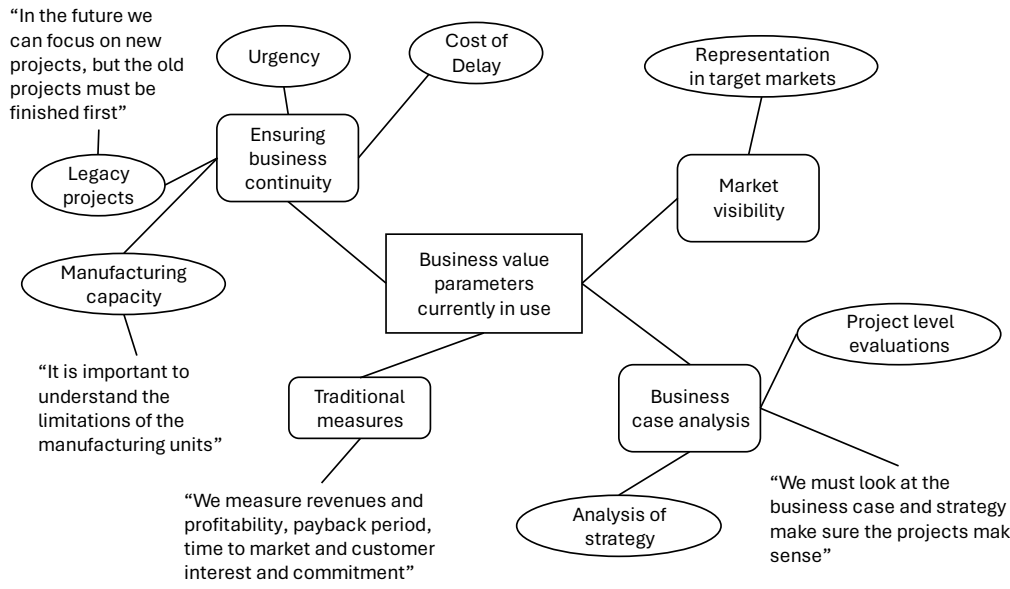

Figure 6 A mind map presenting the parameters currently used by the product owners (Source: the author).

The topic of manufacturing also came up during the discussions as something important for business continuity. Both increases in production capacity as well as fixing issues in the production were something that the product owners considered when evaluating the business value of backlog items. The latter of the two came up mainly as an aspect of the urgency of completing each item.

Market visibility was also mentioned primarily by one participant as something they utilized to evaluate the business value of items. Currently it was only used as a measurement of "Does this item allow us to be visible in a market we currently are not visible in?". Market visibility as a potential business value parameter is discussed in more detail in chapter 4.3.

The traditional measurements of value came up once again as something that is currently used. Out of them the most common factors mentioned were revenues and

profitability as well as the payback period of projects. Time to market and the levels of customer interest and commitment were also factors that were mentioned by one participant.

4.1.4 The effects of the current portfolio strategy development process on product backlog prioritization

Most of the participants at the time of the interviews were familiar with the internal portfolio strategy development process introduced when the organization shifted towards agile. This strategy creation process is geared towards the product owners and aims to systematize the process of defining the strategies for each agile team. Another output of the process is the roadmap for each individual product backlog. As this portfolio strategy development process was created for the product owners and is directly linked with the targets that should be measured in evaluating the target orientation of backlog items, feedback on it proved to be highly valuable.

Furthermore, aspects of the strategy creation process that should be considered in the prioritization were discussed, and the importance of certain steps of the process for the prioritization became apparent. Especially the steps of the process that produce deliverables essentially formulating the vision of the product owner, are essential for the prioritization process to function. The discussion also led to a better understanding of how the context of each backlog, in which the business value should be measured, is formed.

4.1.5 Constraints of physicality on product development

Some feedback was also gathered during the interviews regarding the challenges the product owners face because of scrum being applied in the development of physical products. Two constraints were raised by the product owners as issues during the interviews. These constraints can be seen in table 6 below.

Theme:	Description:	Supporting quotes:
Dependencies	Issues revolving around external commitments, and dependencies between items	"We are dependent on the work of other teams and cannot always do the things we want to" "We often have to account for the needs of other teams in our prioritization" "Testing facility times are limited and often are not scheduled far into the future" "We might have a commitment to deliver something to a customer and have to prioritize work related to that commitment" "When you are developing physical products often a certain order must be followed in development"
Expertise issues	Issues caused by the fact that each team member has a unique skillset	"If I have an electrical engineer and a mechanical engineer their skills are not necessarily transferrable" "We have to work around holidays, vacations and sick leaves and ensure that everyone is always working efficiently" "There should be avenues for different competencies to be accounted for in the prioritization" "We have to balance what our priorities are and what resources we have"

Table 6 Constraints of physicality discussed in the interviews.

The first issue was that there are many dependencies affecting the order in which the items must be completed. Some of these dependencies are internal, and usually revolve around certain product development activities needing to be completed before other activities can be started. Other dependencies are external and typically have to do with certain developmental work having been promised to a customer or another business function or simply with bottlenecks in testing facility availability.

The second issue raised in multiple interviews, was that all of the developers have different expertise in different fields and so while in an ideal world evaluating the relative importance of the backlog items would be enough, in reality strictly following the priority

list may not be possible. This is due to the fact that only certain members of the team might have the expertise necessary to carry out the highest priority items, but for the team to remain as efficient as possible everyone must be working on something all the time. An example of this constraint raised by one of the product owners was having a mechanical and an electrical engineer in the development team who obviously have very different skillsets and thus may not be able to complete items in each other's field of expertise. During the interviews, the latter of the two came up as something the product owners hoped would be solved in the application of the prioritization method.

4.1.6 Feedback on the proposed method for backlog prioritization

The method emerging from the literature review was presented to the product owners to receive feedback on it. This feedback was necessary for both validating the method and further improving it to suit the needs of the product owners. The model was presented in three parts. First, the division of the prioritization into parts in accordance with the ideas of Rubin (2012) was discussed. This was followed by a discussion of the four-dimensional model presented by McGreal & Jocham (2018). Last, the idea of business value being evaluated utilizing the parameters created on the basis of the analysis of the agile manifesto by Schuh et. al. (2018) was discussed.

The overall consensus over splitting the prioritization process into two was positive. Some product owners were already following a similar approach, and the participants currently not following the approach were open to the idea. One improvement suggestion raised during the discussions was the possibility to lift items from later releases to the top of the prioritized backlog. The addition and removal of items not present in the roadmap into the backlog was also discussed, as for some product owners urgent and unforeseen tasks appear regularly. The answers of each participant can be seen in table 7 below.

Do you see the process being split according to the schedule as something positive?

Participant:	Answer:	Explanation:
A	Yes	"I think as a theory it is valid as long as I would be able to move items ahead of schedule"
B	Yes	"I like this idea of splitting the process and already have something similar"
C	Yes	"Yes, I think it would be a good idea"
D	Yes	"I think the dependencies and constraints should be evaluated already during the first part of the process but otherwise it seems valid"
E	Yes	"I am concerned about slotting in unexpected items that my team gets a lot of but otherwise it seems good"
F	Yes	"I have been working on a process like this myself and like the idea of splitting the items into different buckets"
G	Yes	"I think it would work as long as we do not hold the prioritized order as a must and allow the developers to choose the items to work on each sprint"

Table 7 Opinions on a schedule-based division of items.

The discussions surrounding the four-dimensional model for backlog prioritization, presented by McGreal & Jocham (2018), were similarly positive. The interviewees accepted the model as a viable option for prioritization that included all the necessary aspects the participants felt should be evaluated. It is important to note that certain participants had initial doubts about the model until its use had been properly understood. These opinions are discussed in greater detail in figure 7 and the associated paragraph below.

The mathematical formula associated with the model was also discussed. When asked if the weight of the three aspects, cost or size, risk, and business value, should be the same in the decision-making process the answers were mixed. Some said that they should, others that they should not. These answers can be seen in table 8 below.

Furthermore, when looking at the formula and how it functions a few ideas for improvement appeared. One suggestion was to talk about the absence of risk instead of risk as giving a higher score to the variable resulted in a higher rank score, but the items with low risk should obviously be prioritized in cases where the other variables stay the same.

Another suggestion was to simply drop the risk below the fraction bar so that items with low risk could be awarded with a low score for risk and result in a higher rank score.

Do you think the variables should hold equal weight?

Participant:	Answer:	Explanation:
A	Yes	
B	No	Business value first, risk second, and cost/size third most important
C	Yes	
D	No	Business value should weigh more
E	Maybe	Hard to say
F	Maybe	Some people underestimate risk others overestimate, so it depends
G	Yes	

Table 8 Responses to the weights of the variables in the four-dimensional model.

In terms of the four aspects of the model, the dependencies were very important but relatively simple and self-explanatory in the opinion of all the participants, but the other aspects of the model yielded more discussions. Analyzing the cost or size was something the participants saw as not only quite difficult but also as being linked with the risk. Similarly, the risks were seen as somewhat difficult to estimate. Some participants raised the point that emphasizing the risks including both business risks and technical risks is important.

When discussing the use of business value in backlog prioritization most of the participants agreed on the idea of broadening the definition of business value to cover a multitude of aspects, both tangible and intangible, to better evaluate the business value of the small increments, that may not have an easily calculable financial return. The business value of the items should in the eyes of some participants hold more weight than the other aspects. The consensus was that the approach of utilizing a weighted scorecard best fits the purpose of evaluating business value for the model in a systematic manner. These opinions can be seen represented in figure 7 below.

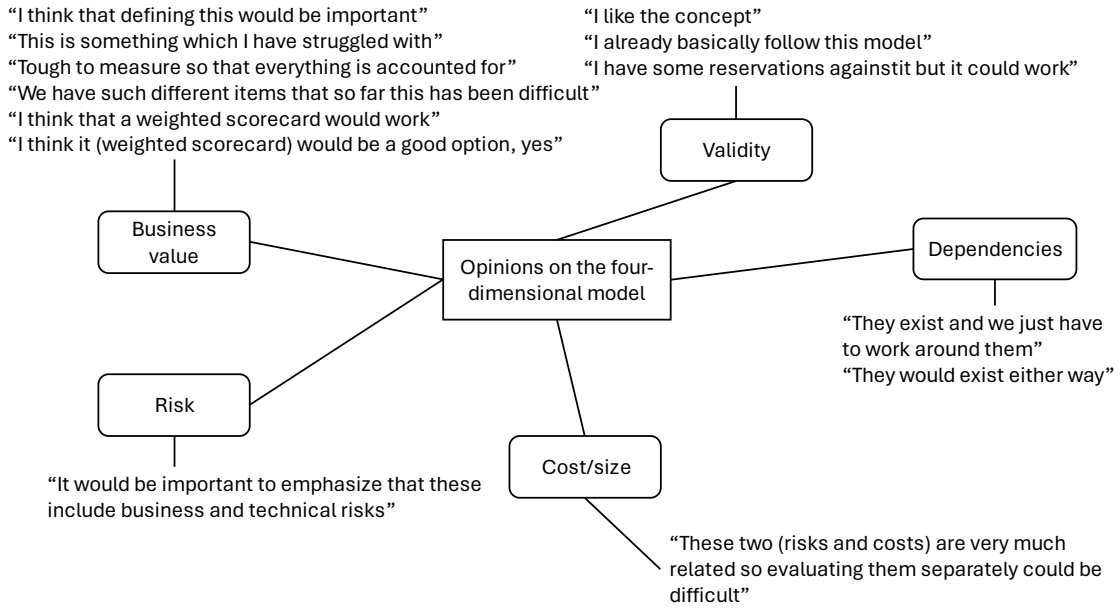

Figure 7 Opinions on the model of McGreal & Jocham (2018) (Source: the author).

In terms of the parameters to utilize for accomplishing the evaluation of the business value of the items, all of the participants were of the opinion that the list of parameters presented in chapter 2.5 did not include anything unnecessary and was quite comprehensive. The discussions did, however, result in a few additional parameters and other suggestions for improvement. Discussions around these parameters are presented in table 9 below.

Theme:	Description:	Support from interviews:
Existing parameters	The existing parameters were seen as something that largely captures the essence of business value	"I think these cover everything necessary" "I do not think that anything is missing" "At the moment nothing (more) comes to mind"
Additional parameters	Certain parameters were suggested to be added	"I think that process optimization is something that is also important" "Business continuity is something we have to always think about when evaluating value" "I think that market visibility should be added" "Business continuity is maybe missing"

Adjustments to existing parameters	Certain parameters were suggested to be modified	"We have team members who need to learn specific competencies so that is something that could also be evaluated here (as a part of knowledge acquisition)" "Maybe the name of this could be changes so that it takes process optimization into account" "The minimal part should be redundant if we have done everything right"
Relative importance	The results on the relative weights of the parameters were mixed	Everyone had a different view on what is the most and least important in the list of parameters presented when asked to rank them "Ranking these is very difficult" "What did the others say was the most important"
Use in practice	The use of these parameters in practice raised some concerns	"I fear that this might be too much work" "It might be better to choose the most relevant parameter(s) for each item" "I think the weights should fluctuate" "At the moment this is probably the most important for me but as the team matures it could become less important"

Table 9 Themes surrounding the proposed business value parameters.

One improvement suggestion regarded the name of the parameter meant to address items aimed at fixing errors. The proposed name for the parameter was process optimizing. Along with the new name the parameter should be broadened to include awarding points for items aiming to improve internal processes. Another suggestion for the name that arose from the interviews was error resolution. This name was seen as an accurate depiction of the items the parameter was aimed at giving points to.

Another suggestion that surfaced from the discussions was to introduce a parameter for measuring the effects an item has on market visibility, brand image, and the reputation of the company. Another parameter suggestion was to measure the value of ensuring business continuity. This parameter could help in instances where items that may not have much value outside of ensuring that the continuity of existing business is secured.

The results were mixed the comparative importance of these parameters. Each product owner had a different view on what the most and least important parameters are, and which parameters should have more weight as a result. This together with a comment made by one of the participants about the necessity for the weights to fluctuate over time, and the definition of business value as being contextual by Schwartz (2016), suggests that the relative weights of the parameters should be left up to the product owners so that the weights match their specific context.

Some additional comments made by the product owners in relation to these discussions were to address the issues around the constraints associated with the varying levels and areas of expertise within the teams. Somehow evaluating the spread of expertise and available resources in the prioritization model was suggested as a potential solution. Another suggestion was to evaluate the learning and expanding expertise of the team members under the parameter of knowledge acquisition into the model.

One additional comment made by a product owner during the interview was that while the list of parameters being comprehensive was positive, there may be too much for the product owner to consider with each item. And that instead the product owner should select a parameter, or a set of parameters, for each item matching the purpose the item is set to serve.

4.2 Evaluation of the validity of the method based on the results

The core concepts of the method proposed to the product owners seem to hold validity. These core concepts include dividing process in two, the strategic guidance of the process stemming from the roadmap, the use of the four-dimensional model of McGreal & Jocham (2018) for the high effort prioritization, and the use of a weighted scorecard for the evaluation of the business value of the backlog items.

In terms of the choice of a weighted scorecard to carry out the evaluation of the business value of a backlog item the product owners agreed. The reason why they thought that this approach was the best, was that by utilizing a weighted scorecard not only could they mold the relative weight of the parameters to suit their context, but they could also change it over time to adjust for changes in the market and even for the typical yearly cycles such as holiday periods.

4.3 Analysis of the improvement suggestions

There were multiple suggestions on how the method could be improved so that it accounts for some aspects the product owners were concerned about. Below in table 10 a summary of these suggestions can be seen. A brief overview of the analysis of the suggestion, how it could be implemented, and what positive effects that would have are also presented in the table.

Suggestion:	Analysis:	Implementation:	Potential positive effects:
Account for available resources and spread of expertise.	Important to account for but evaluations would create too much extra work into the process.	Best practice is to allow the developers to choose the work they complete each sprint, and to have the prioritized product backlog act as a suggestion rather than a must.	Shows business value perspective to the team members and eases the selection of work. Might encourage team members in expanding their expertise
Allow for the movement of items ahead of schedule.	The method allows the addition, removal, and moving of items. The low effort part of the process is key for this.	The method already allows manual changes by the product owner	Can help teams generate value faster by postponing items with low value and completing high-value items ahead of schedule
Accounting for addition of randomly appearing tasks into the backlog.	Certain teams have more of these than others. These items have varying levels of urgency and value.	Put these items through the same prioritization process as the other items whenever they appear to determine their priority	These items will naturally find their place in the priority. Will remove pressure to complete them immediately as the team can reflect on their priorities.
Choosing one or more parameters per item.	The idea would work best in scenarios where the company already uses a classification system for their product backlog items. In cases where one is not	If the organization or the product owner implements a classification system, then a parameter or a set of parameters could	Workload might be reduced, and the process might be more suited for certain product owners.

	followed the process would become less systematic and more reliant on intuition. The suggestion would reduce workload when evaluating business value but increase workload by adding another step into the process.	also be associated with certain types of items.	
Account for process optimizing.	Processes often can be optimized to reduce waste and therefore increase profitability, but it does not fit under the parameter of resolving errors.	Introducing it into the reduction of complexity under the criteria of minimalism would be easy.	Items aimed at optimizing processes would be accounted for in the prioritization process.
Ensuring production capacity is accounted for.	Ensuring that production capacity is accounted for in the prioritization seemed important to multiple participants so it should be accounted for in the prioritization.	The definition of reaching simplicity includes ensuring accessibility. This relates directly to production capacity issues.	Production capacity would be accounted for in the prioritization. This would ensure timely deliveries.

Table 10 Table of improvement suggestions and analysis on them.

In terms of the suggestion for evaluating the available resources and spread of expertise, the easiest way to approach minimizing waste caused by these issues would be to have the prioritized backlog act as a suggestion for the development team who in the end plan each sprint so that the right amount of work is completed. This is a common approach that ensures all team members are working efficiently and eliminates the need for a more complicated approach. This also ensures that each team member is free to work both on items matching their respective expertise, and items that challenge them and potentially develop their skills and knowledge. To further ensure the team members keep learning and expanding their capabilities, a product owner could introduce evaluations for skill acquisition under the knowledge acquisition parameters or even as a part of measuring the impact an item has on employee satisfaction.

The two-stage model presented by Rubin (2012), already includes the possibility to lift and drop items in the backlog as well as the possibility to add and remove items from the backlog, as these actions are necessary for the product owner to fulfill their role in

refining the backlog. By allowing for this fluidity the process better suits the continuous improvement idea at the heart of agile and allows the product owner to act as the primary driver of the development of their product. To ensure that the model for prioritization does not become too rigid and too heavily focused on the release schedule, it would be beneficial to add a step into the process that reminds the product owners to take a deeper look at the items of the next release to see if some items should be worked on already in the current release. As for the tasks appearing randomly, and needing to be taken care of urgently, by undergoing the same prioritization process as all the other items, they should end up at the right place in the product backlog.

As for the idea of choosing a parameter or a set number of parameters based on the purpose of the item for the evaluation of business value, the benefits for this approach in reducing the workload of the product owner in the process could not be entirely capitalized at the moment. The reason for this is that, as things stand, within the organization all the items introduced to the backlog are listed as user stories rather than by following one of the categorization models presented in chapter 2.1.2. If one of these models were to be followed, then choosing the parameter to evaluate the items by could be turned into a systematic process, reducing the workload of the product owner. At the moment, however, this suggestion would either lead to a mostly intuition-based prioritization system or a system where the same amount of work is needed regardless. However, the intuition-based approach could be beneficial in the low effort prioritization for the items in later releases.

As mentioned, there was a suggestion to take the act of process optimizing into account in the prioritization process. In chapter 2.5 the thoughts of Bodell (2016) regarding simplicity were discussed. Bodell (2016) defines simplicity as something that is, among other things, minimal. This minimality refers mainly to reducing unnecessary features to increase profitability. Therefore, there should be no issue in including process optimization into the prioritization process by simply expanding the definition of minimal to include reducing all waste to increase profitability. This would ensure that in case there is a

process that needs to be optimized, items aimed at meeting this goal would receive points in the prioritization. This would also simplify the selection of a name for the parameter aimed to give points to items that are needed to fix defects and other errors as there were only two suggested names for the parameter, process optimization and error resolution.

The suggestion of adding parameters aimed at evaluating business continuity when evaluating the business value of items is a good idea. This way a key concern shared among the product owners would be addressed. What this parameter could include is discussed later in chapter 4.4. However while ensuring adequate production capacity is clearly an aspect of it, increasing production capacity clearly relates to the idea of accessibility in Bodell's (2016) definition of reaching simplicity. Therefore, production-capacity increases could also be considered as a factor when evaluating the effect an item has on reducing complexity.

4.4 Gaps in the prioritization parameters

As stated, business continuity was seen as an important factor of business value by the product owners. This business continuity comprised finalizing existing projects, committing to new projects aimed at improving the reliability of the value creation processes such as the manufacturing lines, and those that aim to fix issues in these value creation processes. Therefore, evaluating whether a backlog item will have a positive or a negative impact on business continuity should be added into the list of fundamental objectives under the primary objective of successfully applying agile principles into practice.

In terms of what the product owner may look for when evaluating the effect an item has on business continuity, evaluating whether the item will have a negative or positive impact on business continuity could be enough. This way items that help improve business continuity through, for example, the creation of redundancy systems would receive points in the evaluation of business value.

Another aspect of business continuity is retaining the existing customer base and sales created through them. Customer acquisition according to Gallo (2014) is typically at least five times more expensive than customer retention. Furthermore, Reichheld (2001) estimates that a small increase in the percentage of retained customers can increase profits substantially. This is caused by customers typically tending to focus their business on reliable suppliers (Reichheld, 2001). This effect is closely related to the halo effect discussed in conjunction with market visibility in this chapter. The net promoter score according to Reichheld et. al. (2021) is a commonly used indicator for measuring the portion of customers who are so satisfied with their experience that they recommend it to others. Baehre et. al. (2022) found there to be a positive link between net promoter scores and future sales growth. Furthermore, Merlo et. al. (2014) mention that while a high level of customer participation often leads to positive returns, generating customer-to-customer promotion is also important for companies wishing to maximize the value gained from a single customer. Sustainability is also an aspect that could be considered under business continuity as according to Cohen et. al. (2015, pp. 4–8) sustainability is at its core all about finding continuous and efficient processes and is therefore a practical solution for managing organizations long-term.

In terms of finalizing the projects started before the organizational shift, as already mentioned, these projects are being completed to make more room for new projects. As time passes the strategies and objectives of each agile team will also become clearer and continue evolving. With these changes the projects that suit the new strategies and objectives will remain in the product backlog, while the ones that do not will either be modified accordingly or get removed from the product backlog. This means that each item should be considered an equal part of the product backlog, and therefore prioritized using the same process regardless of when it was started.

The two-stage process where the release schedule is followed should be enough to ensure the completion of these items, as long as these projects are accounted for in the

strategy of the agile teams. Furthermore, as the target orientation aspect of business value revolves around the vision of the product owner, as long as the vision of the product owner is to finalize the old projects in conjunction with new ones, the items related to legacy projects will not necessarily lose points in the business value evaluation process. This, however, is of course dependent on the strategy and vision of the product owner accounting for these legacy projects accurately.

Another aspect the product owners thought was important to evaluate was market visibility and perception. This encompassed everything from brand image and company reputation to simply being visible in the market. Brand image and company reputation have been widely studied and so their details are not discussed in detail. What is however important to note is that as Cretu & Brodie (2007) point out the brand image heavily influences the quality of products and services perceived by the customer and that company reputation affects the value the customers perceive as well as customer loyalty.

The reason why market visibility is important in this context is that if there is a market the product owner wishes to target but has no products or solutions for, it may be important to get something that can be communicated to that market done, as fast as possible, to become visible to the potential customers the product owner wants to target. This is to say that even if the final product or service is not finished the customer either gets something that they can begin using that will be iteratively improved or will get information in the form of a concept, prototype or document that will let them know that something is being developed. This way the company can begin creating a foothold in the market even if they are not ready to launch the solution they have created.

What this means for the process of evaluating the business value of product backlog items is that the visibility of the company in different markets and the reputation and brand image it holds should not be excluded. The three are very closely linked together because at the end of the day they all concern what the customer sees and as such they can be formed into a fundamental objective in the objectives hierarchy. The way to

evaluate this market visibility is to not only look at if the item makes the company visible in the market but also how the item affects the perception of the company's brand and reputation in the eyes of the customer. As the product owner should be focused on their specific context, evaluating the visibility of the company in the general market may not be effective. Instead, the product owner should evaluate the visibility the company has in the target markets of the product owner.

Other phenomena discussed in relation to market visibility were centered around the creation of additional sales for existing products and services with the launch of something new. The phenomenon included market expansion, cross-selling and the halo effect. These were discussed as especially beneficial to the teams who were focused on creating systems for specific customer segments. All three of these were seen as beneficial to account for when measuring business value, and as something related to the idea of increasing market visibility.

Market expansion is a growth strategy where a company offers existing products to a new market to generate additional revenues (Monash business school, 2023). Cross-selling according to Kapur (2023) refers to offering complementary products and services after the initial sale. Cross-selling creates a parallel revenue stream for the company while also delivering more value to the customer (Kapur, 2023). The third phenomenon discussed was the halo effect. The halo effect according to Psychology Today (2020) is a form of a cognitive bias where an initial positive judgement of a person affects the perception of the person as a whole. In business this cognitive bias can cause customers to positively view everything a company produces due to one positive experience with the products of the company (Psychology Today, 2020). According to Rosenzweig (2007) this phenomenon can also cause a negative halo to be cast on a company and its products in cases where the company has been unsuccessful.

As stated, these phenomena were discussed in the context of generating additional value by increasing market visibility and the brands image and reputation. By leveraging

these three phenomena effectively the product owner can turn something simple produced for a niche into something that will generate additional revenues for the company through the sale of other products and services. By considering these phenomena during the evaluation of the impact an item has on market visibility the product owner can then account for the additional value they provide.

4.5 Adjustments to the method based on the results

In this chapter the adjustments made to the prioritization method on the basis of the interview results are presented. The proposed prioritization method, the proposed parametrization of evaluating business value and a description of the process for implementing the proposed method are presented.

4.5.1 The proposed method for backlog prioritization

The proposed method consists of the following components. The two-stage prioritization model discussed by Rubin (2012), the high effort prioritization process, and the low effort prioritization process. The high effort prioritization process is based on the four-dimensional prioritization method of McGreal & Jocham (2018) and can be further divided into sub-components that are the analyses of risk, cost or size, dependencies, and business value, as well as the final calculation of the rank score of each item. The steps of the process are illustrated in figure 8 below. A more detailed description of what each step includes and how the method should be implemented is presented in chapter 4.5.3.

As stated, the process starts with a division into two stages in accordance with the writings of Rubin (2012). This model proposes the utilization of a roadmap to identify a schedule for projects to understand when certain items must be completed. The roadmap creation process is not discussed in detail in this thesis as the company that commissioned the thesis already has a working solution for roadmap creation, and thus

it was left outside the scope of this thesis. If this model is used by an organization that does not have a roadmap creation process, the important thing to remember about it is that it acts as the primary input for various levels of strategy into the prioritization process and as a visual representation of the product owner's vision for fulfilling strategic goals.

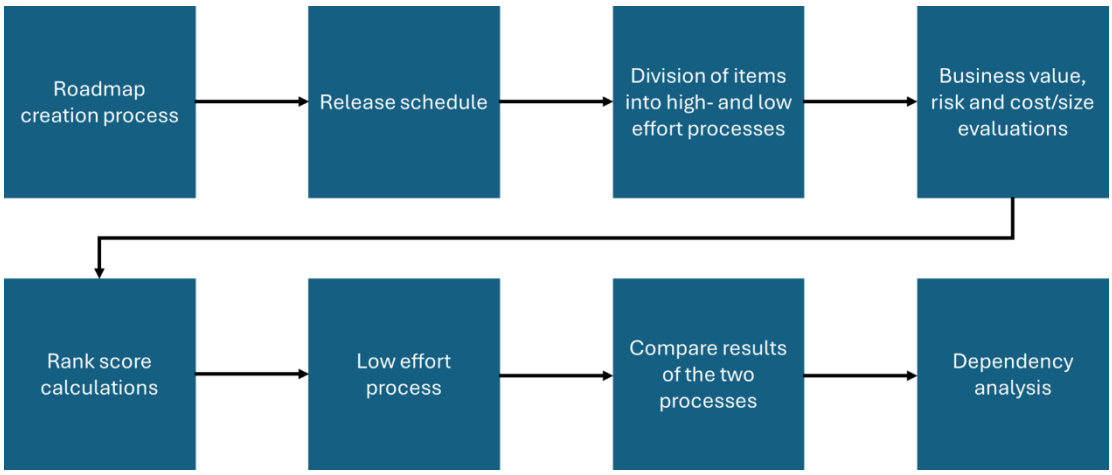

Figure 8 Steps of the proposed prioritization method (Source: the author).

It is the roadmap that guides the release schedule, which in turn decides which items are timing wise the most important and thus the roadmap acts as the tool dividing the items to those that must go through a higher effort prioritization process, those that must go through a lower effort prioritization process, and those that do not yet have to be considered in the prioritization process at all.

The items that are going to be completed for the next release should be prioritized using a high effort process. This process aims to seek the most valuable items so that they may be completed first. The proposed method for this is the model of McGreal & Jocham (2018). For the use of this model the product owner needs to consider four aspects. Both the risk and cost should be measured in relation to the other items, as their relative impacts on the business are what the model measures, so a scale such as 1-5 or 1-10 should be utilized. The cost or size of an item typically, but not always, refers to the amount of effort needed by the developers to complete it. As such the estimate for the

cost or size should typically come from the development team. Risk on the other hand refers to both technical and business risks in this context, but since the increments are small and often require very little resources the risks tend to be inherently low. Due to this, and the fact that for the use of the model only a crude estimate on a scale such as 1-10 is needed, there is no need to develop a high effort estimation procedure for it.

The third aspect the product owner needs for the calculation of the rank score of an item is an estimate of its business value. As discussed in chapter 2.5, business value is contextual and is made up of several tangible and intangible aspects. Charlesworth (2013) proposes that when estimating subjective measurements in a decision-making process the objectives hierarchy tool should be used for keeping the process simple and transparent. Parnell et. al. (2013, pp. 47–62) suggest that when using this tool to support mathematical calculations the process should be further simplified by eliminating the means objectives to ensure that certain aspects are not double-counted. The organization uses agile methodologies in its product development and as such the primary objective of successfully applying the agile principles into practice was selected. An analysis of the metrics that should be used to reach this objective, and how the measurement could be simplified, is presented in detail in chapter 2.5 and the objectives hierarchy updated to reflect the results of the interviews is presented in chapter 4.5.2.

This objectives hierarchy lists the objectives the organization attempts to reach in order to fulfil its primary objective and therefore they act as the aspects that should be measured when attempting to evaluate the value produced by an item to the organization. Parnell et. al. (2013, pp. 47–62) discuss this and state that a method where the performance scores are bound to one metric should be preferred. Scorecards are a way to accomplish this, and they are discussed in chapter 2.3. To accommodate changes in the market and the contextual nature of business value the weighted scorecard approach should be preferred.

The last aspect to consider in the model proposed for the high effort prioritization process are dependencies. It is evident that in some cases certain items simply cannot be completed before others, and that this is an aspect that has to be considered in the process. Dependencies are also a bigger issue in cases where the company produces physical products based on the interview results. Aside from evaluating whether they exist and where, and adjusting the prioritization accordingly, there is very little that can be done. Due to this, while the dependencies must be reflected in the final prioritized backlog they do not act as a component of the rank score calculation, and should therefore be introduced into the prioritization of the product backlog through manual adjustment by the product owner.

To evaluate the interdependence of different backlog items, dependency analysis should be conducted. Decaprio (2006) describes the purpose of dependency analysis as a way of finding relationships between the execution of an activity and other activities and events. The goal of dependency analysis is to create an understanding of the interdependence of activities and events as well as understanding how resource constraints affect the execution of activities (Decaprio, 2006). This dependency analysis then suits the purposes of understanding the dependencies of backlog items and how these interdependencies of items should affect the prioritization of items.

As for the calculation of the rank score of the items prioritized using the high effort process, a simple formula is proposed by McGreal & Jocham (2018). In this formula the sum of the business value and risk scores of an item should be divided by the size or cost score of the item. As was discussed in chapter 4.1.6 of the thesis this formula did not receive universal validation, and several ways to modify it were proposed by the interviewees. Talking about the absence of risk instead of risk, valuing the variables differently and more were discussed in the interviews. The changes were not drastic however, and so while modifications to the formula might be necessary depending on the context, the formula acts as a good starting point. It therefore seems that the decision for the final formula used in the calculation should be left up to the individual and approached

empirically. As long as the formula measures all three variables and results in a single output, it can be used to order the items accordingly.

As for the items that are not so critical from a timing perspective as they are not part of the next release, a lower effort method for prioritization should be used. Some commonly used methods like MoSCoW and Kano are discussed in chapter 2.4. Whichever method is used for this should be left up to the individual as the goal of the process is to produce an initial estimate while being lower in effort. This means that the process will rely on the expertise and intuition of the individual so it too should be approached empirically and adjusted as appropriate. In chapter 2.2 the essentials of successful product ownership are discussed, and the findings of the chapter could act as the starting point for the empirical process of defining the low effort prioritization the product owner wants to use.

4.5.2 Proposed parameterization for measuring business value

As stated in chapter 2.5 the basis for generating the set of parameters to measure business value with was initially conducted using the objectives hierarchy approach where the fundamental objectives, in accordance with the ideas of Parnell et. al. (2013, pp. 47–62), act as the aspects that are measured. But as stated in chapter 4.4 based on the interviews two additional aspects of business value should be added to the fundamental objectives. These additional aspects to measure are business continuity and market visibility. Below in figure 9 an updated objectives hierarchy can be seen. In this figure the two additional aspects of business value have been formed into fundamental objectives under the same primary objective of successfully applying agile principles into practice.

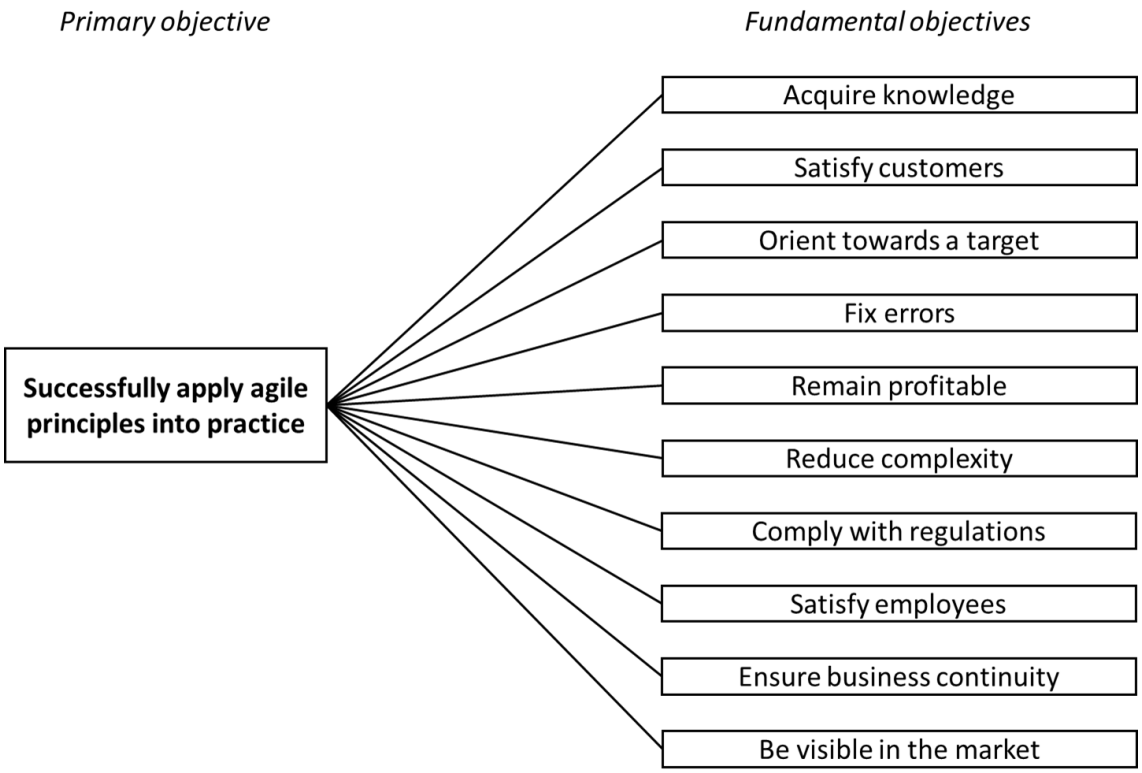

Figure 9 Updated objectives hierarchy (Source: the author).

4.5.3 Process description for the implementation of the proposed model

The process of carrying out the prioritization is described in figure 10 below. In the figure the process is described in the form of a process flowchart. As discussed, the prioritization process begins with an evaluation of the release schedule. This can be attained by creating a roadmap. The release schedule should act as the basis for completing the first stage of the prioritization. During this stage, the product backlog items should be ordered based on when each item should be completed for the projects to stay on schedule. The roadmap creation itself is not discussed further for the reasons discussed in chapter 4.5.1.

After this initial ordering of the items is complete, the product owner should select items that will undergo a high effort prioritization process, the items that will undergo basic lower effort prioritization and the items that will not be prioritized for the time being. As

discussed, the basis for this division should be the release schedule. In practice this means that the items at the top after the initial ordering should be prioritized using the high effort process, the items more towards the middle using the lower effort process and the ones towards the bottom should not yet be touched. This is described in the flowchart by a fork in the process. And as is described in the flowchart, this will produce two outputs that will be carried on further in the process.

The right side of the process concerns the high effort prioritization process. This part of the process has two inputs. The list of items that will undergo the process and the objectives hierarchy. The list of items can be reached using the aforementioned steps and the objectives hierarchy and the process of its creation has been extensively described in this thesis so its creation or contents will not be discussed further. The high effort prioritization process begins with an evaluation of the correctness of the objectives hierarchy. The objectives hierarchy should be adjusted if necessary. The fundamental objectives should then be used to create a scorecard. This scorecard should be turned into a weighted scorecard by evaluating the relative weights of the aspects measured in the scorecard. This scorecard is then used to evaluate each item, and the output of the process are evaluations of the business value of each item. This output should be evaluated for its validity. If the evaluations do not seem valid to the product owner the process should be started again by evaluating the correctness of the objectives hierarchy. If the evaluations seem correct, the output should move on to the next part of the process.

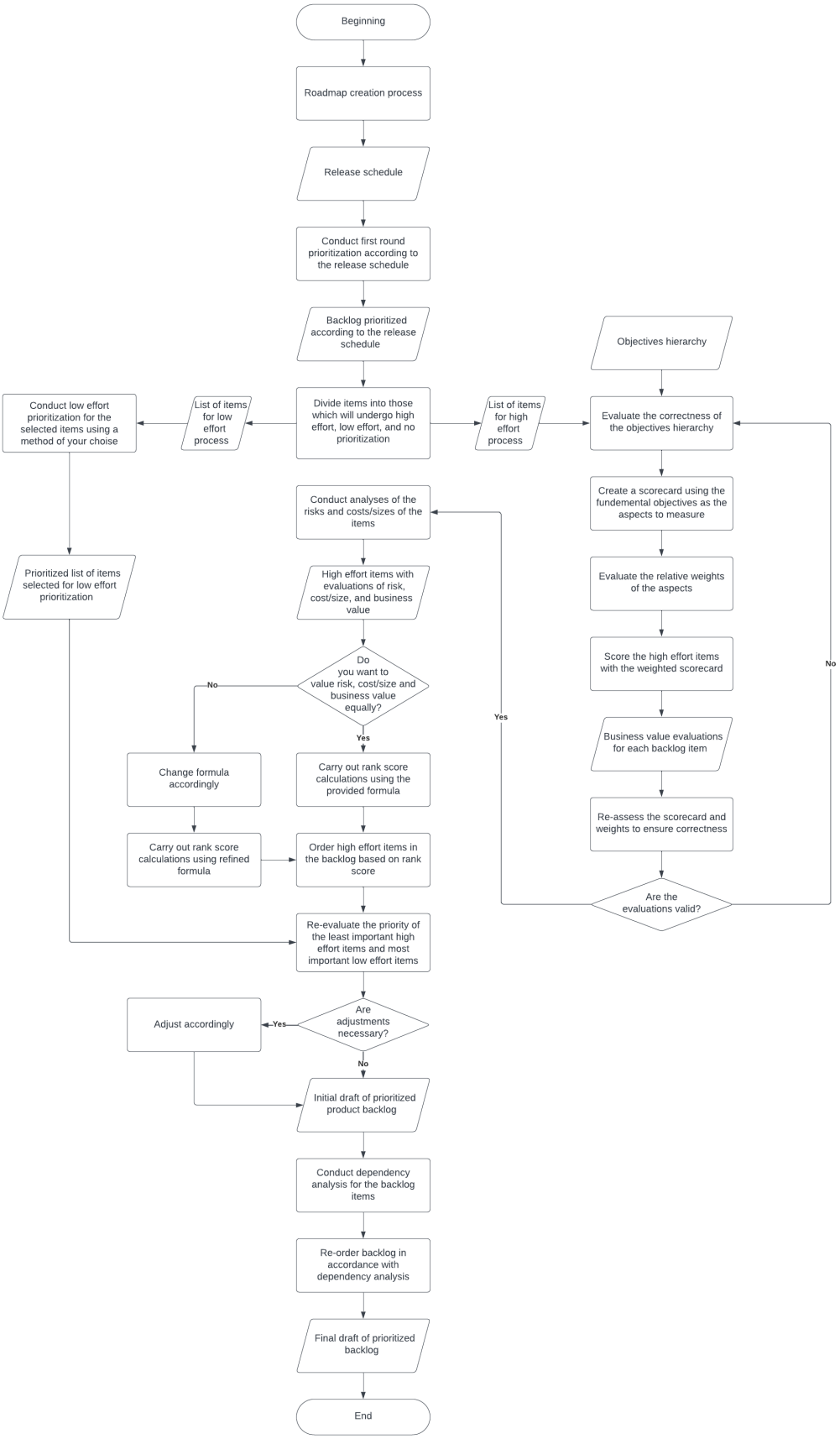

Figure 10 Flowchart of the prioritization process (Source: the author).

The next part of the process is to analyze the amount of risk associated with the items prioritized using the high effort prioritization process. An analysis of the cost or size of each item should also be completed. These should be evaluated using a numerical scale, for example 1-10. After this each item in the high effort prioritization process should have an evaluation of its business value, risk, and size or cost.

At this stage, the product owner has all the parameters they need to carry out the calculation of the rank order as dictated by the formula provided by McGreal & Jocham (2018) for the use of their model where the sum of risk and business value is divided by the cost or size. As stated in chapter 4.1.6, the product owners had differing views on if the weight of these variables should be the same in the decision-making process. Because of this, there is a decision the user must make at this point in the flowchart. If the user decides that the three should hold equal weight in the formula no adjustments are necessary. If, however, the user thinks that they should not hold equal weight they must first adjust the formula accordingly and then carry out the calculations of the rank scores of the items. This adjustment can be accomplished by adding a multiplier to one of the variables. The adjustment could also be accomplished by using different scales for the evaluations of the variables. Once the calculations have been carried out the items should be ordered according to the rank score.

Once the ordering of the high effort items based on the rank score is complete it is time to move on to carrying out the items prioritized with the low effort process. As is stated in the flowchart, and in chapter 4.5.1, the selection of the method for conducting this low effort prioritization process should be left up to the user. Regardless, the idea is that the process is based on intuition rather than a systematic process, to minimize the workload required at this stage of the overall process.

The prioritized list of items from the low effort process side and the prioritized list of items from the high effort side should then be compared with one another. Specifically,

the least important items according to the high effort process, and the most important items according to the low effort process, should be compared by the user and evaluated if changes in priority are needed among those items. If adjustments are necessary, they should be made before carrying on to the next stage of the process.

The user should now have an initial draft of the prioritized backlog, there is, however, one more aspect to consider. The dependencies are one of the four dimensions of the model presented by McGreal & Jocham (2018). As discussed in chapter 4.3 dependencies are more significant in organizations that create physical products but even in cases where the products are non-physical, dependencies often exist to some extent. To account for the dependencies some form of dependency analysis is needed. Methods for this dependency analysis are discussed in chapter 4.5.1. After the analysis is complete, the items affected by dependencies should be re-ordered accordingly. After this is complete the user should be left with the final draft of the prioritized backlog. A backlog, in which, the most urgent items according to the schedule have been prioritized in a systematic manner, and in a way that maximizes value while minimizing risks and costs, and in which the items that are not so urgent according to the schedule have been evaluated by the product owner to see if any of those items should be completed ahead of schedule.

The process of prioritization is more of a continuous process than an intermittent one. Despite this, when applied into practice there is a clearly defined beginning and end to the process. The first reason for this is that as time passes, items from the backlog are completed. And when the product owner wants to re-prioritize their backlog, they must start the process by going through the roadmap creation process to update it so that the roadmap is adjusted to possible changes in the market. Another reason is that the prioritized product backlog is a clear output of the entire process and if the product owner wishes to adjust the prioritization, they should again begin by taking a look at the roadmap creation process.

In the flowchart the items prioritized using the high effort process are referred to as “high effort items” and the items that are prioritized using the low effort process as “low effort items”. It is important to note that these names do not refer to the amount of effort needed to complete the items but rather the effort used in the prioritization process of the items.

5 Conclusions

In this chapter the conclusions of the thesis are presented. These conclusions are presented as a reflection of the research questions and how they are answered by this thesis. These answers act as the key findings of this thesis. The limitations of the findings, their managerial implications, and suggestions for future research into the topic are also discussed.

5.1 Summary of the key findings

The research questions this thesis was built around were presented in chapter 1. These research questions were formed as follows:

RQ1: *What are the parameters that a product owner should take into account when defining the value of product backlog items?*
RQ2: *How much weight should each parameter have in the decision-making process?*
RQ3: *How should the parameters be utilized in order to acquire the relative priority of each item?*

The parameters this thesis proposes to be used when evaluating the value of product backlog items were formed on the basis of the objectives hierarchy. This objectives hierarchy is presented in chapter 4.5.2 and includes 10 fundamental objectives this thesis proposes to be used for measuring the business value of product backlog items. These parameters are to measure knowledge acquisition, customer satisfaction, target orientation, error fixing, profitability, reduction of complexity, regulatory compliance, employee satisfaction, business continuity, and market visibility. By utilizing these parameters in the evaluation of value for each backlog item, an organization can capture business value from a large perspective, accounting for multiple tangibles and intangibles associated with business value.

As for the weights each item should hold in the decision-making process, this thesis was unable to conclude on a universally applicable solution. As discussed in chapter 2.5, business value is contextual and as such its definition is dependent on the context in which it is defined. Seven product owners were interviewed to find their opinions on what weight the defined parameters should have in the process and the conclusion of these interviews is that it depends from person to person. It is then the conclusion of this thesis that while a list of the parameters for evaluating the value of items can be created, a universally applicable set of weights cannot be created. The weights these parameters hold should therefore be left to the individual doing the evaluation based on their contextual understanding of value.

For the evaluation of the value of an item to be translated into something that can be used for prioritizing the backlog, it should be reflected against the resources that are required to complete the item and the risks associated with the item. An analysis of the dependencies between each item is also necessary to carry out the ordering of the product backlog items. Furthermore, this ordering should follow the ideas of Rubin (2012) in that this prioritization process should only be carried out for the items scheduled to be completed first, while the items scheduled for later cycles of development do not require as much effort in their prioritization process. The reasoning behind this is threefold. Firstly, this will ensure strategic guidance for the prioritization process as the schedule is ascertained from the roadmap, which is the product of strategic evaluations of different projects. Secondly, this aligns with the thoughts of Schwaber & Sutherland (2020) about the process of refining product backlog items continuously. Thirdly, this will minimize the amount of work required to complete the prioritization process and avoid unnecessary work from the product owner.

5.2 Managerial implications

The managerial implications of the findings of this thesis revolve around the prioritization method itself. The method and the related findings on how it should be applied into

practice provide support for product owners in organizations utilizing the scrum framework in their product development. The discussions on how it could potentially be modified to better fit the needs of the individual presented in chapter 4.5.3, are also important for managers wishing to have the model applied into practice. This is due to the discussions presented in chapter 2.2 about the empirical approach each product owner must apply into refining their tools.

Furthermore, the discussions about successful product ownership in chapter 2.2 may provide support for product owners in other aspects of their work. For other members of organizations utilizing scrum the discussions may help in understanding the point of view of the product owner, fostering a better relationship with them, or supporting them in being successful in their role.

As for the discussions about decision analysis, specifically in cases where multiple parameters are present, in chapter 2.3 the managerial implications can be viewed from a broader perspective. In almost all managerial positions decisions must be made and often those decisions must be made based on multiple variables. In those decisions the findings of this thesis may be helpful.

The proposed parametrization of business value may not be applicable in other organizations, especially if they do not follow agile methodologies in their product development. Despite this, the process utilized for the definition of business value in this thesis, where the objectives hierarchy is utilized to provide a list of measurable aspects, could be followed by decision-makers in order to reach a better understanding of business value in their context.

The findings of this thesis in relation to applying agile principles in the manufacturing sector also pose certain implications on decision makers. Firstly, the discussions around the difficulties caused by different, non-transferable, expertise of the developers in choosing the items to work on during each sprint provide an example of the types of

problems faced by organizations adopting agile principles in the manufacturing sector. The same can be said about the issues around the high amounts of dependencies and commitments the teams have to work around. Both of these issues, however, would exist no matter what product development method is used, and as such, are something that have to be acknowledged, but also something that can be worked around. The former two issues are discussed in more detail in chapter 4.1.5. In chapter 2.1.1 additional issues in agile development in the manufacturing sector are presented and discussed. And while these issues cause certain attributes of a successful product owner to be even more useful in agile organizations in the manufacturing sector, they are nothing that cannot be worked around with innovative solutions. These attributes are presented in detail in chapter 2.2.

5.3 Limitations of the findings

The findings of this thesis are generally applicable to most companies utilizing scrum in their product development. The necessity for the utilization of scrum is, however, a clear limitation for the findings of this thesis, as without scrum being utilized, there is no product backlog to prioritize. As the primary objective used in the creation of the business value parameters is to apply agile principles into practice, the parameters themselves could be used by organizations utilizing some other agile methodology instead of scrum. A limitation for the utilization of the parametrization is that since the means objectives were not explored, the parameters cannot be used as such outside the scope of mathematical calculations for value. If the parameters were to be used in some other context the user would have to first define the means objectives that are currently missing.

The constraints faced by companies utilizing scrum for the development of physical products were explored in this thesis. When evaluating the business value parameters, and designing the final prioritization process in general, an emphasis was placed on ensuring that these constraints are accounted for. These constraints of course do not exist in all companies. However, that does not mean that the companies who do not develop

physical products cannot use the process, but rather that those companies can place a lower emphasis on them. For those companies prototypes are still an important part of the development process and they too can have issues with dependencies and differentiated expertise among the development teams.

The companies who do not currently utilize scrum or any other agile method for their product development, and even those who use an agile method that is not scrum, the general outline of the prioritization process can be useful. The utilization of a weighted scorecard for measuring the relative value of development work, accounting for risks and costs when considering priorities, the utilization of the objectives hierarchy tool for generating the metrics of the scorecard and figuring out the dependencies of increments are all examples of universally applicable tools that can be used in the fields of product and project management.

5.4 Suggestions for future research

The general findings of this thesis concern only those organizations that are currently applying scrum as their product development methodology, and as such, the functionality of the method in organizations where scrum is not being applied could be researched. This research could focus on the aspects that do and do not work outside the framework of scrum and how the method should be modified to better suit the needs of those organizations.

As the method is a novel framework its functionality has not yet been tested in the organization. Therefore, future research could be carried out into the effects of the model on the ability of the organization to generate value, as well as its effectiveness in the purpose it was designed for which is product backlog prioritization.

The purpose of the prioritization method is to be a first draft of a functional model in an agile environment where continuous improvement, and a cyclical approach to

development, are at the core of all development. As such further rounds of research could be carried out to further improve the method. This would align with the approach of grounded theory, as the method calls for multiple rounds of data collection and analysis to ensure that the model is a completely accurate reflection of reality. Those further rounds of research were left outside the scope of this thesis but could be completed in order to further refine the method and to ensure its validity.

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Appendices

Appendix 1. Interview questions

How do you currently prioritize product backlog items?

Do you currently measure the business value of product backlog items?

Which parameters, factors or criteria do you currently use when measuring the business value of the items?

What are the factors that you would like to be included in the prioritization process that currently you are unable to account for?

What are your views on the strategy creation process and its relationship with product backlog prioritization?

Based on what was presented, what are your thoughts on the prioritization method and its components?