

Risk Management of New Product Development- A Manual for SMEs

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ABSTRACT,

Although the resource and capability restraints of small and medium sized enterprises (SMEs) have been widely discussed and acknowledged in literature and research, little has been done yet to develop tools to assist SMEs in dealing with the different risks in their business. This is particularly true for the risk management of new product development (NPD) in SMEs. While a large number of products still fail in the market after launch, mostly due to insufficient market research in the early stages of the development process, there are so far no practical risk management tools for SMEs that could assist them in managing the risk of the NPD process and increase product success. However, this is particularly relevant for SMEs due to their small size and limited resources, which means that the failure of a new product in the market can have fatal consequences for a SME. Within this paper, a risk management manual for SMEs, focused on the most relevant risk factors in the NPD process of SMEs, is created. The frame of the manual is composed of the main risk categories of the NPD process, spread over the general stages of the new product development. Furthermore, this paper provides a straightforward risk diagnosing method, by using a number of screening questions to help SMEs identifying their most important risks. Finally, the manual provides a variety of tools to help answer these risk diagnosing screening questions and thereby assist SMEs in managing their risk in the NPD process and facilitate the success of new products in the market.

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Keywords: Risk management, new product development, SMEs, risk manual, innovation, product innovation, systematic literature review

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9th IBA Bachelor Thesis Conference, July 5th, 2017, Enschede, The Netherlands.

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1. INTRODUCTION

Risk Management in the new product development (NPD) process is an important and frequently discussed topic in literature as risk is not only a constantly present factor in new product development, but the management and minimization of risk has also been found to have a positive and significant impact on the new product performance of a company in most industries (Oehmen et al., 2014; Mu and MacLachlan, 2009). While risk management plays an important role in new product development in general, it is of particular importance for small to medium sized enterprises (SMEs), as they have certain disadvantages compared to large firms, such as their limited resources in terms of time, financial and human resources as well as capabilities in general (Gilmore et al., 2013; Verbano and Venturini, 2013; Moreno-Moya and Munuera-Aleman, 2016). So, while SMEs make up a large part of the economy in Europe (Gilmore et al., 2013), SMEs are more dependent on the success of their new product developments as a failure of the product in the market would have a large, negative effect on the SME's overall health due to their limited resources and capabilities (Ricondo et al., 2006). Efficient and effective innovation management can help SMEs overcome their disadvantages and survive in competitive environments (Leithold et al., 2016). While the importance and necessity of risk management in new product development projects is acknowledged and emphasized in literature (Leithold et al., 2016; Teller et al., 2014), there is still a lack of appropriate tools and measures tailored to the needs of SMEs, despite gaining more attention (Pereira et al., 2013). However, as mentioned above, risk management of the NPD process is of particular importance for SMEs, which is why it is important to research and develop risk management approaches tailored to the characteristics of SMEs in order to aid their success and survival. So, this identified gap is going to be addressed in the course of this research with the final objective of providing a manual with implementable risk management techniques for SMEs. This is to support these companies during the development process of new products in a manner which is complementary to the characteristics of SMEs rather than just applying the risk management practices from large companies, which can often be overly static and complicated for the simpler structure of a SME. Since, despite the structure and some components of the manual and the research are leaning on existing risk management methods, such as the Stage-Gate® model, whose structure will be used as outline for the manual, the manual created in this paper adds value to existing literature as well as SMEs. The value is added by not only pointing out which risks to look out for in the NPD process, but also by making the management of these risks more tangible for SMEs. This is done by identifying the most important risks for SMEs in the NPD process for the scope of this research, as well as spreading these identified risks in the different stages of the NPD process over the different categories of risks in the development process. While existing tools, such as Stage-Gate®, point to the different risks in the NPD process (Cooper, 2008), this research additionally provides the SMEs with more explicit recommendations on which tools can help managing the identified risks as well as how to use them.

Therefore, a research question as well as a number of sub-research questions have been formulated, which will be answered throughout the course of this paper in order to reach the research objectives set above. These are

- I. *What are the relevant risks for SMEs in the NPD process and how can these be managed?*
 - a. *How can 'risk' and 'risk management' be defined within the new product development process?*
 - b. *What types of risks are there in the NPD process?*
 - c. *What are the requirements for a useful and beneficial manual for the risk management of the NPD process for SMEs?*
 - d. *How can SMEs diagnose risks in the different stages of the NPD process?*
 - e. *What kind of tools and measures are there for the risk management of the NPD process?*

After introducing the methodological approach of this paper and conceptualizing the most important components and introducing the different typologies, a manual will be created with the aim of not only fulfilling the set research objective but also to answer the set research questions. Through that a valuable manual for SMEs will be created containing simple but effective techniques of identifying risks in the different stages of the NPD process and also a detailed description of varying tools on how to manage these risks to support them with dealing with the risks associated with the development of new products as far as possible.

2. METHODOLOGY

The methodological approach for the development of this paper is conducting a literature review, or more specifically, a systematic literature review. This can be defined as "a formally planned approach in finding, evaluating and summarizing all available evidence on a specific research question" (Niazi, 2015). Therefore, a strategy will be formulated on how to reach the research objective set above as well as on how the above formulated research questions will be attempted to be answered. To aid the formulation of said strategy, the three-step methodology approach suggested by Tranfield et al. (2003) will be followed. The three steps of this approach are

1. Planning the review
2. Conducting the review
3. Reporting and dissemination

Planning the review is mainly concerned with identifying the need for the research to be undertaken, which is discussed in chapter one of this paper by identifying the gap in current literature, which has led to this research.

Before going further with describing the process of conducting this literature review, the desired outcome of this research is going to be discussed in more detail. Since the goal of this research is to create a valuable device for SMEs to help them with their risk management of the new product development process, the decision was made to create this device in the form of a risk management manual. This decision was made as it is believed that the structure of a risk management manual will add the most value to an SME due to its

straightforward presentation and elaboration of contents. The structure of this manual will be composed of the general stages of the new product development process, to give a clear and understandable frame to the different risk management components, which will be presented in the manual. To make the structure of the manual even clearer another dimension in form of the main risk categories which can be observed in the NPD process will be added to the components of the manual. The components of this manual will follow the main components observed in most risk management methodologies, which are risk identification, risk assessment and risk control (Keizner and Vos, 2003; Ricondo et al. 2006) to cover the aspects relevant for successful risk management. For the risk identification it is important that the identification method has an intuitive character to it and thereby is not overly static or complicated. So, the approach chosen for the risk identification is asking screening questions to assess whether the critical components of the NPD process are in place before moving further with the innovation idea. For the scope of this paper, the screening questions are aimed at identifying the most important risk factors identified for SMEs in the NPD process, to really raise the SMEs awareness to the importance of those components.

Conducting the literature review is about the identification of appropriate sources to be used and discussed throughout the course of the review within the different components of the paper.

In order to achieve this, a combination of sources, consisting of search engines such as Google Scholar, Scopus and Web of Science will be used in order to gather relevant books and articles on the topic with a well-rounded set of keywords included in the data collection.

As the main research question is to be answered in the end of the paper as a result from the outcomes of the different sub-research sections, strategies for each of the sub-questions will be defined to help answer them.

- a. *How can 'risk' and 'risk management' be defined within the new product development process?*

For the definition of the terms 'risk' and 'risk management' for this paper, keywords such as 'risk', 'general risk', 'definition of risk', 'conceptualization of risk', 'innovation risk for SMEs', 'risk management' and 'risk in the NPD process' will be searched to find appropriate data for setting the initial understanding of these terms for the remainder of the paper.

- b. *What types of risks are there in the NPD process?*

As the second research question of the paper is about the typology of different risks which might occur in the stages of the development process of new products, keywords to be included for this component are 'stages of the NPD process' 'types of risks' 'new product development', 'different risks in NPD process', 'obstacles in new product development' and 'difficulties of new product development' or 'project management'. The outcomes from this data search will then be evaluated to identify the most relevant components for SMEs and scope for this research by addressing additional data using search

terms such as 'new product failures', 'new product failures in SMEs', 'Barriers of SMEs to new product development', 'Success factors of SMEs in new product development'.

- c. *What are the requirements for a useful and beneficial manual for the risk management of the NPD process for SMEs?*

To gather data for this research question, key words such as 'requirements for risk management in SMEs', 'Risk management requirements' 'organizational characteristics of SMEs', 'risk management for SMEs' and 'risk management practices for SMEs' were included to the search.

- d. *How can SMEs diagnose risks in the different stages of the NPD process?*

For the data collection for this component of the paper items such as 'risk diagnosing tools', 'risk measurement in NPD', 'risk assessment', 'risk management measurement tools' and risk methodology are included.

- e. *What kind of tools and measures are there for the risk management of the NPD process?*

Search items for this sub-question will depend on the outcomes of the assessment of important risk factors to consider of sub-question b. But general keywords include 'risk management measurement tools', 'tools for risk management in NPD', 'risk management tools for SMEs', but also more specific keywords such as 'competitor analysis for SMEs', 'competitor analysis for new product development' etc.

Once literature sources have been gathered, it will have to be assessed whether the sources are reliable and relevant, which will be done by taking into account the publication year of the source as well as the times it has been cited by other researchers. After this step, the content of the sources will be sighted and analyzed to then be integrated into the research paper in appropriate passages.

3. CONCEPTUALIZATION

Before introducing the typology of the new product development process and the different risk categories, a number of terms need to be conceptualized first, in order to create a common understanding of them for the remainder of this paper.

3.1 Risk

For the scope of product development, risk can either be the risk of not meeting performance requirements or not being able to deliver a certain product (August, N/A). Additionally, risk can be described as "the possibility of suffering harm or loss due to an undesirable event" (Grit, 2015). In other words, risk in the NPD process in particular, is the chance of situations occurring which one would rather like to avoid as they can have a negative impact on the development of the product, like failure in the market after launch, which can have severe consequences for the SME, due to their limited financial resources.

3.2 Risk Management

As the outcome of this paper will be a manual of how SMEs can manage risk in their new product development, it is important to define what is meant by risk management and what it entails. Risk

management generally has the aim of identifying and managing risk in order to be able to deal with it when it occurs through for example eliminating, minimizing or controlling the risk. This is achieved by implementing tools or systems which help identifying, analyzing, evaluating and addressing the risks of different projects which a firm undertakes (Raz and Micheal, 2001). So, within the new product development process this means that the manager has to be aware of what the risks are that might occur and when they might occur. Furthermore, it is important to analyze the circumstances of the new product development along the way and to consciously make the decision whether the product idea can continue moving through the development process or whether it would be better to either freeze the idea or even scratch it.

4. TYPOLOGY

As the focus of this paper is the risk management of the new product development process, the different stages of the NPD process will first be described in order to give a general understanding of the setting of this paper. To do so the five stages of the new product development process of the Stage-Gate® model will be used as it provides a clear and concise overview of the process. Additionally, the type of innovation on which this paper is focused on will be introduced and explained. Afterwards, the different risk categories which can occur in the new product development process will be introduced as well as they will further facilitate the structuring of the risk management manual.

4.1 Stages of the New Product Development process- Stage-Gate®

The development of a new product can be a difficult and challenging process, which usually aims to achieve the following three objectives, namely 1) maximizing fit with customer requirements, 2) Minimizing the development cycle time, as well as 3) controlling the developing cost (Schilling, 2013). As these are challenging objectives, tools have been developed to aid the development process of new process. One of these tools is the Stage-Gate® model. Within this paper, the Stage-Gate® model will be used to give the frame for the risk management manual by providing a clear, structured overview of the new product development process (Cooper et al., 2002). As mentioned above in the methodology section, the main requirement for the frame of the manual is that it is understandable with clearly understandable components, which is fulfilled by the Stage-Gate® model as opposed to twelve step approaches as adapted by Rochford & Rudelius, which could make the presentation of the components of the manual overly complicated and scattered.

4.1.1 Discovery and Scoping

The very first initial stage of the new product development process which takes place before the actual activities of the process are starting is the discovery or idea generation stage. This stage consists out of activities which aid the discovery of new opportunities for a firm and help generating new business ideas for example act upon identified opportunities or to generate new business ideas in general through for example brainstorming or customer input.

Scoping is the first stage of the actual development process according to the Stage-Gate® model and is about assessing the technical merits and the market prospects of a certain

development project in a quick and inexpensive way in order to get an initial idea of the characteristics of the new product under development.

4.1.2 Build a Business Case

The second stage of the process is about further analyzing and assessing the viability of a product idea after an initial positive outcome from the scoping stage. The result of this stage is a business plan consisting of a product and project definition, a project justification as well as a project plan. In order to create this plan, a number of analyses need to be conducted to create this well-rounded picture of the product development project. These analyses can include a study of user needs, an assessment of technical feasibility, operations assessment and a financial analysis.

4.1.3 Development

After the business plan has been created in stage two, these plans are now being translated into more tangible deliverables. Now the manufacturing and operations plan is mapped out and the actual design of the new product as well as the development of the product begin to shape through for example the creation and first evaluations of a prototype design. Additionally, the marketing launch is being developed along with test plans for the next stage of the development process.

4.1.4 Testing and Validation

After a prototype and development plan has been set up for the new product in the previous stage, it is now the purpose of this stage to provide a form of validation for the development project. This includes testing and validation of the production and manufacturing process, the economics of the project, the product itself as well as customer acceptance regarding the new product. In order to achieve this production trials as well as customer field trials can be conducted next to in-house testing work.

4.1.5 Launch

The Launch is the fifth and final stage of the new product development process. This is the beginning of full production and commercial launch and thereby marks the full commercialization of the product. In order to assess the success of the product launch, a post-launch review should be conducted to decide and identify whether the initial goals of the new product are being achieved.

4.2 Risk Categories in the NPD Process

In the conceptualization section above, 'risk' has been identified as an unfavorable situation or condition which should be avoided or minimized in order to be successful in the new product development process. To make this concept clearer, the risk in the new product development process will be broken down into different risk categories. When looking at the clustering of risks in project management, or more specifically in the product development process, it becomes apparent that the main categories of risk are technical, market, commercial and organizational risks (Ricondo et al., 2006; Mansor et al., 2016). While the sub-categories of these risks can vary per industry and setting of a company (Hartman and Ashrafi, 2004), a general introduction of the different types of risk will be given below.

4.2.1 Technical Risk

Technical risk, or technology related risks is an intrinsic risk and can entail a number of sub-sections such as the design of the product, manufacturing technology and intellectual property (Keizer and Vos, 2003). These are mainly concerned with the internal competencies of the firm and their ability to execute and fulfil certain targets with the resources which a firm has at its disposal. One of the main risk here for example lies with the product not meeting safety and performance requirements in the end after the development process (Cooper, 2003).

4.2.2 Market Risk

Market risks can include factors such as consumer acceptance and marketing risks, competitor risks and the risks of substitution in the market the firm is competing in (Keizer et al. 2005). For this extrinsic risk category, main risks include low acceptance or even rejection of the product in the market or being outperformed by a competitor (Cooper, 2003). As these factors lie in the external environment of the firm, some sort of screening needs to take place to identify those risks for a certain company.

4.2.3 Commercial Risk

Commercial risk is concerned with the extent to which a product, or rather a product idea, would be financially feasible for the firm developing the product (Keizer and Vos, 2003). The risk here is for example for the product under development violating resource constraints such as the set budget for the development project, which needs to be minimized through appropriate budgeting and forecasting methods (Cooper, 2003).

4.2.4 Organizational Risk

Finally, organizational risk in the new product development process includes factors such as the communication within the firm while striving for the realization of the product as well as the idea acceptance of the new product of different parties of the company and the availability of necessary resources for the development of the new product (Keizer and Vos, 2003).

Now that an initial understanding of risk and risk management in general, the structure of development process along with the different risk categories which can be encountered has been created, the manual can be created to help SMEs manage risk in the new product development process containing the components introduced above.

5. MANUAL

Firstly, for the creation of the manual there are a number of requirements for the successful use of this manual that need to be identified after which the different components of the manual will be introduced and described.

5.1 Requirements

Since this manual is supposed to aid the risk management of the innovation process of new products of SMEs, the components of the manual need to be simple, yet effective and easy to use (Marcelino-Sábada et al., 2014) by being presented in a user-friendly manner. Seeing that SMEs are generally low in organizational complexity, the manual needs to match their characteristics by not only covering a range of risks and

approaches, but also doing so by providing a straight-forward application and implementation of the approaches.

Another requirement for this manual to be used successfully, is to integrate it into a cross-functional work setting, which has been identified as one of the most critical success factors in the new product development process (Owens, 2007; Huang et al., 2008; Moreno-Moya and Munuera-Aleman, 2016). This is to facilitate communication and knowledge exchange between different functions within the company to increase the capability of the firm to identify many risks and to evaluate them properly. Communication between the R&D members and the marketing members of the team is of particular importance, as they technically are at two different ends of the process flow, but have to come together in the beginning of the new product development process to be able to identify as many risks as possible together (Shim, et al., 2016).

5.2 Components

When examining an overview of different risk methodologies (Ricondo et al. 2006) it becomes apparent that there generally are three phases, or steps, to risk management in the development of new products or projects. These are risk identification, risk assessment and risk response development and control (Keizner and Vos, 2003). Within these phases the participants of the development process come together in order to identify the number of risks which might occur during the process. These are then evaluated and the possible impact of said risks discussed and assessed. Therefore, to aid the risk identification process of the different risks, a number of screening questions will be provided in order to help checking for the different kinds of risk in the development process. To develop a risk response and risk control mechanism, a number of tools and approaches will be provided as answers to the different screening questions and thereby help managing the risk of the new product development.

To further narrow down the scope of this paper and to make its contents particularly relevant to SMEs, a look has been taken at what companies in general, and SMEs specifically, commonly struggle with the most regarding the new product development process. When examining existing sources on the matter, it becomes apparent that new products, launched by SMEs in particular, often fail due to improper marketing efforts despite being technically functional (Mansor et al., 2016). These lacking marketing efforts include missing or insufficient market analysis (Comanita, 2013) and thereby failing to take the most crucial factors regarding the success of a new product appropriately into consideration, which have been identified as customer acceptance and customer satisfaction (Mansor et al., 2016; Barrios and Kenthoft, 2008). In addition, the commercial risk of a new product, which is influenced by the extent to which customers accept the new product in the market and are willing to purchase it, is seen as another major challenge and thereby risk for SMEs when developing new products (Barrios and Kenthoft, 2008; March-Chordà et al., 2002). As the actual perception of the new product in the market and the commercial viability of the product can only be exactly seen and measured after the launch of the product in the market, when high amounts of financial and technical resources have already been invested by the company and poured into the product development process, it has been pointed out that products need to fail early in the development process in order to avoid the risk of developing and

launching the product only to have it fail in the market (Comanita, 2013). Based on these findings, the chapter on tools to manage the risk of the new product development process with a specialization on SMEs, will be more focused on the first two stages of the process and the categories of market and commercial risk (s. Table 1). In Table 1, the stages of the new product development process are shown, along with the different identified risk categories as well as the screening questions, which will be answered later in the manual. As mentioned above, the main risks for an SME in the NPD process lie in the first two stages of the process and in the market and commercial risk categories, which is why they have been highlighted in the table above. The gaps in the table do not mean that there are no risks to be expected in those stages and risk categories, but merely that the ones shown have been identified as the most important ones and will therefore be discussed for the content of this paper.

5.3 Screening Questions for Identifying Risks in the different stages

As mentioned above, a number of screening questions will be formulated to help with the risk identification. The different questions are spread over the different stages of the new product development process and will be organized along the different risk categories as introduced earlier by marking the questions with ‘M’ for market risk, ‘C’ for commercial risk and so on. Since risk has earlier been conceptualized as the chance of unfavorable situations occurring which can negatively impact the product development process, a look has been taken at what kind of components are important and relevant in the different stages of the process for the product to be not only successfully developed but also successfully commercialized after launch. So, the screening questions are derived from these components in the

new product development process and are thereby facilitating the identification of risk in the process, since they give guidance to assess whether the necessary data or requirements are present for the new product idea to be moved further through the stages. Through that, the risk of producing a product, which will take up a lot of company resources without high chances of success in the market, will be managed and minimized. To help formulate these questions, the important features of the different stages as described above were considered, as well as insights of the risk identification questionnaire suggested by Pereira et al. (2015) have been included. If a screening question can be answered with ‘yes,’ so if this component and the associated data with that component are already fulfilled, the product idea can move onwards in the development process. If a question is answered with ‘no’, a look should be taken at section 5.4 of this paper which contains different tools and guidelines to help gather the required data in order to make a decision about the progression of the product idea through the process. Here it is important to mention that the information and data gathered through the tools has to be critically reviewed by the development team. For example, if the clear list of competitors has been created in the Scoping stage of the process, the implications of the outcome need to be evaluated. So, while the provided tools give a guideline on what kind of data should be there to make the decision, the development team needs to critically evaluate the information to decide whether to proceed with the product idea or not.

5.3.1 Discovery and Scoping

As mentioned above, this stage is to briefly and quickly assess whether an idea for a new product is promising and should be continued further. Therefore, relevant questions to be asked in this stage include:

- 1) *Is the product idea free of eventual property rights? (T)*
- 2) *Is the target market for the product known and defined? (M)*
- 3) *Is there a list of competitors regarding the target market segment of the new product? (M)*
- 4) *Is the product going to add value to target customers?*

Table 1. Risk screening questions in the stages of the NPD process per risk category and tool index

	Market	Technological	Organizational	Commercial
Discovery & Scoping (tools in section 5.4.1)	Is the target market defined? Is the new product going to add value to target customers? Is there a list of competitors?	Product Idea free of property rights?		
Build a Business Case (tools in section 5.4.2)		Is the product meeting safety, environmental, regulatory requirements?	Is the organization of the process and the relations within the team-members clear and goal-oriented?	Are there sales projections for the new product? Are there sufficient financial resources?
Development (tools in section 5.4.3)		Clear supply and production process for reliable product delivery? Specifics of the prototype clearly defined?		
Testing & Validation (tools in section 5.4.4)		Does the testing of the prototype reach the pre-defined criteria?		
Launch (tools in section 5.4.5)	Is there a clear process to measure the product acceptance and marketing sales?			

5.3.2 Build a Business Case

The second stage of the process is about further defining the product idea and its feasibility, which is why the answering of the following questions correctly is crucial for the further development of the product:

- 1) *Is the new product meeting all requirements regarding licenses, safety, environment and regulations? (T)*
- 2) *Are there sales projections for the new product? (C)*
- 3) *Are there sufficient financial resources for the development of this new product? (C)*
- 4) *Is the organization of the process and the relations within the team-members clear and goal-oriented? (O)*

5.3.3 Development

Once the business case for the product has been built, the development stage is entered during which the new product takes its first actual shapes so the following questions are more aimed at designing a successful creation process of the new product:

- 1) *Is there a clear supply and production process in order to provide reliable product delivery? (T)*
- 2) *Are the specifics of the prototype clearly defined for first testing and evaluation? (T)*

5.3.4 Testing and Validation

During this stage of the development process the initial product, prototype and production ideas are put into practice and tested for their feasibility and practicality, so the questions in this stage are helping with finding appropriate performance measures:

- 1) *Does the testing of the prototype reach the clearly pre-defined criteria? (T)*

5.3.5 Launch

During this final stage the new product is fully commercialized and introduced to the market. The most important feature in this stage is to control whether the product is living up to its expectations regarding market and sales performance, which is why the screening question for this stage is to help identifying the success of the new product:

- 1) *Is there a clear process to measure the product acceptance and marketing sales? (M)*

5.4 Tools for Answering the Screening Questions

After the screening questions for identifying the ideal features of each of the development stages, tools can be introduced to help achieve having these components in place and therefore minimizing the risk in the process. To structure the content of these tool chapters, a simple generic structure is used to make the following of the content of the tool chapters more clear (s. Figure 1)

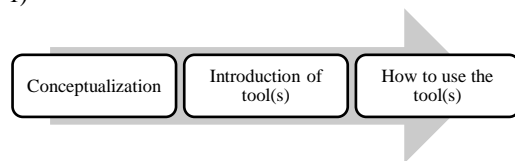


Figure 1. Structure of the tool chapters

5.4.1 Discovery and Scoping

	Market	Technological	Organizational	Commercial
Discovery & Scoping (5.4.1)	Target market defined? Value added to target customers? List of competitors?	Product Idea free of property rights?		

5.4.1.1 Is the product idea free of eventual property rights? (T)

The property rights meant at this stage of the new product development process describe intellectual property rights, which include trademarks, copyrights and patents (Gov.UK, N/A). The purpose of these rights is to prevent other entities, like persons or companies, from stealing or copying another's intellectual property or intangible assets (Honoré, 1995). In the past, intellectual property has particularly grown in importance for technological companies, due to the technological knowledge they have, which makes up for the larger part of the market valuation of a company and distinguishes them from their competition, rather than merely the size of their manufacturing facilities (Siedel & Haapio, 2011).

The risks that lies here for a company at the beginning stage of developing a new product, is another company already having property rights, such as a patent, on the product idea in question. If this is not recognized in time before moving on to the next stages of the development process, resources might be wasted on the new product which would not be allowed to be produced and launched, since it would violate the rights of another company's property rights.

In order to check for eventual property rights on a certain product idea, a number of databases and websites can be consulted to search for copyrights or patents which could conflict with the new product idea. Some of these databases are:

The World Intellectual Property Organization (wipo.int)

Patentscope

Global Brand Database

Global Design Database

Hague Express

Rijksdienst voor Ondernemend Nederland (rvo.nl)

Espacenet

Nederlands octrooiregister

Europees octrooiregister

Databank octrooilicenties

5.4.1.2 Is the target market for the product well-defined? (M)

As one of the main objectives of the first stage of the NPD process is assessing the market prospects of the product idea, it is important to have the target market of the new product defined, additionally to having an initial insight in the customer profile (Majava et al., 2014). The target market can be described as the chosen segment that a company has decided to serve, with the customers of said segment having similar characteristics, so that usually one marketing mix strategy can be created to match the requirements of the segment (Kraaijenbrink et al., 2013). In order to make decisions regarding the target market, the market first needs to segmented which can be defined as "the identification of individuals or organizations with

similar characteristics that have significant implications for the determination of marketing strategy” (Kraaijenbrink et al. 2013). This segmentation is done using different criteria depending on whether the segmentation is being done for consumer or organizational markets. The criteria for consumer markets includes behavioral, psychological and profile characteristics, while the organizational criteria includes characteristics such as demographics, economics and geographic (Baines et al., 2013). These segmentation criteria characteristics contain different subcategories as can be seen in Table 2.

Table 2. Customer Characteristics for consumer and organizational markets

Segmentation Criteria	Characteristics	Subcategory
Consumer	<i>Behavioral</i>	Purchase/transaction
		Consumption/usage
		Media usage
	<i>Psychological</i>	Technology usage
		Lifestyle
		Personality
		Perceptions
		Attitudes
		Motives
		Benefits sought
<i>Profile</i>	Demographic	
	Socio-economic	
	Geographic	
Organizational	<i>Demographic</i>	Size
		Age/life cycle
		Industry (NACE Code)
		Type/role
	<i>Economics</i>	Revenue/turnover
		Profit
	<i>Geographic</i>	Budget
		Local
		National
		Multinational
		Global

Here the company has to think about and assess what kind of customer they want to serve and reach with their product to further create their customer profile on what kind of need the targeted customers might have and through which channels the customers are most effectively to be observed and reached. This is important in order to be able to match the derived customer profile with the product characteristics to increase the chances of success in the market.

5.4.1.3 Is the new product going to add value to target customers? (M)

As of 2014, still 72% of new products which enter the market end up failing (Simon-Kucher & Partners, 2014), assessing the usefulness of a new product or verifying a product idea with potential customers can not only pose a great challenge, but is also of great importance. Depending on the type of innovation which a company is developing, there are different steps and methods to be taken in order to gather and evaluate data on how potential customers might perceive the new product. If the new product is an incremental innovation, the product idea is likely to be already more aligned with the current market situation of the company. Additionally, the customer profile and needs are already generally known and mapped out, as mentioned above, or the trigger for developing this new product

was even the feedback or input from customers on the existing products of the company. In such circumstances, more traditional market research tools (s. Table 3) can be used at this point to either determine or verify whether the new product idea would add value to customers.

This is due to the fact that the market in which the company is tapping into which the new product is going to compete in might be mainly unknown. Therefore, the new customer target market, as discussed above, needs to be taken into consideration when making further inferences about the perceived value by customers. Also, the customer profile might change or has to be reassessed. For these kinds of innovation more in-depth market research tools can be applicable to dive deeper into the customers’ perception to uncover unconscious and unarticulated needs (s. Table 4) (Mohr et al., 2014). Some of the methods listed by the author, like empathic design, due to its obtrusiveness, or stand-alone surveys, due to their superficial character have been left out and will not be discussed in this chapter, due to the obtrusive and superficial

Table 3: Market research tools for incremental innovation

Tool	Function
Survey	Data collection by questioning members of a population (Dooley, 2009)
Concept Test	To be used at the beginning of the process to help generate ideas through either observational techniques, brainstorming, focus groups or depth interviews
Conjoint studies	A survey research tool that can statistically predict what kind of combination of product attributes across different brands or process customers will prefer to buy

Table 4: Market research tools for radical innovation

Tool	Function
Customer visits	Face-to-face communication with customers, field research, firsthand knowledge, interactive conversation, inclusion of multiple decision makers at the customer location
Empathic design	Focuses on understanding user needs through empathy with the environment of the user rather than from the consumer’s direct articulation
Lead users	They are customers who are well aware of market trends and innovate solutions to their own problems; information collected from them comes from the leading edge of the market and can fuel breakthrough innovations

Quality Function Deployment (maybe leave out because extensive tool)	Engineering tool which integrates technical attributes of a new product with customer needs and perceptions
Prototype testing	A prototype is a model for the planned product or service, which needs to meet technical design specifications, and can be assessed by potential customers
Active co-creation	Active co-creation is the process of including an external member, e.g. customers, to the new product development process

Some of these methods, are ideally already used at the beginning of the new product development process for the idea generation stage, when the innovation is consciously inspired, or even co-developed, by customers. These methods include for example concept tests and active co-creation and empathic design. However, at this stage of the process when the new target market for the innovation has been defined, some of these methods can be used to verify the new product idea before moving further with it through the process. For example, a survey in combination with the conjoint analysis method could have create valuable insights into the perception of future customer, or identified lead users could be invited to review an initial rudimentary prototype idea.

The above mentioned measures can be suitable for establishing the fit between the new product idea and the product with the customers, but should the product idea tap into a completely new market, new potential customers might be hard to motivate to invest time and effort into the collaboration with the SME at this point.

So, while the market research tool can be helpful for the gathering of data from customers, and their value should not be underestimated, a large portion in the decision making process at this stage relies on the intuition of the manager, preferably with insights from an industry expert, who has more in-depth knowledge of the market which the new product is targeting.

So, for making an educated go decision for the product at this stage of the development stage, an intuitively decision, guided by market research tools and influenced by smart scenarios, could minimize the risk at this point in the process.

A tool which can help an SME with making this decision in a more guided and visualized way is the value proposition canvas. This canvas is a straightforward tool which helps companies and managers mapping out their customer profiles and their value propositions, so essentially how the company can add value to its customers by taking the perspective of the customer into consideration (Osterwalder et al., 2014). The first component of the value proposition canvas is the **customer profile**, which consist out of identifying your customer's 'jobs' that they try to get done, which can include tasks that they want to get done, problems which they are trying to solve or needs that they want to satisfy. The customer profile also includes the 'pains' customers might face in these 'jobs' and the 'gains' or benefits which they are expecting from performing a 'job'. This customer

profile is built up from the target market which has been defined in the scoping stage of the process. The insights about the target market are now used in this step to help making decisions about the value of the product for customers, when there is a new product idea without initially existing customers of the company.

When trying to identify the customer's job or task which they are trying to get done, it is important to take the customer's perspective into consideration since what the company might deem as important to the customer, might not be as important to the customer at all. The three main categories of jobs are functional, social and personal or emotional jobs.

For a **functional job** the customer wants to get a specific task done or solve a specific problem, such as writing a report or helping clients.

An **emotional job** includes a customer wanting to look good or gain power and status, for example being perceived as competent.

A **personal or emotional job** is concerned with the consumer seeking a specific emotional state like feeling good or secure through for example feeling secure at one's job.

However, not every job has the same priority to customers, so the identified jobs should be ranked from insignificant up to important to highlight the jobs with greater priority to customers.

Customer pains include anything that annoys, inhibits or prevents a customer from getting their jobs done or performing their tasks, which can include undesired outcomes and problems, obstacles and risks associated with performing the jobs. As well as for the job importance, when mapping out the customer pains, the severity of said pains should be ranked from extreme to moderate.

The **customer gains** include the benefits the customers are striving to achieve by performing different tasks and jobs, which should as well have a ranking, in this case from essential gains to 'nice to have' gains.

Once the customer profile is known, the fit between the components of the value proposition and the components of the customer profile can be established and checked.

The **value proposition** consists out of three components which are firstly the product or service the company is offering to their customers, secondly which pain relievers the product or service is providing to customers and thirdly what kind of gain creators the product or service is offering to the customers and thereby identifies the gap or need the new product is filling for the customer (Tyrtsted, N/A). The essential point in this part of the value proposition canvas is to create or verify a match between the gain creators and the more essential gains, the pain relievers and the more severe pains and thereby ensuring that there is a need for the product or service in the market. S. Table 5 for examples of questions suggested by Osterwalder et al. (2014) helping to identify the relevance of the pain relievers and gain creators which are offered by a certain product or service.

Table 5. Guiding questions for matching pain relievers and gain creators

Guiding Questions	Pain Relievers	Gain Creators
Could the product or service...	- produce savings? - make the customers feel better? - fix underperforming solutions?	- produce outcomes your customers expect or that exceed their expectations? - outperform current value propositions?

	<ul style="list-style-type: none"> - eliminate risks the customers fear? - limit or eradicate common mistakes customers make? - eliminate barriers that are keeping the customers from adopting value propositions? 	<ul style="list-style-type: none"> - make the customer's work or life easier? - do something specific that the customers are looking for? - produce positive outcomes matching the customers' success and failure criteria?
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5.4.1.4 Is there a clear list of competitors regarding the market segment of the new product? (M)

Once the target market has been defined, it is important to scan for and map out potential competitors with whom the company would be competing within the target market, as it is a relevant strategic step to be aware of the competitive environment before starting to develop the new product (Bergen and Peteraf, 2002). While studies have found that companies who do conscious competitor analysis and who are aware of their competitors in their markets generally benefit more from innovation and have higher new product performance (Ledwith and O'Dwyer, 2009.; Story et al., 2014), SMEs in particular tend to underestimate the impact of this step in new product development despite the associated positive effect (Story et al. 2014).

One of the reasons why SMEs tend to struggle with environmental, and thereby also competitor analysis, is that they tend to lack the human and time resources to do an extensive environmental research or do not see the need to spend these resources on an environmental analysis because they are not fully aware of the necessity and advantages (Wong et al., 2014). When scanning the environment, there are three basic steps to be followed by SMEs to help the process along which are to firstly the scope of the scanning, so what is that they want to know, secondly the frequency of the scanning and thirdly the sources of information which they can draw insights from (Wong et al., 2014). What SMEs would want to know in this step of the development process of their new product is who the competitors in the market are, what they are going to be competing for, for example the customer demand situation or the available suppliers. To help analyze these factors of the new market, components of the five forces model by Porter can be used (Dobbs, 2014). While there are criticisms to this model like the lack of depth, it is still a valuable scanning tool at this stage of the process, especially when broken down into more tangible dimensions (Dobbs, 2014). Therefore, things which the SME ought to know before making the decision to further pursue the product idea, include the number of existing competitors, the growth of the industry, product differentiation in the market, supplier concentration and prices for substitutional products in the market (Dobbs, 2014). The identification of competitors in the target market of the company can be further facilitated by taking a two-step approach, by not only identifying but also analyzing the identified competitors (Bergen and Peteraf, 2002) (s. Table 6). The identification of competitors is a more broad

approach and is done by assessing which players in the market have similar resource characteristics and fulfill the same or similar customer needs or will be able to do so in the near future (Bergen and Peteraf, 2002). This identification can for example be done by using the industry's NACE (Nomenclature generale des Activites economiques dans les Communautés europeennes) code, which categorizes firms and organizations based on their business activities (OECD, 2013; Siccode, N/A) to identify competitors which are producing comparable goods in the industry (Bergen and Peteraf, 2002). However, additional sources should be used to identify competitors who may stem from countries who are not using the NACE code (s. Appendix 1) as well as to narrow the relevant competitors further down to the specific target market, as the NACE classification can be broad. Additional sources include other external sources, since SMEs tend to lack internal information sources because of their small size. These external sources can range from customers, who prove to be a valuable source of information on competition, especially in very dynamic environments, which are more likely to change and make the scanning process even more difficult (Wu and Olk, 2014), to existing suppliers. However, if the SME is not familiar with these members of their environment for the new product yet, they can either consult other existing contacts which they have, who could provide insights into the market which the SME is targeting or search for and use sources such as business journals and industry specific magazines to get an understanding of the industry and market specific characteristics of the new product (Wong et al., 2014).

Table 6: Scanning of competitors

	Identifying competitors	Analyzing Competitors
Scope of scanning	<ul style="list-style-type: none"> • Companies that have similar resource capabilities • Firms who fulfill similar or the same customer needs • Number of existing competitors • Growth of the industry 	<ul style="list-style-type: none"> • Product differentiation in the market • Prices of substitutional products • Supplier concentration
Sources of information	<ul style="list-style-type: none"> • NACE codes • Customers and suppliers • Web research 	<ul style="list-style-type: none"> • Business journals (industry specific) • Customers and suppliers • Web research

Since this scanning is going to be part of the Scoping phase of the development of a new product, the scanning should be done at least once at this stage of the process, while keep monitoring eventual changes to these factors throughout the course of the development process by the means of various information sources mentioned above.

5.4.2 Build a Business Case

	Market	Technological	Organizational	Commercial
Build a Business Case (5.4.2)		Product meeting safety, environmental, regulatory requirements?	Organization of the process and the relations within the team-members clear and goal-oriented?	Sales projections for the new product? Sufficient financial resources?

5.4.2.1 Is the new product meeting all requirements regarding, safety, environment and regulations? (T)

Before going further with the product development, it should be assessed in this stage whether the new product idea does meet requirements in the sense of safety, environment and general regulations in addition to the property rights which were checked at the beginning of the process.

As established before it is important for the risk management in the new product development to have a solid understanding of the new product development project before starting to invest more time and other resources on its realization. This includes having the requirements of the products clearly defined in order to have a clear understanding of what is to be achieved throughout the development process (Larsen and Lewis, 2007). An effective method for the process of designing and defining the requirements of a new product is to bear the general product performance criteria in mind which include ease of use, safety in use, reliability and sale price (s. Appendix 2. for the full list) (Trott, 2012). With this in mind it needs to further be established whether the product idea is holding up to general regulations and environmental requirements in order to avoid legal complications of the product later in the process, by for example consulting governmental websites to assess the current legal obligations that a product needs to fulfill.

5.4.2.2 Are there sales projections for the new product? (C)

As was mentioned above, estimating sales numbers for a new product idea is an important aspect in order to manage and minimize the risk of product failure after the launch and should be carried out early in the process. There are different forecasting tools which differ based on the type of innovation the company is developing (s. Table 7).

If the company is developing an incremental innovation the quantitative methods mentioned can be used for developing a sales forecast, since there most likely is past data available with which a sales forecast can be computed.

For radical innovation estimating a sales forecast is not as simple as for an incremental innovation since there often is no accurate historic data with which the sales of the new product can be estimated. However, as listed in the table above, there are a couple of techniques which can facilitate the estimation process.

Table 7. Qualitative and quantitative forecasting tools in innovation

	Incremental Innovation	Radical Innovation
Qualitative		<ul style="list-style-type: none"> • Delphi technique • Analogous data
Quantitative	<ul style="list-style-type: none"> • Moving averages • Exponential smoothing • Time series regression • Holt-Winters Model 	<ul style="list-style-type: none"> • Bass model

(Source: Mohr et al., 2014; Evans, 2014)

Time series are based on historical data, for example weekly sales, assuming that factors and influences, which impacted the sales of the products in the past, will continue to do so in the future. These factors and influences can for example be trends, seasonal effects, cyclical effects or even random behavior. Time series that only contain random behavior are called stationary time series. While a trend of a time series is a gradual downward or upward movement over time, a seasonal effect is one that occurs at fixed intervals of time, e.g. day, week, month or year, and cyclical effects occurring over a more long-term time-frame, such as several years (Evans, 2014). To analyze these trends and seasonality for appropriate forecasting and thereby decision making, forecasting methods such as **moving average methods, exponential smoothing and regression models** as listed in the table above.

The **simple moving average model** is a smoothing method that is applicable for more short-term forecasting, when the time series appears to be relatively stable without distinguishable trends and seasonal effects. This model is correcting for random fluctuations and behavior in the time series to detect the underlying direction of the time series for the forecast. Since in this model, the forecast is based on k observations in the past, the number of past observations k influences the accuracy of the forecast. Generally speaking, the smaller the number of k observations in the forecasting is, the quicker the forecast will react to changes in the time series (Evans, 2014). This method can for example be used with a normal excel sheet using the moving average tool or by using the XLMiner tool, which is an excel add-on and automatically computes the forecasting errors, such as the mean absolute deviation (MAD), the mean square error (MSE) and the mean absolute percentage error (MAPE). The general idea of the moving average method is shown below, using a general example:

$$\text{Week 4 forecast} = \frac{\text{units sold week 1} + \dots + \text{week 2} + \dots + \text{week 3}}{3}$$

The **exponential smoothing method** is similar to the moving average method in the sense that they can both be used, when there are no apparent trends and seasonal factors to be detected in the time series and are therefore both used for rather stable environments (Evans, 2014). The general formula for the exponential smoothing method is described by

$$F_{t+1} = F_t + \alpha (A_t - F_t)$$

Where,

F_{t+1} is the forecast for the time period $t+1$

F_t is the forecast for period t
 A_t is the observed value in period t
 α is the smoothing constant

Same as the number of k observations in the moving average model, the value of α affects the accuracy of the forecast. The closer α is to 1, the faster the model responds to changes in the time series. As well as for the simple moving average model, the computation of this forecast can be done with either the exponential smoothing function in excel, or with the XLMiner add-on. However, care must be taken when entering the value for α in the excel method, since the excel tool will ask for the 'damping factor' instead of the smoothing constant, which is $(1-\alpha)$ (Evans, 2014).

Should there be seasonality in the time series, **multiple regression** could be used to forecast the appropriate sales for these kind of data sets. However, creating data sets in Excel can be tedious endeavor, the XLMiner Excel add-on mentioned before can be used to apply another type of method which produces forecasts when the time series shows seasonality and trends, namely the **Holt-Winters models**. With these models and the XLMiner add-on, forecasts for time series with trends and seasonality can be made, after some trial and error with the input of the smoothing constants (Evans, 2014).

The methods discussed above, are not applicable to completely new product sales forecast, since all of them are based on time series and therefore calculate with the historical data of existing and very similar products. This might not be possible, if there is no, or scarce, initial data from which the sales forecast can be derived. Therefore, some tools for those circumstances are introduced below.

The **Delphi technique** is essentially a forecasting technique which aims to leverage the advantages of group interaction while minimizing the risk of counterproductive group dynamics, for example social desirability (Kauko and Palmroos, 2014). For this a panel of experts comes together and a multi-round survey is conducted in which the participants are anonymously answering a questionnaire about a certain topic or matter which is to be forecasted. The answers to be given on these questionnaires are for example to give numerical estimates, answering yes or no questions and making comments on certain points in the questionnaire. The outcome of these questionnaires is then distributed to the participants in for example a statistics format, with no one knowing who answered what. After each round the participants get the opportunity to modify their answers, so after a couple of these questionnaire rounds, a kind of convergence of answers can be observed as an outcome of the group opinion building process (Kauko and Palmroos, 2014). Nowadays, the Delphi method can also be conducted via an online application in real-time on the internet. For this method to produce valuable outcomes, the participants should be experts in the fields, however, with different backgrounds to facilitate the emergence of a better-rounded end result (Kauko and Palmroos, 2014).

The **analogous data method**, works with taking historic data from a related product to forecast the sales for the new product. Here it is crucial to make the appropriate links between the existing and the new product to make the forecast most accurate. This means to form a logical link between the existing and the new product by for example having a look whether the products serve a comparable need or have similar characteristics (Mohr et al., 2014).

The **Bass model** is pre-launch forecasting technique which can be used already without initial sales data available and is most appropriate when there is no closely competing alternative. This model uses the diffusion of innovation to predict sales for the new product (Mohr et al., 2014). The Bass model is a diffusion model which produces as its outcome the 'Bass Curve' with which it is then going to be possible to make inferences about how many units of the products future consumers might buy and when they are going to adapt the new product (Bass, 1969). This is done by explaining the S-curve of a new product, so the assumption that the sales of a product starts slowly, then increases rapidly until the increase flattens again, with the diffusion theory, which is concerned with the understanding why innovations spread in the market (Mohr et al., 2014). So, it has been found that when a new product is launched into the market, early adopters try to reduce the uncertainty about the superiority of the new product by obtaining information about it. Early adopters tend to seek information more through mass media, while later adopters tend to rely more on interpersonal sources, such as word of mouth (Mohr et al., 2014). The formula of the Bass model is

$$n_t = (p \times \text{Remaining potential adopters}) + (q \times \text{Adopter Proportion} \times \text{Remaining potential adopters})$$

Where

n_t is the number of adopters at time t (Sales)

p is the coefficient of innovation (mass media)

q is the coefficient of imitation (word of mouth)

The coefficients can either be estimated by using analogous data (see above) or by using industry values. However, while this method has shown viability and usefulness in helping estimating the sales for new products, there are some underlying assumptions of the model, such as that the coefficients remain constant over time, or difficulties, such as the correct estimation of these coefficients, it can lack reliability in some forecasting situations (Mohr et al., 2014).

5.4.2.2 Are there sufficient financial resources for the development of this new product? (C)

As mentioned above, SMEs generally have limited financial resources for doing their business and operations which also extends to their new product development. Therefore, it is important to have a realistic view on how well the company is equipped to undertake the new product development. For this there are a number of financial analysis tools which can be applied here to help SMEs, such as the net present value (NPV) and the internal rate of return (IRR) to analyze whether the investment of the new product development will lead to a positive return for the SME (Bhuiyan, 2011). However, the IRR will not be discussed in this paper, due to its disadvantages when compared to the NPV method, such as the possibility that there can either be no IRR or multiple IRR, which can lead to confused decision making (Hillier et al., 2011).

The simplest method that can be applied by an SME at this point, is answering a number a screening questions in order to gain awareness and understanding of both their financial situation as well as the financial toll, which the new product development could have on them. These questions include (Schilling, 2010):

- i. How long will the project take to complete?
- ii. If the company misses its target deadlines, what impact will it have on the value of the development project?
- iii. How much will the development process cost? What are the investments associated to the process?
- iv. What is the variability in these costs?

- v. What are the manufacturing costs associated with this new product?
- vi. Will the company need to cover additional costs related to customer adoption after launch (e.g. installation, technical support)?

Answering these screening questions can help the SMEs create valuable awareness of whether they deem themselves well enough equipped to take on these costs and move forward with the development process.

Additionally, the answers to these questions help in calculating the NPV value of a certain new product development project. The net present value is essentially the present value of cash inflows minus the present value of cash outflows, which is done by discounting the future cash flows of a project to their present value. Therefore, a positive NPV indicates a positive return on the investment for undertaking the project (Schilling, 2010). The general formula (Investopedia) for calculating the NPV value is

$$NPV = \sum_{t=1}^T \frac{C_t}{(1 + r)^t} - C_0$$

Where

C_t is net cash inflow during the period t
 C_0 are the total of the initial investment cost
 r is the discount rate. And
 t is the number of time periods

The screening questions help with the calculation of the NPV, since they provide insights to which costs to include in which component of the NPV formula.

For example, C_0 , which is the initial investment cost of the new product development, includes all the cash outflows that are invested in the new product before it reaches the market. This can contain the research and development cost, the additional fixed and variable costs associated with the development, such as the acquisition of new machines and facilities and the additional labor hours for producing the new product.

C_t on the other hand, describes the expected cash inflows, which are obtained after the product has been launched. To help the estimation of these cash inflows, the SME needs to know for example how many units of the product they are aiming to sell to their identified target market based on the previously conducted sales forecast, and what price they are aiming to sell these units for (Hillier et al., 2010). The discount rate can either be identified by calculating the company's weighted average cost of capital (WACC) (s. Appendix 3), if the new product development project has a similar risk profile to the one of the current operations of the company (Hillier et al., 2010) or, if the new development project is riskier than the usual operations of the firm, by using the current treasury bill, or T-bill, as the value of the discount rate (Schmidt, 2013), or an appropriate substitute based on the country of investment.

In spite of the NPV being able to give valuable insights for making estimates about the financial impact and future of a new product development, there are flaws to this method which need to be mentioned and taken into consideration. Firstly, the NPV

method does not take the strategic importance of a product for the company into consideration and secondly, heavily discriminates against developments that take a longer time and are higher in risk and can thereby undervalue a new product if only the strictly financial aspects are taken into account (Hillier et al., 2010). So, while a negative NPV is an important warning sign to not go further with the new product idea, this can be weighed against the strategic importance of the project. However, a go decision with a negative outcome of the financial assessment should only be done in exceptional situations.

5.4.2.3 Is the organization of the process and the relations within the team-members clear and goal-oriented? (O)

This component is related to the organizational type of risk in the new product development process, with implications on how to best manage the people involved in the NPD process. As mentioned above, implementing this manual in a cross-functional setting has been defined as a requirement for the practice of risk management, as it is a substantial component of the risk management process, as there is input from different functions in the company needed to identify and assess the different kinds of risk. Furthermore, studies have found, that culture and climate in the team are influential factors on the success of the product development process (Kahn et al., 2012). While these components are difficult to assess due to their intangible character, main risks with these components entail that there either is no clear NPD group and leader, or at least a clear communication of the objectives of the NPD process and clear allocation of activities, or that the communication between the different functions in the company is poor and that the top management or head of the company does not actively facilitate and motivates the NPD process (Kahn et al., 2012). To assess to what extent these factors pose a risk in the new development process, is very dependent on the company and its culture and employees and can be facilitated through organizational behavioral theories and tools by measuring and assessing for example job attitudes and personality traits in the firm (Robbins and Judge, 2012). As this is a lengthy process and would exceed the scope of this paper, it can be concluded for now, that it is important for the new product development process that tasks and responsibilities are clearly defined and distributed as a condition for the cross-functional team to communicate effectively about the development process.

5.4.3 Development

	Market	Technological	Organizational	Commercial
Development (5.4.3)		Clear supply and production process? Specifics of the prototype clearly defined?		

5.4.3.1 Is there a clear supply and production process in order to provide reliable product delivery? (T)

When creating a new or adjusting an existing operations and supply process for a new product development project, a couple of guidelines can help SMEs to manage the risk in this stage of the process. Since the technical conditions in different firms can be expected to vary

depending on for example the existing or needed facilities for the new product development process, not too much detail can be provided at this point. However, general criteria can be given to assist the managers to identify and minimize the risks in this area. There are four main parts of the planning and control of an operations process for a product which are scheduling, loading, sequencing, and monitoring and control (Slack et al., 2013). These components can be addressed by asking questions such as when to do things?, how much to do?, in what order to do things? and are the things going to plan? respectively (Slack et al., 2013). Within these operations and supply components, a number of potential failures or risks can occur, which can have an impact on the cycle time of producing the new product. These include supply failures, human failures, organizational failures and technology and facilities failures (s. Table 8).

Table 8. Risks in the operations and supply process (Slack et al., 2013)

Supply	Failure in the quality or timing of goods and services (e.g. supplier delivering the wrong or faulty components)
Human	Can either be key personnel leaving the organization or people are making mistakes in their jobs
Organizational	Failure in of processes and procedures (e.g. risks in the designing and resourcing of processes)
Technology and facilities	Facilities include all systems and machines or equipment of a firm and the risk of one of these components failing could cause downtime and thereby delays

One tool which can be used at this point to help prevent risk in these processes occurring is the failure mode and effect analysis (FMEA). The objective of this tool is to identify different risk factors in these processes that would be critical to the different identified failures in the operations and supply process in order to attempt to prevent the failures from happening at all (Slack et al., 2013). There are three main questions used in this approach to assess the different risk factors. These are

- What is the likelihood that failure will occur?
- What would the consequences of that failure be?
- How likely is such a failure to be detected before it affects the customer?

These three questions are then quantitatively evaluated to calculate the risk priority number (RPN) for each of the potential causes of risk (Chin et al., 2009). For example, if the occurrence of one identified risk factor to a failure is rated 6, the severity of the risk rated 8 and the detection of failure rated 2, the risk priority number for this failure would be 96 and would be given a lower priority when eliminating a certain failure than a risk associated to that failure with a higher RPN, for example 160. A

guideline on the rating scales of the FMEA can be found in Appendix 4.

While there are certain identified limitations to this tool, such as that the relative importance between the three questions is not taken into consideration or that the three questions, or factors, of the RPN are difficult to be determined precisely and are more expressed in a linguistic way (e.g. likely, important, etc.) (Chin et al., 2009), this tool can still prove to be very useful in the cross-functional setting of the new product development team when creating awareness and assessing the risks which could occur in the operations and supply process of the product.

5.4.3.2 Are the specifics of the prototype clearly designed for first testing and evaluation? (T)

In order to make the product idea more tangible and to test it for technological durability and maybe even customer opinions as mentioned above, a prototype of the product idea can be constructed based on the product requirements which have been established. A prototype is a simplified version of the new product with the focus on the most important product features (Grit, 2015). At this step, it is important to be precise and articulate about the expected and desired product characteristics, such as durability or feel, which have been developed and verified in the steps above. This is relevant as the prototype is going to be tested and the results of said test evaluated in the following stage, which is why it is important to have clearly formulated what is expected of the prototype.

5.4.4 Testing and Validation

	Market	Technological	Organizational	Commercial
Testing and Validation (5.4.4)		Does the testing of the prototype reach the pre-defined criteria?		

5.4.4.1 Does the testing of the prototype reach the clearly pre-defined criteria? (T)

After the prototype has been designed in the step above, it now needs to be tested whether the prototype is successful in the testing phase. While the exact testing situations are likely to vary depending on the company and type of product which will be tested, the product testing should generally be done in a rigorous, robust and realistic way (Kass, 2015). Rigorous implies that the test needs to provide sufficient power, confidence, and resolution to be able to detect and correctly interpret the both desired and undesired outcomes of the testing, while robust highlights the importance of the test to cover the complete range of factors which can be expected during the operation of the product item. Finally, the realistic characteristic of the testing means that the test has to include representative operators, scenarios and measures which are representing the actual operating environment of the product (Kass, 2015).

As the rigorous dimension of the testing is concerned with establishing the correct cause and effect relationships between observed outcomes and their causes, tests need to be run more than once to be able to differentiate between the actual causes and effects of the observed outcomes from random or ‘noise’ observations. In a product test the rigorous dimension could for example be fulfilled by either running the durability test a number of times in order to be sure

that the product can withstand the external impact or by testing the product with a relevant portion of the identified target market. As the testing of the prototype can be done in collaboration with customers as mentioned above, however, since the product is a radical innovation, there are some additional factors to consider. Since a product idea which is classified as a radical innovation can be expected to be advanced and new to the market and the customers, the right customers need to be selected for prototype testing, so that the testing will have a useful outcome for the company (Lettl, 2007). This means that these users for prototype testing should be lead users of the target market and therefore have not only have relatively high knowledge about the general type of products, but is also interested and motivated to engage in the thinking and testing of a new product idea (Lettl, 2007). These lead users can be identified through reviewing the target market defined in earlier steps to be able to research users in the market which would be most interesting for and interested in the prototype testing. Furthermore, prototypes can be tested on their durability under surroundings which the final product might have to endure.

The robustness of the test is characterized as identifying and assessing all relevant factors of the product, both in the testing as well as the actual operation setting the product would usually be used in. Therefore, different conditions need to be considered when testing an item in addition to the conditions identified in the product requirements. For example, when having lead users test the product, it might be observed that the users are using the product in a different setting than expected, which could give new insights into the potential of the product.

The realistic dimension of the product testing is about increasing the validity of the test outcomes to for example the rest of the market by ensuring representative testers, performance measures and test environment (Kass, 2015). This aspect of testing can be facilitated by using a scenario analysis to create scenarios in order to be able to explore and define under which circumstances and with whom the product should best be tested (Weidenhaupt, 1998).

If the prototype is not meeting the set criteria, the reasons for the failure need to be identified and solutions for the identified problems created. Should it not be possible for the team to create feasible solutions to correct for the identified errors in the prototype, the product requirements might need to be reviewed or the design updated based on the outcome of the prototype testing. Should the outcome of the prototype testing should be successful and the design concept of the product along with the technological requirements of the product can be validated, the product idea can move forward in the development process.

5.4.5 Launch

	Market	Technical	Organizational	Commercial
Launch	Clear process to measure the product acceptance and marketing sales?			

5.4.5.1 Is there a clear process to measure the product performance after launch? (M)

Once the new product has been developed and launched, it is important to measure the success in the market of the new product, to assess further implications for the processes of the firm. Not only is this needed to adjust for order quantities and such, but also to see whether the product is yielding the expected return as predicted before, or not (Huang et al., 2004). Should the product not yield the expected return and this is noticed timely through various measures, the company can take action to identify where problems might lie and try to positively influence sales numbers. For example, if sales are lower than expected, maybe the marketing efforts of the company regarding the new product to the target market can be intensified to raise more awareness about the company's innovation.

6. CONCLUSION

The purpose of this literature based research was not only to identify which risks an SME might encounter throughout the new product development process, but furthermore to create a manual to provide tools and measures which can aid SMEs in identifying, assessing and managing those risks. To achieve this, a methodological research strategy was created to help answer the identified research questions in this paper and thereby identify what is generally understood by risk or risk management, which types of risks can be found in the development process, what the requirements for a useful risk management manual for SMEs are, how SMEs can diagnose risk in their new product development process and what kind of tools and measures SMEs can use to help manage their identified risks. Once all these aspects of the sub-questions established for this research are investigated and answered, the overall research questions of *What are the relevant risks for SMEs in the NPD process and how can these be managed?* can be answered.

When assessing the general perceptions and definitions of risk and risk management in existing literature, it became apparent that it is perceived as the identification, assessment and prevention of undesirable situations occurring throughout the new product development process, which is the definition which was used to describe these terms for the remainder of the paper. While there were many sub-categories of risk identified in the NPD process, which can also vary depending on the industry the company is competing in, the four main risk categories identified were market, technical, organizational and commercial risk, which need to be monitored and measured throughout the development process, since they have an impact on how successful the product of a company will be after launching it to the market. With this initial understanding of the NPD process and its risk components in mind, the requirements for a useful and valuable tool for SMEs could be identified. Since SMEs need to be aware of the risks when developing and launching their new product to avoid market failure of the product and the severe consequences this could have on the company, but usually have limited resources to do so, the risk management manual for the SME needs to be simple but effective and easy to use. Therefore, to facilitate straight-forward identification of the different risks, screening questions have been formulated based on the components of the NPD process and their risks to create an intuitive and fast way of identifying the main risk components for the SME which can have a large impact on the success or failure of their product development. After these questions were formulated, tools and measures were identified that can help answer these screening questions and help the manager of the NPD process to make better informed decisions about the prospects of the new product throughout the development process.

With all these outcomes of the sub-research questions, it can now be concluded, that the most relevant risks for an SME to address in the NPD process are market and commercial risk factors, especially in the first two stages of the new product development process. SMEs generally have simple structure and communication processes within the firm, so they best benefit from a manual which is easy to implement in the existing procedures around new product development and which creates a general understanding among all members involved in the NPD process from different functions. Furthermore, the straightforward character of first providing screening questions for identifying the risk in the process and then a set of tools to help further conceptualizing and managing the risk, with the use of visual aids throughout the manual, provides an understandable guideline for SMEs to follow and manage their risk and increase the chances of developing a successful new product.

6.1 Managerial Implications

The main managerial implication to be drawn from this research for an SME, is to not underestimate the risks that can be encountered in the new product development process. Furthermore, special attention is to be drawn to the first two stages of the NPD process, since it has been found that this is where most new products fail. While the actual failure usually is only detected after launch, when the product does not meet its estimated targets and the company is losing money, this is often due to improper research and assessment in the beginning of the process. Moreover, the requirement for the usage of the manual to be used in cross-functional settings should not be underestimated. Due to the different kinds of risks in the NPD process, knowledge from all functions needs to be taken into consideration in order to identify the risk properly as well as manage it with the tools in an effective manner. This manual provides a clear guideline for SMEs on what risks to focus most on in the NPD process, or rather, which risks not to underestimate if they want to be successful with their new product.

6.2 Limitations and Further Research

Some limitations of this research should be noted. Due to the limited time frame of this research, the outcomes and contents of this paper have not yet been tested in the NPD process of SMEs, although great care has been taken in identifying and implementing relevant literature for creating this paper, and thereby the manual. Moreover, the scope of this paper has been on the risks which are most commonly the most important for SMEs, as identified during the literature review, therefore the list of screening questions and the associated tools and approaches are not yet complete. Therefore, the table of the manual is not to be understood in the sense that there are no relevant risks to be encountered there, but rather that they simply could not have been covered for the scope of this research. Additionally, while the proposed structure of the tool section was to include a conceptualization of the most important terms, followed by an introduction of the tools over to a guide on how to use the tool, especially the last step, was not always possible in a great level of detail. This is due to the industry and company specific factors that at some point begin to influence the proper application of the tools, so some of the tools had to remain more general for this paper. Additionally, since the manual has yet to be tested, it cannot be yet said, whether the tools introduced in the manual will be useful for all SMEs or how some of them might have to

be altered in practice to fit the characteristics of the SMEs even better. Based on the limitations identified above, some further research is suggested to dive deeper into making this manual even more applicable and implementable for SMEs. Firstly, while the research conducted in this paper provides a solid base for a risk management manual to be used by SMEs in their new product development, it now needs to be extended and tested in practice. This means both including even more risk factors on the theoretical side which can additionally be identified in current literature as well as testing the manual in collaboration with actual SMEs to assess the usability and advantages of the manual under real conditions. Moreover, testing and using the tool leads to a continuous learning process, through which the manual can constantly be improved and updated. This means that by using the manual in different SMEs in different industries, will enable the manual to become more and more detailed and specific to the special circumstances of different types of firms and different types of innovation.

7. ACKNOWLEDGEMENTS

My gratitude goes to my supervisors Dr. Matthias de Visser and Dr. Michel Ehrenhard for their feedback and guidance during the past weeks of writing my Bachelor thesis. Furthermore, I would like to thank the fellow students of my Bachelor circle, as well as my friends for the support during finalizing my thesis.

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9. APPENDIX

Appendix 1: Countries that use NACE Codes (SICCODE)

Austria	Ireland
Belgium	Italy
Bulgaria	Lithuania
Cyprus	Luxemburg
Czech Republic	Latvia
Germany	Malta
Denmark	Netherlands
Estonia	Poland
Greece	Portugal
Spain	Romania
Finland	Sweden
France	Slovenia
Croatia	Slovak Republic
Hungary	United Kingdom

Appendix 2: Product Performance criteria (Source: Trott, P. (2012))

1) Performance in Operation	2) Reliability
3) Sale Price	4) Efficient delivery
5) Technical sophistication	6) Quality of after-sales service
7) Durability	8) Ease of use
9) Safety in use	10) Ease of maintenance
11) Parts availability and cost	12) Attractive Appearance/shape
13) Flexibility and adaptability in use	14) Advertising and promotion
15) Operator comfort	16) Design
17) Environmental Impact	

Appendix 3: Formula and Components of the WACC

$$WACC = \frac{E}{V} \times RE + \frac{D}{V} \times RD \times (1 - TC)$$

V	This is the combined market value of the firm made up of debt and equity
E	The E stands for equity which is the market value of the firm's equity
RE	This stands for the cost of equity which is the return which equity investors require on their investment in the company
D	The D stands for debt, which is the market value of a firm's debt
RD	This is the cost of debt and stands for the return which lenders require on the debt of the company
(1-TC)	This stands for the corporate tax rate of the firm

Appendix 4: Rating Scales for FMEA

Occurrence of failure	Rating	Possible failure occurrence
Remote probability of occurrence	1	0
Low probability of occurrence	2-3	1:20.000
Moderate probability of occurrence	4-6	1:2.000

High probability of occurrence	7-8	1:100
Very high probability of occurrence	9	1:10
Severity of failure	Rating	
Minor severity	1	
Low severity	2-3	
Moderate severity	4-6	
High severity	7-8	
Very high severity	9	
Catastrophic	10	
Detection of failure	Rating	Probability of detection
Remote probability that the defect will reach the customer	1	0-15%
Low probability that the defect will reach the customer	2-3	6-25%
Moderate probability that the defect will reach the customer	4-6	26-55%
High probability that the defect will reach the customer	7-8	56-75%
Very high probability that the defect will reach the customer	9-10	76-100%

(Source: Slack, 2013)