Final MSc Thesis

Optimised NPD: How to Put the Theory into Practice – A German Case Study from Mechanical Engineering –

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Abstract

This research paper investigates how a German premium mechanical engineering manufacturer can optimise its current NPD process according to the contemporary scientific literature. Furthermore, this research paper investigates how the company can ensure the successful implementation of an optimised NPD process amongst its employees since this constitutes a major challenge to companies in the German mechanical engineering industry. To that end, the company's current NPD process was described and analysed before a future state which is based on the findings of the current scientific literature was designed. In a final step an implementation plan was devised for how to successfully implement the proposed changes to company XYZ's current NPD process amongst its employees. The implementation plan is based on the findings of the current scientific literature dealing with successful change management. As the findings of this research paper show, company XYZ is advised to primarily restructure its current NPD process. Secondly, company XYZ is advised to incorporate technology road mapping in its strategy formulation process, introduce a formal and systematic portfolio management process using ranking and financial evaluation methods altogether, make use of/develop a NPD evaluation software tool, make use of product modules also across its different product categories, make its departments responsible of the timely execution of a NPD activity, introduce a comprehensive visual management system to be able to react to NPD project deviations directly and to create transparency within the organisation and to train its employees in terms of leadership behaviour and leadership abilities, so that a more effective and more efficient NPD process is attained.

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1 Introduction

Nowadays, many manufacturing companies face the challenge of having to provide their customers with continuously new and tailor-made products if they want to ensure the competitiveness and the growth, thus, the long-term survival of the company (Baumol, 2002) (Schumpeter, 1939). Shortening product life cycles further elevate the pressure to innovate (Bünting, et al., 2015). Therefore, new product developments (short: NPDs) are considered 'the nexus of competition' (de Visser, 2013, p. 2) and are the reason why managers these days are on the continuous lookout for new, proven ways of how to mould their companies' NPD processes to be more effective and more efficient while at the same time not diminishing the companies' innovative capabilities (Bünting, et al., 2015) (Kahn, Barczak, & Moss, 2006). Effective and efficient NPD processes are regarded as a potential source of competitive advantage, while companies that fail to innovate i.e. that fail to bring novel products that fit the needs of the customer to the market, are considered to be at a disadvantage (Brown & Eisenhardt, 1995) (de Visser, 2013).

In Germany, the mechanical engineering industry is considered as one of the most innovative industries producing technologies of great, worldwide success. With a volume of €5.4 billion the research and development expenditures of the German mechanical engineering industry accounted for about ten percent of Germany's total research and development expenditures and for about 5.5 percent of Germany's gross domestic product in 2013. Remarkable figures for an industry dominated by medium-sized companies. 90 percent of the companies in that particular industry employ less than 250 employees. However, the industry cannot effort to lean back either. The increasing competition from Asia is one of the reasons why (Bünting, et al., 2015). Next to that, a recent study by the Staufen AG and the Verband Deutscher Maschinen- und Anlagenbau (short: VDMA) (2015) revealed that there is room for further improvements amongst Germany's mechanical engineering companies with regard to their current NPD processes. According to that study, current NPD processes in Germany's mechanical engineering industry are characterized by extended development times, a lack of standardisation and a too great variety of products. The study also found out that 39 percent of all NPD projects fail due to several reasons, and very often multiple reasons at the same time. The most common reasons identified are that a project is not finished on time (83 percent), that the newly developed product is in the end too costly to manufacture (59 percent), that the development of a new product is more expensive than initially planned for (32 percent) or that a newly developed product does not adhere to qualitative and/or functional standards (13 percent).

Besides that, the study concluded that merely six percent of all NPD projects in the industry are, in the end, a success on the market (Bünting, et al., 2015). According to Bünting et al. (2015) this marginal success rate stems from a majority of NPD projects being approached in an intuitive, unsystematic way. Coordinated NPD processes for the purpose of transforming a new product idea into an actual, innovative product seldom exist amongst companies in the industry. Even if a company has initialized a new, systematic NPD process, that new, systematic process is rarely implemented by a company's employees. Of the companies of a

size of 100 to 500 employees in the sample 80 percent had introduced a standardised NPD process, but only by 28 percent of the companies' employees the process was also implemented (Bünting, et al., 2015).

The primary goal of this research paper is to design a more effective and more efficient NPD process for a German mechanical engineering manufacturer. In addition, this research paper attempts at illustrating how to successfully implement the changes suggested to be made to the company's NPD process amongst its employees, so that the new process is actually used in practice. As shown before, the successful implementation of change poses a major challenge to the German mechanical engineering industry. Company XYZ is a premium mechanical engineering manufacturer and the current market leader in its respective field which is why company XYZ is looking for a way of how to further optimise its current NPD process without having to make any compromises with regard to its innovative capabilities. It is of importance to company XYZ that future NPD projects are brought to the market in time, adhere to the company's qualitative and functional standards and can be developed and the final product be built within the targeted cost brackets. Consequently, the central research question of this research paper is:

How to make company XYZ's NPD process more effective and more efficient and how to implement the proposed changes to company XYZ's NPD process in practice?

In a first instance the current NPD process of company XYZ is described and analysed 'to capture a snapshot of how things are done and where the improvement potentials lie' (Seth & Gupta, 2005, p. 45). After that a future state will be 'discussed to show how things should be done' (Seth & Gupta, 2005, p. 45) according to the findings of the current scientific literature. In a final step an implementation plan is devised for how to successfully implement the proposed changes to company XYZ's current NPD process amongst its employees. This implementation plan is also based on the findings of the current scientific literature i.e. on how to successfully implement change in organisations.

The rest of this research paper is structured as follows: the next section will review answers by the current scientific literature to a set of sub-questions relevant to answering the central research question of this paper. In chapter 3 the methodology is described. Following that, it is elaborated on the current problems and business consequences company XYZ faces regarding its current NPD process. Chapter 5 provides a description of company XYZ's current NPD process, presents the conducted analyses as well as the findings of this case study. Section 6 discusses the implications and limitations of the study and chapter 7 concludes the paper.

2 Literature Review

To be able to answer the question central to this research paper one has to provide answers to a set of different sub-questions first. Those sub-questions are: (1) How to identify the improvement potential in a company's current processes? (2) What does an ideal NPD process look like? (3) How to successfully implement change amongst a company's employees? In this section of the paper the answers to these sub-questions given in the current scientific literature are reviewed.

2.1 How to Identify the Improvement Potential in a Company's Current Processes?

Since the success of most businesses is nowadays dependent on the efficiency and the effectiveness of an organisation's core processes, researchers and practitioners developed several tools and techniques for identifying and eliminating all kinds of process inefficiencies over the years (Ballé & Ballé, 2005) (Niedermann & Schwarz, 2011) (Seth & Gupta, 2005). Triggered by the advancing globalisation and the advancing digitalisation the trend shifted from the optimisation of individual business functions towards the optimisation of entire business processes. This trend is commonly referred to as either Business Process Reengineering (short: BPR) or Business Process Optimisation (short: BPO) (Hammer & Champy, 1993) (Niedermann & Schwarz, 2011). In the course of this research paper it will be referred to as BPO since the overall goal of this case study is the optimisation of company XYZ's current NPD process and not just the reengineering of that particular process.

2.1.1 BPO: Procedure and Challenges

In general, BPO comprises three steps: (1) data integration, (2) data analysis, and (3) detection and implementation of improvements. The overall goal of BPO is selecting 'the right process designs and the application of the most appropriate optimization techniques' (Niedermann & Schwarz, 2011, p. 89). In the following the three different steps in BPO as well as the challenges it is important for BPO to overcome are reviewed in greater detail.

The first step in BPO, data integration, is concerned with gathering and integrating all data possibly relevant to the business process under investigation. Generically speaking two sorts of data need to be gathered and integrated at this stage. For one, process data needs to be collected i.e. the process paths taken, the duration of the individual activities, etc. Secondly, operational data is needed. Operational data refers to e.g. information about process subjects. In a second step – data analysis – the process model created at the end of stage one and the rest of the gathered data are analysed. The tools and techniques that can be used to analyse the given data range from the calculation of process duration times or process related costs to data mining techniques. Lastly, the detection and the implementation of the improvements take place. During this step of the BPO process inefficiencies are disclosed and ways of how to overcome the disclosed process inefficiencies

are devised i.e. tools, techniques, strategies of how to optimise the investigated business process are presented. This also entails strategies on how to implement the process improvements in practice (Niedermann & Schwarz, 2011).

Nonetheless, to ensure that BPO is also effective in practice several challenges with regard to BPO have to be addressed first. In practice the first two steps in BPO – data integration and data analysis – often do not receive the necessary attention and are, in default thereof, poorly executed. The major problems at these stages of BPO are that usually only very simple analysis tools and techniques e.g. metrics are used and that very often optimisation tools and techniques only take into account a single source of data. In addition to that, many optimisation tools and techniques have been developed in isolation which is why the combination of different optimisation tools and techniques can be problematic and the interpretation of the results should be done after careful consideration of the respective results. Lastly, 'there is little to no integration between the different BPO steps, which makes especially the application of complex optimization [tools and] techniques difficult' (Niedermann & Schwarz, 2011, p. 90).

2.1.2 BPO: Tools and Techniques

The use of BPO tools and techniques is 'often limited as both the selection and the application of the appropriate techniques are challenging tasks' (Niedermann & Schwarz, 2011, p. 88). Consequently, many tools and techniques are disregarded by practitioners, and potentially resulting process improvements are not implemented as a result. Nonetheless, one optimisation technique commonly used in practice is benchmarking. Through the identification of discrepancies between an organisation's practices and the practices used by the wider industry, and especially those practices used by its industry leaders, benchmarking is viewed as a sophisticated technique of how to attain not only an increase in business performance, but also as a way of how to achieve a sustainable, competitive advantage over the other actors in an industry.

In benchmarking the identification of discrepancies between an organisation's and an industry's practices, thereby emphasizing which organisational practices need to be replaced, adapted, or which other practices to include, is done in three successive phases: (1) performance benchmarks to obtain data describing the discrepancies between an organisation's and an industry's practices, (2) process proficiency i.e. the phase during which the organisation performing the benchmark archives its current business processes, and responsibilities for certain business process improvements are assigned with the goal of becoming more accomplished, and (3) best practice mastery which refers to an industry's practices regarded as best practices by the organisation performing the benchmark being incorporated into its own practices. A valuable optimisation tool for performing the first two phases of a benchmark is a best practices framework. A best practices framework 'provides a standard set of descriptions and characterizations and a basis of evaluation for complex functional processes' (Kahn, Barczak, & Moss, 2006, p. 108) as well as a better understanding of the functioning of those processes with regard to their performance, key

challenges, and suggestions for further process improvements. In other words, a best practice framework provides 'a context in which to describe one's own activities and to delineate process characteristics as being favourable or unfavourable' (Kahn, Barczak, & Moss, 2006, p. 108) in addition to a direction for suggestions of other practices with the purpose of adding a surplus to an organisation's current business performance (Camp, 1998).

Besides benchmarking and the use of a best practices framework Value Stream Mapping (short: VSM) is another valuable BPO technique often used in practice. VSM can be defined as 'the simple process of directly observing the flows of information and materials as they now occur, summarising them visually, and then envisioning a future state with much better performance' (Jones & Womack, 2000, p. 1). While the current status is analysed to see how things are done and where the potential for process improvements lies, the future state describes how things should be done (Seth & Gupta, 2005). Whilst there are numerous VSM tools for the reduction and elimination of different wastes already newer classifications and application areas keep on emerging (Beesley, 1994) (Forza, Vinelli, & Filippini, 1993) (Hines & Rich, 1997) (Jessop & Jones, 1995) (New, 1974) (New, 1993) (Seth & Gupta, 2005). The work of Hines and Rich (1997), for example, offers a classification of seven different VSM tools: (1) process activity mapping (origin: industrial engineering), (2) supply chain response matrix (origin: time compression/logistics), (3) production variety funnel (origin: operations management), (4) quality filter mapping (origin: new tool), (5) demand amplification mapping (origin: system dynamics), (6) decision point analysis (origin: efficient consumer response/logistics), and (7) physical structure mapping (origin: new tool) which is considered very useful in its respective areas of application.

Overall, VSM tools are developed with two requirements in mind. Firstly, to 'understand the interdependence of one function, department or even whole unit over an other, and to capture a holistic view about a situation where the conventional industrial engineering recording tools do not help much' (Seth & Gupta, 2005, p. 46). VSM is regularly used in organisations' efforts to become more lean. This means that VSM is regularly applied by organisations in an effort of enhancing the value stream of a certain business process i.e. an organisation's effort of enhancing the efficiency of a particular business process such as in NPD (Mascitelli, 2011). The concept of lean, commonly referred to as lean manufacturing or lean production, is a concept which originated at the Toyota Motor Corporation (short: Toyota) almost 30 years ago. The ultimate goal of lean is the reduction of waste to a minimum level to ensure a maximum level of flow in an organisations business processes (Shingo, 1989).

In the beginning, lean was solely meant to improve productive capacities but gradually it became apparent that lean also constitutes a solution to the problems underlying other sorts of wastes such as poor quality and other fundamental management problems (Seth & Gupta, 2005). Anything that does not add any value to the final product or that exceeds the minimum of resources to create value for the final product can be ascribed as waste. This also entails that waste can be found anywhere i.e. in policies, procedures, product designs, etc. (Russell & Taylor, 1999) (Seth & Gupta, 2005). A more elaborate classification was provided by Monden in 1993. Monden distinguishes between three common categories: (1)

non-value adding (short: NVA), (2) necessary but non-value adding (short: NNVA), and (3) value adding (short: VA) (Monden, 1993). A few tools used in lean manufacturing to reduce waste include e.g. one-piece flow, visual control, Kaizen, cellular manufacturing, inventory management, Poka yoke, standardized work, workplace organisation or scrap reduction (Russell & Taylor, 1999).

2.2 What Does an Ideal NPD Process Look like?

As stated in the previous section one valuable tool in BPO is the use of a best practices framework because best practices resemble those practices that have already shown to be working for other organisations in practice (Dooley, Subra, & John, 2002). Such a best practices framework for NPD has been established by Kahn et al. in 2006. This NPD best practices framework defines NPD as a process comprising of six different dimensions which are evaluated across four levels of sophistication: (1) poor/rudimentary practice, (2) better practice, (3) good practice, and (4) best practice by the established framework.

While levels two and three describe competitive practices, level four practices are practices leading to a distinctive, competitive advantage according to Kahn et al. (2006). The six dimensions a NPD comprises and which are evaluated amongst these four levels of sophistication of the framework are: (1) strategy, (2) portfolio management, (3) process, (4) market research, (5) people, and (6) metrics and performance evaluation. The first dimension, strategy, refers to defining and articulating an organisation's NPD focus including NPD opportunities as well as the real and unarticulated needs of its customers. Portfolio management describes the practices used to distinguish between those NPD projects with which to continue in the NPD process and with which NPD projects to stop. The process dimension includes all the activities and gate criteria in an organisation's NPD process from the start of the NPD process until the launch of the final product. Market research refers to learning to understand trends in an organisation's macro-, meso- and micro-level environment. The people dimension is concerned with the human resources available and team-related initiatives while the sixth dimension, metrics and performance evaluation, is concerned with the practices included in the evaluation, the recognition and the reward of a NPD project.

The benefit of such a framework is that it illustrates what an organisation needs to do to transition to higher levels of sophistication if an organisation does not rate itself as best practice (level four) already on any of the six before mentioned dimensions of a NPD process. In the end, Kahn et al. (2006) conclude that organisations should, for one, introduce a strategic, long-term orientation with regard to NPD, implement a formal portfolio management process as well as an overall, formalised NPD process, conduct proactive market research, make use of cross-functional teams and employ standardised evaluation criteria and metrics to optimise their current NPD processes. At the same time Kahn et al. (2006) mention that while the framework favours formalised NPD processes, 'too much formalization also has the potential of stymieing the NPD process to a standstill – both in terms of novel ideas and speed' (Kahn, Barczak, & Moss, 2006, p. 114). Instead, it is far

more likely that a curvilinear relationship prevails between the introduction of formalised practices and the stimulation of NPD. Even more so, there is no one size fits it all NPD process meaning that 'companies essentially need to develop a customized NPD project portfolio and a corresponding mixture of processes that together meet strategic innovation needs across incremental projects, extensions into new markets, and radical innovation projects' (Kahn, Barczak, & Moss, 2006, pp. 114-115) (Loch, 2000). Therefore, more research is required to find out whether NPD sophistication is the reason for sustainable bottom-line benefits (Kahn, Barczak, & Moss, 2006).

Other than Kahn et al. (2006), Bünting et al. (2015) describe the NPD process as a process comprising of eight different dimensions: (1) developmental strategy, (2) technology and product development, (3) innovation process, (4) development process, (5) developmental organisation, (6) multiple project management, (7) directing system, and (8) shop floor management. Bünting et al. (2015) also describe how an optimal NPD process is characterised across the eight different dimensions of the NPD process. A sophisticated developmental strategy, for one, leads to a targeted NPD process with minimised risks and has a sustainable influence on the quality, functionality and the manufacturing costs of the final product according to Bünting et al. (2015). Besides that, an efficient technology and product development is characterised by modularity, the existence of clearly defined interfaces, taking into account the current stages products are in in their respective product lifecycles as well as the customers' experience and the avoidance of over engineering. An effective and efficient developmental process distinguishes between innovative (third dimension) and developmental process (fourth dimension) with an optimal developmental process being characterised by a focus on customer oriented products and the avoidance of NVA activities. A lean developmental organisation as Bünting et al. (2015) call it is characterised by segmenting products based on major competencies in the organisation, the use of cross-functional teams, independent product managers and the respective departments solely being responsible for being on time. Efficient and effective multiple project management means having to prioritise NPD projects in accordance with the overall business strategy of the organisation, to govern NPD projects based on their adherence to the development schedule, an utilisation of (human) resources of maximally 80 percent, etc., while an optimal directive system leaves room for continuous BPOs, enables employees to solve problems on their own terms and pays attention to the generalisation and specialisation of certain skills crucial to the organisation. Lastly, efficient and effective shop floor management makes use of tools such as visual management, systematic problem solving processes and increases the business performance by the use of appropriate leadership skills and behaviours (Bünting, et al., 2015).

The key challenge in designing an optimised NPD process for company XYZ is that the company is looking to increase the effectiveness and the efficiency of its NPD process while maintaining its innovative capabilities. In this regard Toyota is once more taking on a leading position. As Ballé and Ballé (2005) describe it: 'Toyota's product development process is just as innovative and counter-intuitive to traditional engineering management as lean manufacturing is to mass production' (Ballé & Ballé, 2005, p. 18). Twelve years back Toyota's NPD process was eight times more efficient than the NPD processes of its

competitors in the US for example. Therefore, Ballé and Ballé (2005) labelled Toyota's NPD process as lean and the concept of lean development emerged.

According to Ballé and Ballé (2005) lean development at Toyota starts with its engineers taking into account the responses, needs and wants of its customers with regard to a product. These are then used for the creation of a clear vision of the new product to be developed which sometimes can even be fundamentally challenging of the existing product. This vision then serves as a reference to 'arbitrage conflicting constraints within the design process' (Ballé & Ballé, 2005, p. 18). This requires that the vision of the new product to be developed is clearly communicated amongst all of those involved in the development of the new product. Taking the customer into account can, thus, be summarized as the first lean development principal at Toyota. The second principal of lean development at Toyota is that the possibility of late engineering changes is limited to avoid late, disruptive engineering changes as much as possible. In fact, no engineering changes are allowed after production drawings are released at Toyota. At Toyota this is referred to as the Perfect Drawings or Zero EC principal. While the first two principals of Toyota's lean development are concerned with its design process the latter two principals focus on the actual production of the new product to be developed. The third principal is concerned with 'mastering the flow of drawings and tool elaboration' (Ballé & Ballé, 2005, p. 18). Firstly, is the production of the final drawings planned with very much accuracy. This is only possible because large key issues are already resolved during Toyota's design process. Second of all, enabled the use of digital assembly software Toyota to cut the amount of vehicle prototypes by 65 percent and the number of crash tests by 50 percent. The last principle of Toyota's four lean development principles focusses on the actual production of the final product. It takes into regard the costs to manufacture the final product as well as the quality of the final product.

To be able to develop a new product as efficient as possible Toyota takes a look at all aspects of the remaining NPD process once the final drawings are released to ensure that the new product 'will be built within the targeted cost brackets' (Ballé & Ballé, 2005, p. 18). Nevertheless, the Toyota NPD process does not simply resemble a collection of NPD best practices. In fact, it resembles a complete system. Often the purpose of individual NPD practices only becomes apparent within the system and very often NPD practices that work very well within the system do not prove to be effective on their own. Therefore, taking a look at how Toyota's NPD is built up in general yields better insights into understanding the system behind Toyota's lean development process. In general, it consists of four distinct phases: (1) a concept phase leading to the chief engineer's concept paper, (2) a system-designed phase with concurrent engineering, (3) a detailed design phase with design standards, and (4) a prototype and tooling phase with lean manufacturing (Ballé & Ballé, 2005).

2.3 How to Successfully Implement Change amongst a Company's Employees?

To fully answer this sub-question this part of the literature review deals with two aspects crucial to successful change management. The first section discusses the process of how to

implement change within organisations. Different models of implementing change within organisations that are recommended for change agents to follow if a change is to be successfully implemented within an organisation are discussed here. The second section is concerned with what employees experience during change processes. It is of importance to get a better understanding of why employees decide either to implement or not to implement a new process in practice before someone is to introduce a new process within an organisation if it is to be avoided that the change efforts will fail (Armenakis & Bedeian, 1999) (Kotter, 1995). In the end, it are those employees affected by the change who decide on whether or not a change process is of success. If those employees affected by the change decide to also use e.g. the new NPD process in practice the change management efforts are of success, but if those employees affected by the change decide not to confirm to the changes the change management efforts undertaken inevitably failed.

2.3.1 Implementation of Change within Organisations

In 1947 Kurt T. Lewin was the first one to introduce a descriptive model of change processes (Armenakis & Bedeian, 1999) (Cameron & Green, 2015). Lewin (1947) describes change as a continuous process going through three successive phases. The first phase, unfreeze, is about examining the current status quo and about preparing to make the change happen. The second phase, move, relates to moving to the desired state through participation and involvement while the third phase, refreeze, is concerned with establishing the new status quo permanently (Lewin, 1947). On the basis of Lewin's conceptual model several researchers came up with other multi-phase models that change agents shall follow through if organisational change is to be implemented successfully in the years thereafter (for a more comprehensive overview of this research see Cameron & Green, 2015).

Judson (1991), for example, describes a model of how to implement change that comprises five different phases: (1) analysing and planning the change, (2) communicating the change, (3) gaining acceptance of new behaviours, (4) changing from the status quo to a desired state, and (5) consolidating and institutionalising the new state. Judson also elaborates on predictable reactions to the change and how to overcome the resulting resistance to the change efforts undertaken. Alternative media, reward programs, and bargaining and persuasion are amongst the different methods Judson discusses to overcome the, to be expected, resistance in the different phases of the change process (Judson, 1991). Kotter (1995), on the other hand, introduces eight steps to leading change in the way organisations operate: (1) establishing a sense of urgency by identifying the need for change, (2) forming a powerful guiding coalition that has enough power to implement the change in the organisation, (3) creating a vision that functions as a reference to the change efforts and devising strategies to arrive at the desired state, (4) communicating the vision, first and foremost, through the guiding coalition leading by example, (5) empowering others to act on the vision whilst overcoming obstacles to the change efforts, (6) planning for and creating short-term wins to reinforce the upsides of the change amongst the employees and to create momentum for continuous change efforts e.g. through visualising performance improvements and by rewarding those actively engaging in the new processes leading up to

the improvements in performance, (7) consolidating improvements and producing still more change to make sure the transformation does not end along the way and using the momentum created to do so, (8) institutionalising new approaches through showing the connection between the improvements in performance and the new processes implemented (Kotter, 1995).

Besides that, Galpin (1996) stresses the significance of an organization's culture embedded in its rules and policies, customs and norms, ceremonies and events, and rewards and recognition. Galpin proposes a wheel of nine wedges: (1) establishing the need to change, (2) developing and disseminating a vision of a planned change, (3) diagnosing and analysing the current situation, (4) generating recommendations, (5) detailing the recommendations, (6) pilot testing the recommendations, (7) preparing the recommendations for rollout, (8) rolling out the recommendations, and (9) measuring, reinforcing, and refining the change (Galpin, 1996). Later on, in 1999, Armenakis et al. develop two models combining parts of Lewin's work (1947) with the theory of social learning (Bandura, 1986). While the first model stresses the importance for the readiness for change which is created when the resistance towards change is minimised, the second model is concerned with facilitating the change, so that the change is actually taken up and institutionalised. The purpose of both models is, thus, to get those affected by the change to support it i.e. becoming agents of change.

The assumption underlying both of the models is that the basic change message is transmitted successfully. To be transmitted successfully the basic change message has to contain the following elements according to Armenakis et al. (1999): (1) discrepancy which refers to the need for change, (2) self-efficacy, in other words, that it is possible to successfully change, (3) personal valence to show that change is in the benefit of all, (4) principal support to illustrate that those affected by the change are supportive of it, and (5) appropriateness to strengthen that the desired change is right for the focal organisation (Armenakis, Harris, & Feild, 1999). Besides that, Armenakis et al. (1999) also devise strategies on how to efficiently transmit the basic change message which are of equal importance to researchers and practitioners. Those strategies entail: (1) persuasive communication such as speeches by change agents and articles in employee newsletters, (2) active participation by those affected achieved by vicarious learning, enactive mastery, and participative decision making, (3) certain human resource management practices e.g. selection, performance appraisal, compensation, and training and development programs, (4) symbolic activities i.e. rites and ceremonies, (5) diffusion practices such as best practice programs and transition teams, (6) management of internal and external information, and (7) formal activities that demonstrate support for change initiatives e.g. new organizational structures and revised job descriptions (Armenakis, Harris, & Feild, 1999).

All of these models illustrate the change process as a process of multiple, subsequent stages. Planning and executing such processes requires time and effort. Any mistake such as skipping any of the stages in the change process to speed up the implementation of the intended change will, therefore, compromise the success of the whole process in the end. In addition to change processes being multi-phased and ongoing processes all of the models stress that the existing context an organisation is operating in as well as the context

surrounding the change are as important to the successful implementation of change within organisations as the change process itself (Armenakis & Bedeian, 1999).

2.3.2 Implementation of Change amongst Employees

The conclusion that individuals are also going through a process when experiencing change was first made by Elizabeth Kübler-Ross based on her work with terminally ill patients (Cameron & Green, 2015) (Kübler-Ross, 1969). Another model based on the same idea that 'when facing change in the external world, an individual can experience a variety of internal psychological states' (Cameron & Green, 2015, p. 31) was developed by Virginia Satir (Satir, Banmen, Gerber, & Gomori, 1991). While psychodynamic research did not originate in an organisational context research into individuals undergoing change in organisational contexts confirmed that individuals experiencing changes within organisations are going through similar stages during organisational change processes (Cameron & Green, 2015).

In an organisational context, Isabella (1990) develops a model aimed at explaining how employees interpret certain events in a change process for example. The model distinguishes between four distinct phases: (1) anticipation during which hearsay is used to construct several, individually differing versions of the actual situation, (2) confirmation during which events are standardised using a common frame of reference to make 'presumptions about what will be, based upon what has been' (Isabella, 1990, p. 17) i.e. past events are used to interpret current events during this phase, (3) culmination during which conditions before and after an event in the change process, in reaction to which the vision of the desired state was revised, are compared, and (4) aftermath. Aftermath refers to the evaluation of the change by those affected by it (Isabella, 1990). A similar four stage model describing how employees affected by a change experience the change process has been developed by Jaffe et al. (1994). The model depicts the following stages: (1) denial which occurs when employees do not believe that it is necessary for the organisation to change and do not believe that the change is of a permanent nature or will even be implemented after all, (2) resistance i.e. the employees are not engaging in the change process, actively sabotaging its final implementation or trying to persuade those in charge of the change process of its uselessness, (3) exploration during which the change efforts are tested to determine the usefulness of the proposed change in an endeavour to actuate whether the change is delivering on its promises made by its change agents, and (4) commitment during which support for and the implementation of the change by those affected by it are shown (Jaffe, Scott, & Tobe, 1994).

According to Armenakis and Bedeian (1999) the combination of those two models yields that during anticipation employees are prone to exhibit denial and display resistance during the confirmation stage. As a consequence denial and resistance are likely outcomes should those employees affected by the change be not appropriately prepared for the change to be implemented Armenakis and Bedeian (1999) state. To counter any resistance to the change the actions taken by the change agents during the culmination phase which is when exploration takes place have to be regarded as being of positive effect. Lastly, aftermath is

when those affected by the change evaluate to which extent they are going to commit to the change. The combination of the two models, thus, offers insights into how to manage employees' responses and behaviours during a change process accordingly, so that change management success is ensured.

Additionally to resistance, change processes can cause other unintended employee responses e.g. cynicism, feelings of stress or lesser organisational commitment that can also lead to further resistance even if a general need for change is recognized by those affected by it (Armenakis & Bedeian, 1999) (Clarke, Ellett, Bateman, & Rugutt, 1996). While resistance mainly occurs when an individual's own interests are being threatened by the change, cynicism occurs when employees crucial to an organisation do not believe in the actions of senior management level change agents anymore (Clarke, Ellett, Bateman, & Rugutt, 1996) (Reichers, Wanous, & Austin, 1997). Feelings of stress, on the other hand, can arise amongst those employees affected by the change if in coherence with the change those affected by it also have to adapt their current behaviours and work related routines, and even more so if new skills have to be acquired. Established behaviours and work related routines provide employees with a sense of itself positively reinforcing control. In default thereof, work related uncertainties are diminished and feelings of stress reduced. Once a change process is initiated which in further consequence renders employees' current behaviours and work routines obsolete those employees experience higher levels of work related uncertainties and, subsequently, greater feelings of stress (Callan, 1993) (Schabracq & Cooper, 1998).

Contrary, organisational commitment can be used as a measure of the impact of organisational change on the relation between an organisation and its employees. More specifically, the degree of employees' compliance commitment which describes an employee's willingness to adhere to e.g. organisational policies, identification commitment i.e. an employee's feelings of belonging with an organisation and its other organisational members, and internalisation commitment which refers to the institutionalization of values connected to a change convey employees' psychological attachment towards an organisation. Meanwhile, employees' psychological attachment is connected to their performance as well as their feelings of stress, the levels of cynicism displayed, and withdrawals from work. All of which effects employee turnover (Becker, 1992) (Becker, Billings, Eveleth, & Gilbert, 1996) (Meyer & Allen, 1997). This means that an increase in employee turnover in light of organisational changes can also be seen as a result of failing change management efforts.

3 Methodology

Before analysing company XYZ's current NPD process it will first be elaborated on the problems the company is currently facing with regard to its NPD process and the business consequences following from that in the coming chapter. This is done to gain a better understanding of why it is that company XYZ is looking to optimise its current NPD process as well as to arrive at a first indication of where the current process inefficiencies might be hidden in company XYZ's NPD process momentarily in place.

Elaborating on the problems and resulting business consequences the company sees itself exposed also constitutes the start of the BPO process. As described earlier (compare paragraph 2.1) BPO comprises three subsequent stages. During the first stage (i.e. data integration) all data possibly relevant to company XYZ's current NPD are collected (Niedermann & Schwarz, 2011). This also includes the company evaluating its current NPD process based on the best practices framework developed by Kahn et al. (2006), so that different kinds of data from different sources are integrated and BPO related risks minimised (compare paragraph 2.1). Besides that, a process model of the company's current NPD process is developed at the end of stage one to illustrate the process flow in NPD at company XYZ at this moment (Seth & Gupta, 2005). In their best practices framework Kahn et al. (2006) describe this as the process dimension which refers to 'the NPD stages, corresponding activities, and gate criteria for moving products to launch' (Kahn, Barczak, & Moss, 2006, p. 110). Mapping all these activities is the first step in VSM which is about visualising the current status of a business process to see how things are done and where the potential for improvements lies which is also directly linked to the second stage in BPO (i.e. data analysis) (Seth & Gupta, 2005). During this stage, the process model created as well as the data gathered are analysed. Lastly, the current process inefficiencies hidden in company XYZ's NPD process momentarily in place are described as well as strategies devised to overcome those particular process inefficiencies during the third stage of the BPO process (i.e. detection and implementation of improvements) (Niedermann & Schwarz, 2011). This encompasses mapping a desirable, future process model, the second step in VSM (Seth & Gupta, 2005). The strategies then devised to overcome the current process inefficiencies are based on the findings of the current academic literature reviewed earlier (compare paragraph 2.2). In addition to that, are the devised strategies specifically tailored to company XYZ and to the achievement of the overall BPO objectives since there is no one best way of how to conduct NPD (Kahn, Barczak, & Moss, 2006) (Loch, 2000).

After an optimised NPD is proposed the remaining step is to outline an implementation plan of how to introduce the new, optimised NPD process amongst company XYZ's employees. The implementation plan is based on the eight-step process of leading change proposed by John P. Kotter in 1995 which is one of the most widely used models in implementing organisational change (Kotter, 1995) (Niedermann & Schwarz, 2011) (for a visualisation of the different steps in the methodological procedure of this research paper see the appendix: Appendix A).

4 Company XYZ: Current Problems and Business Consequences

In the past company XYZ saw itself frequently confronted with two types of problems in relation to its NPD process. On the one hand, the company oftentimes experienced having too little time to test its NPDs if those were still to be tested within the initial timely limits of the respective projects. On the other hand, company XYZ was regularly testing new product concepts in the past which turned out to be not fully developed yet at the point of testing. These cases constitute a problem for company XYZ if as a result the introduction of a NPD on the market is delayed. A delayed market introduction entails that sales opportunities are missed and that because of that lesser revenues are generated. For those reasons, company XYZ is looking to optimise its NPD process.

As a first step in attempting to do so company XYZ reorganised its NPD process over the course of the last year (i.e. 2016) because it had identified lengthy decision-making procedures as the main cause underlying the two problems previously described. The company went from a stage-gate process to a NPD process involving work packages. The difference between the NPD process involving work packages which is currently employed and the stage-gate process used before that is that instead of a competence team evaluating NPD projects only at certain points in time i.e. the different gates in a stage-gate process, NPD projects are now being monitored and evaluated by a competence team on a continuous basis. With the new NPD process involving work packages everyone in the competence team is, therefore, constantly involved with the company's different NPD projects at this point. Before that, not everyone involved in the evaluation of the company's NPD projects did always know about the company's most recent developments. This, in the opinion of company XYZ, led to more time for consideration being required before a decision on whether or not to continue with a NPD project could be made by everyone in the company's competence team and, in the end, causing the problems the company has often times been facing in the past.

5 Analysis

In the coming sections of this research paper the current NPD process employed by company XYZ is being described and discussed. This includes the findings of the evaluation of company XYZ's NPD process by several of its employees with knowledge about the company's current NPD process. Furthermore, an optimised NPD process for company XYZ as well as a plan of how to successfully implement that optimised process amongst company XYZ's employees are being developed in the coming sections of this research paper.

5.1 Evaluation of Company XYZ's Current NPD Process

In the table at the end of this paragraph (i.e. Table 1. Descriptive Statistics) the findings of the evaluation of company XYZ's current NPD process by its employees can be found. The participants evaluated company XYZ's current NPD process based on the NPD best practices framework developed by Kahn et al. in 2006 (compare chapter 2.2 of this research paper).

The findings show that apart from the process and the people dimension the opinions on the sophistication of the NPD practices employed by company XYZ's differ considerably amongst the different participants. Overall, the results range from better (i.e. level two) to best practice (i.e. level four). While the sophistication of the process dimension of company XYZ's current NPD process was evaluated as being of good practice (i.e. level three) by all of the participants, the opinions regarding the sophistication of the people dimension range from good (i.e. level three) to best practice (i.e. level four). At this point, it has to be mentioned that if a participant indicated that the sophistication of the NPD practices currently employed by company XYZ amongst one or more of the different NPD process dimensions show equal characteristics of two levels of sophistication a value of .50 in-between the two respective levels of sophistication has been assigned. This means that if a participant indicated that the sophistication of the NPD practices currently employed by company XYZ amongst one or more of the different NPD process dimensions range between levels two (i.e. good practice) and three (i.e. better practice) a value of 2.50 has been assigned for example. Due to that, the maxima for the dimensions market research and metrics and performance evaluation show values of 3.50. This translates to the NPD practices employed by company XYZ amongst these NPD process dimensions were evaluated as being somewhat between good (i.e. level three) and best practice (i.e. level four) by at least one of the participants. The opinions on the sophistication of the practices employed by company XYZ amongst the other dimensions of its NPD process range from being of better practice (level two) to somewhat between good and best practice (i.e. 3.50) or best practice (level four).

No dimension of company XYZ's current NPD process was evaluated as being only of rudimentary practice (level one). All over, the sophistication of the NPD practices employed by company XYZ were evaluated as being of good practice (i.e. level three → ΣMEAN = 18.00; 18.00 / 6 = 3.00) by the participants of the evaluation. This evaluation is indicative of the employees of company XYZ judging the company's current NPD practices as being quite

sophisticated already, but as not being without room for further improvements. This is particularly true for the dimensions market research (MEAN = 2.83) and metrics and performance evaluation (MEAN = 2.67).

Table 1. Descriptive Statistics

	N	Minimum	Maximum	Mean	Standard Deviation
Strategy	3	2,00	4,00	3,00	1,00
Portfolio Management	3	2,00	4,00	3,00	1,00
Process	3	3,00	3,00	3,00	0,00
Market Research	3	2,00	3,50	2,83	0,76
People	3	3,00	4,00	3,50	0,50
Metrics and Performance Evaluation	3	2,00	3,50	2,67	0,76
Valid N (listwise)	3				

5.2 Analysis of Company XYZ's Current NPD Process

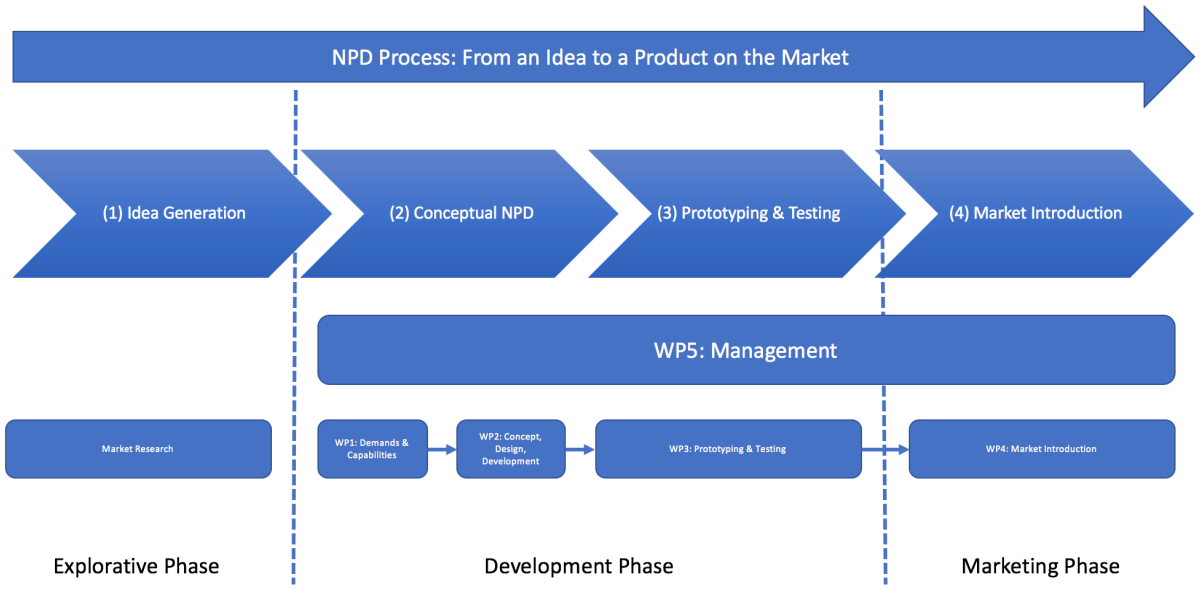
Before the different dimensions of company XYZ's current NPD process are being described and discussed in greater detail using the frameworks developed by Kahn et al. (2006) and Bünting et al. (2015) a VSM of company XYZ's current NPD process using process activity mapping is first being created and described (compare chapters 2.1 and 2.2 of this research paper). As a VSM tool originating in industrial engineering process activity mapping is mainly used 'when time is being used ineffectively' (Hines & Rich, 1997, p. 48) and as a result 'the waste of waiting occurs' (Hines & Rich, 1997, p. 48) as the problems company XYZ has oftentimes been facing with regard to its current NPD process in the past are indicating (compare chapter four of this research paper).

Hines and Rich (1997) describe the ideal state in a factory setting as follows: 'the ideal state should be no waiting time with a consequent faster flow of goods. Waiting time for workers may be used for training, maintenance or kaizen activities and should not result in overproduction' (Hines & Rich, 1997, p. 48). Process activity mapping comprises five different stages of which the first two i.e. (1) the study of the flow of processes, and (2) the identification of waste, are being performed in this section of the research paper. The other three steps i.e. (3) a consideration of whether the process can be rearranged in a more efficient sequence, (4) a consideration of a better flow pattern, involving different flow layout or transport routeing, and (5) a consideration of whether everything that is being done at each stage is really necessary and what would happen if superfluous tasks were removed, are being performed in the next section of this research paper when an optimised NPD process for company XYZ is being proposed (i.e. chapter 5.3) (Hines & Rich, 1997).

5.2.1 VSM of Company XYZ's Current NPD Process

Company XYZ's NPD process (see Figure 1. VSM Current NPD Process Company XYZ below) currently comprises four different stages: (1) idea generation during which market research is being conducted and new product ideas are being screened, (2) conceptual NPD which involves the conceptual development of the entirety of a new product before progressing to stage three, (3) prototyping and testing which includes the building of a product prototype which is then used to test the newly developed product concept, and (4) market introduction during which all activities necessary to bring a newly developed and validated product to the market are performed. As it can be seen in the VSM below (i.e. Figure 1. VSM Current NPD Process Company XYZ below) these four subsequent stages can also be grouped into three distinct phases: (1) an explorative phase, (2) a development phase, and (3) a marketing phase.

Figure 1. VSM Current NPD Process Company XYZ



As previously described already company XYZ is conducting market research and is screening new product ideas during the explorative phase of its current NPD process. After that the developmental phase starts. This phase includes stages two and three in company XYZ's current NPD process i.e. the conceptual NPD and prototyping and testing. These are then split up into different, sequential work packages. The first work package includes pre-developmental activities such as the development of a business case for a potentially new product as well as the determination of demands and capabilities of the potentially new product in a so-called user requirements specification (short: URS). After that, a so-called functional specifications document (short: FSD) is determined in the beginning of the second work package. Thereafter, the product concept and design are fully developed before progressing to stage three in company XYZ's current NPD process and the third work

package which is performed at this stage. The third work package includes the building of a product prototype, the validation of the product prototype, the start of production once a new product concept has been approved, etc. During the last stage, i.e. market introduction (marketing phase) the activities necessary to bring a newly developed product to the market are being performed. Those include e.g. creating brochures, determining the retail price of a newly developed product or the training of retailers and customers. Next to all of that, a management team is monitoring and evaluating the NPD projects on a continuous basis (work package five). This is done from the start of the second stage of company XYZ's current NPD process on (i.e. conceptual NPD, in other words with the start of the first work package).

Apart from studying the flow of company XYZ's current NPD process it is not possible to identify any other waste because the necessary data e.g. activity related throughput times are not available. However, the company is currently initialising processes to record such relevant data in the future.

5.2.2 Strengths and Weaknesses of Company XYZ's Current NPD Process

In the following the different dimensions of a NPD process as identified by Kahn et al. (2006) and Bünting et al. (2015) are being described and discussed in greater detail. In total nine different NPD process dimensions are covered in this section. These include the six NPD process dimensions which have also already been evaluated by different employees of company XYZ and which are covered by both Kahn et al. (2006) and Bünting et al. (2015). In addition to that, three other NPD process dimensions as identified by Bünting et al. in 2015 are covered. The nine NPD process dimensions to be covered in this section of the research paper, thus, are: (1) strategy, (2) portfolio management, (3) process, (4) market research, (5) people, (6) metrics and performance evaluation, (7) technology and product development, (8) developmental organisation, and (9) shop floor management (compare chapter 2.2 of this research paper).

Strategy

Company XYZ's NPD goals of e.g. being the leading company in its respective field in terms of technology and innovation are clearly aligned with the company's mission and strategic plan for the coming years which e.g. include company XYZ being the best company in its respective field. Next to that, the company's mission and its strategic plan also define strategic arenas for new opportunities such as the progressing digitalisation or cyber physics. Furthermore, is the company's project selection based on criteria derived from its company mission and strategic plan, opportunity identification an ongoing activity at company XYZ, pet projects minimised and there is a standard process in place which defines the timely sequence of all NPD projects (i.e. Figure 1. VSM Current NPD Process Company XYZ). The majority of these NPD practices are either of good (i.e. level three) or of best practice (i.e.

level four) according to Kahn et al. (2006) as well as characteristic of an ideal (development) strategy according to Bünting et al. (2015). What is lacking, however, are clearly defined NPD goals. Currently, company XYZ's NPD goals are kept rather general and do not provide any indication of how the NPD discipline shall aid in achieving the company's overall mission and strategic plan, on how company XYZ is planning to achieve those goals or on which resources are needed to get there.

Portfolio Management

In terms of portfolio management practices company XYZ is primarily undertaking NPD project prioritisation. As described earlier the criteria for the prioritisation of the NPD projects stem from the company's mission and strategic plan. Besides that, there is keen consideration for a balanced mix of NPD projects across all of company XYZ's areas of operations as well as a keen consideration for a balanced mix of explorative and exploitative NPD projects. In addition to that, company XYZ is maintaining an idea bank and utilising an 80 percent threshold when planning in resources for its NPD projects. Nevertheless, further resources in form of e.g. open innovation can also be made available should a new opportunity render itself conspicuous. Alongside the fact that some pet projects do exist the non-existence of a formal and systematic portfolio management process is a blind spot to company XYZ's portfolio management practices. Because of that, trade-offs have to be made in an informal fashion to manage the company's NPD offerings. Decisions are usually made based on the quality of a NPD project, the time it will take to bring a NPD project to the market as well as whether a NPD project can be built and sold within the targeted cost brackets.

Process

Company XYZ designed its new NPD process involving work packages which also cuts across different departments e.g. research and development, sales and operations to better fit its organisational culture (compare chapter four of this research report for example). Documentation on the company's NPD process is also available. Moreover, there is a clear NPD discipline as well as technical and sales-related product managers whose main priority it is to manage all of company XYZ's NPD projects. Technical and sales-related product managers are all working together closely and communicating frequently throughout the whole process. To avoid any NVA activities company XYZ's NPD process is customer-oriented and includes pre-developmental activities such as the formulation of a business case for a NPD project to minimise NPD project related risks. Further than this, an idea bank is maintained and informal NPD evaluation criteria exist. According to Bünting et al. (2015) the developmental phase of an ideal (development) process is split up into three successive phases: (1) a conceptual phase, (2) a constructional phase, and (3) a validation phase, all of which shall take one third of the time of the overall developmental phase. This, however, is

not the case for the NPD process of company XYZ. Despite that, the NPD practices of the process dimension can be seen as of good practice (i.e. level three).

Market Research

Contrary to the average evaluation by the participants of the evaluation of company XYZ's current NPD process the NPD practices currently employed by company XYZ regarding the market research dimension are of best practice (i.e. level four) according to Kahn et al. (2015) and mirror an ideal situation according to Bünting et al. (2015) (for the results of the evaluation see the beginning of this chapter). The NPD project definitions (i.e. URS and FSD) are based on market research with customers/stakeholders, two formal market research functions (i.e. business development managers) exist within the company, market studies are ongoing and conducted parallel to the market research involving customers/stakeholders with the goal of e.g. anticipating future customer needs, and testing is consistently undertaken and required with all NPD projects. For those reasons, one can conclude that the customer/user is an integral part of company XYZ's current NPD process and that market research is closely affiliated with the company's NPD activities.

People

By the end of this year at the latest (i.e. 2017) company XYZ is planning on having established cross-functional NPD teams including a core team which stays on NPD projects for the entire duration of a NPD project. Of those cross-functional teams the employees in the research and development department are fully dedicated to NPD only. They also receive NPD training on relevant topics which are identified together with the respective employee once a year. Additionally, the company is using project management software such as MS Project 2016 to manage its NPD projects, an Enterprise Resource Planning (short: ERP) system to determine NPD project costs and each project has two identifiable project leaders. These NPD practices are of best practice (i.e. level four) according to Kahn et al. (2006). In addition to all of that, the technical product managers' responsibilities include the continuous optimisation of business processes and the employees have the freedom to solve problems they encounter independently, all of which also resembles an ideal directing system (Bünting et al., 2015).

Metrics and Performance Evaluation

Next to some general guiding principles for the evaluation of its NPD projects and some initial screening criteria company XYZ is utilising a team approach to evaluate and make final decisions on any of its NPD projects (compare strategy and portfolio management). Also, projects can now be stopped/killed at any time of the NPD process which is supposed to

speed up the NPD process according to company XYZ (compare chapter four of this research paper). Right now, company XYZ's NPD practices regarding metric and performance evaluation are of better (i.e. level two) to good practice (i.e. level three). In the future, the company will also track and store additional metric data on e.g. the actual project duration against the planned project duration, the actual project costs against the targeted project costs or the actual production costs of a new product against the targeted production costs of the new product. Once these metric data are not only stored but also readily available for analysis company XYZ's NPD practices regarding metric and performance evaluation can be considered as being of good (i.e. level three) to best practice (i.e. level four) (Kahn, Barczak, & Moss, 2006).

Technology and Product Development

In terms of technology and product development company XYZ is using different product modules per product category as well as some looser design rules that specify e.g. how many components are to be used to generate a given number of new products. Besides that, the overall technology and product development process is customer-oriented rather than technology-driven, so that company XYZ can serve the needs of its customers better. A threat to the company's technology and product development process constitutes the possibility that over engineering is taking place when new technologies and products are being developed. This threat will be diminished once company XYZ completes the restructuring of its research development department alongside different technology and product development functions such as hydraulics and construction instead of the research and development department being structured alongside the company's different product categories because that way interdependencies between products out of different product categories will become more readily apparent. The technology and product development dimension, therefore, offers room for improvement and does not fully resemble an ideal technology and product development process yet (Bünting et al., 2015).

Developmental Organisation

Despite the goal of this research paper being the further optimisation of the value stream of company XYZ's developmental organisation the newly devised organisational structure of company XYZ is already clearly value stream oriented. The developmental organisation is supposed to be segmented by developmental functions and cross-functional teams are to be used by the end of this year (i.e. 2017) at the latest. Next to that, independent product managers exist. The product managers are also the ones who are responsible for the timely execution of a NPD activity which is the only aspect not in line with the suggestions made by Bünting et al. (2015) who suggest that the respective departments should be in charge of the timely execution of a NPD activity.

Shop Floor Management

Apart from clear rules of communication such as weekly meetings of the company's NPD competence team and close collaborations between the company's technical and sales-related product managers the company has not yet implemented any other shop floor management techniques, visual management tools for instance. Consequently, the shop floor management dimension leaves a lot of room for further NPD process improvements with regard to the timely execution of NPD projects (Bünting et al., 2015). Currently, the company is thinking about introducing Kanban boards which are commonly used to visualise and improve work flows (Murino, Naviglio, & Romano, 2010).

5.2.3 Findings of the Analysis of Company XYZ's Current NPD Process

Overall, company XYZ is indeed employing a quite sophisticated NPD process with the majority of the NPD practices currently in use being of good to best practice already. Despite that, there is still room for further refinement amongst the different NPD process dimensions previously discussed. The only exception constitutes the market research dimension even though the company's employees identified the market research dimension as one of the two dimensions with the most room for improvement (see the beginning of this chapter). The other dimension company XYZ's employees had identified as one of the two with the most room for improvement was the metrics and performance evaluation dimension. While this currently very well applies company XYZ is already preparing its systems for storing and tracking different NPD related key performance indicators (short: KPIs) in the near future. This constitutes a good and necessary step in the right direction to further optimise the efficiency and the effectiveness of company XYZ's NPD process because it will enable more specific process analyses and NPD project evaluations.

In addition to that, the shop floor management dimension offers several opportunities for further process improvements. The cause of the problems that company XYZ has frequently been facing regarding its current NPD process, on the other hand, is more likely to be rooted within the process dimension and the process flow of company XYZ's current NPD process. Unfortunately, there is no additional data available yet to further investigate or support that claim.

Not having enough time to test a newly developed product concept or testing not sufficiently developed product concepts indicates that delays are caused somewhere in the earlier stages of company XYZ's NPD process and that, therefore, company XYZ frequently runs into timely issues in the later stages of its NPD process. These delays then leave the company with too little time to test a newly developed product concept or result in speeding up the conceptual development of a new product concept which then again results in not sufficiently developed product concepts being tested. The new NPD process involving work packages to speed up decision-making processes may help in speeding up the overall NPD process, but it is not seen as the solution to the problems company XYZ is been facing. Instead it is expected that

the company will face the same kinds of problems again after a while. If one looks at the process flow of company XYZ's current NPD process one can identify that pre-developmental activities which are supposed to take place during the explorative phase in an ideal setting, are now being executed at the beginning of the developmental phase of company XYZ's current NPD process (Bünting et al., 2015). As a consequence, this leaves company XYZ with not enough time for the actual development of its NPD projects which causes timely pressures and ultimately leads to the problems previously described (see also chapter four of this research paper). In the following section, it will be discussed how to circumvent these problems in the future. In other words, it will be discussed what an ideal NPD process for company XYZ looks like.

5.3 Description of the Proposed NPD Process

In this section of the research paper an optimised NPD process for company XYZ is being devised. At first it is first looked at whether the process dimension can be rearranged to ensure a better flow of the process as the process dimension and the process flow have been identified as the root cause of company XYZ's frequent problems. To that end, it will be looked at whether all the activities that comprise the different work packages of company's NPD process are necessary to be performed and/or whether those should be rearranged. Thereafter, a new process layout with the goal of solving the problems company XYZ has frequently been facing regarding its NPD process is being proposed and described. After that strategies of how to make the company's current NPD process even more efficient and more effective amongst the other NPD process dimensions discussed earlier will also be developed.

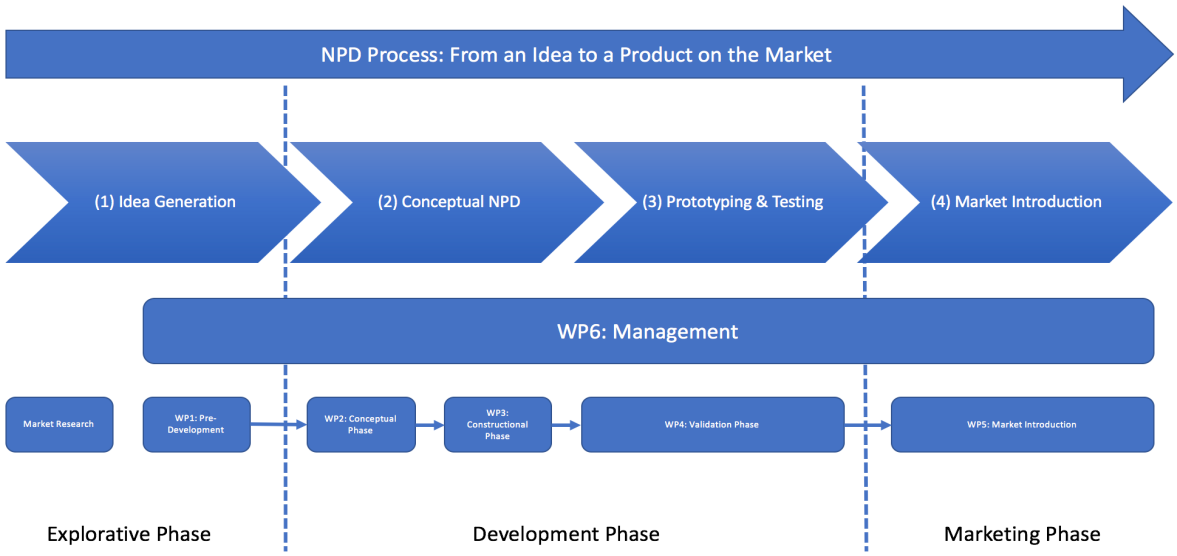
5.3.1 VSM of the Proposed NPD Process

As it has been identified in the previous section of this research paper (i.e. chapter 5.1) the fact that company XYZ is conducting its pre-developmental NPD activities not until the beginning of the development phase of its current NPD process can create timely pressures when developing a new product concept because the developmental phase of the NPD process is cut short. Based on Bünting et al. (2015) a new process layout has been created with the goal of circumventing these problems in the future (see Figure 2. VSM Proposed NPD Process Company XYZ below).

In essence, an additional work package containing company XYZ's current pre-developmental activities has been introduced during the explorative phase of company XYZ's NPD process (i.e. WP1) and the development phase been split up into three equal phases in terms of their timely duration. Those three phases are: (1) a conceptual phase (i.e. WP2), (2) a constructional phase (i.e. WP3), and (3) a validation phase (i.e. WP4). The market introduction (i.e. WP5) and the management work package (i.e. WP6) remain work packages on their own. Apart from the management work package (i.e. WP6) all other work packages have also been reconfigured in the way of which NPD activities they are comprised of. However, no activities have been left out as all of the activities company XYZ is currently

performing with regard to its NPD process are considered to be of necessity and importance to a sophisticated NPD process (a list of all the activities comprising the newly, devised work packages of the proposed NPD process can be found in the appendix of this research report: see Appendix B). The only difference made to the management work package is that with the new, proposed NPD process management oversight already starts during the explorative phase of company XYZ's NPD process. This is because the pre-developmental activities of company XYZ are now being performed during the company's explorative phase to relieve the development phase of its too many duties and the activities that are overseen by management throughout the whole process remain the same activities despite the reconfiguration of the to be undertaken NPD activities.

Figure 2. VSM Proposed NPD Process Company XYZ



5.3.2 Strategies to Overcome the Identified Process Inefficiencies

In the following it will be discussed what NPD practices company XYZ is advised to implement to further optimise its current NPD process amongst the nine different NPD process dimensions that have also been discussed in the previous section of this research paper (i.e. chapter 5.2).

Strategy

Earlier it had been determined that what company XYZ is lacking with reference to its (development) strategy is the definition of more specific NPD goals as the company's current NPD goals are kept rather general and do not provide any indication of how the NPD

discipline shall aid in achieving the company's overall mission and strategic plan, on how company XYZ is planning to achieve those goals or on which resources are needed to get there. A technology roadmap is a supportive tool that can help in the formulation of a sophisticated (development) strategy. A technology roadmap is a time-based chart that combines the markets a company plans on serving in the future, the products and technologies a company is planning on serving the targeted markets with and the resources which are needed in the development of the products and technologies in question (Phaal, Farrukh, & Probert, 2004). Moreover, a technology roadmap provides information about pivotal technologies and technological knowledge gaps that a company will have to close to reach its NPD goals, is useful in coordinating a company's different research and development activities and helps to make sound strategic choices (Garcia & Bray, 1997) (Petrick & Provance, 2005). Besides that, ensures a (development) strategy with clearly defined and specific NPD goals purposeful and targeted NPDs, minimises the risks associated with NPD projects and has a positive effect on the quality, functionality and production costs of a company's NPD projects (Bünting et al., 2015).

Portfolio Management

In terms of portfolio management practices company XYZ is advised to introduce a formal and systematic portfolio management process to avoid that trade-offs must be made in an informal fashion and to further minimise the existence of pet projects (Kahn et al., 2006). In that regard, it is best to combine ranking and financial methods in evaluating NPD projects. Especially financial NPD evaluation methods do not work very well in isolation, an experience company XYZ has also made in the past when solely applying the Net Present Value (short: NPV) method to evaluate its NPD projects (Cooper, Edgett, & Kleinschmidt, 2001). Apart from that, Bünting et al. (2015) suggest many KPIs that shall be taken into consideration when managing multiple projects and that company XYZ is advised to incorporate in a formal and systematic portfolio management process. The biggest benefit of the use of sophisticated portfolio management practices is that the timely execution of NPD projects is improved. In addition to that, the development and the production costs of a NPD can be positively influenced (Bünting et al., 2015).

Process

Apart from restructuring its NPD process and implementing a formal systematic portfolio management process in the ways described earlier there is are no further suggestions for company XYZ of how to further improve the efficiency and effectiveness of its (development) process (Bünting et al., 2015) (Kahn, Barczak, & Moss, 2006).

Market Research

According to Kahn et al. (2006) and Bünting et al. (2015) the market research practices company XYZ is conducting concerning its NPDs are of best practice/mirror an ideal situation. Therefore, there are no suggestions of how the company could further improve the efficiency and the effectiveness of its market research efforts. One technique the company may consider implementing in the future is the use of scenario-based (technology) road mapping. The concept of scenario-based (technology) road mapping is a relatively new one which combines the creation of future scenarios with the development of a (technology) roadmap. Currently the University of Twente (Enschede, NL) is undertaking research to further explore the topic of scenario-based (technology) road mapping (Siebelink, Halman, & Hofman, 2016).

People

As with the market research dimension the people related NPD practices currently employed by company XYZ mirror an ideal situation which is why no further advice is given regarding the company's people management/directive system at this point (Bünting et al., 2015) (Kahn, Barczak, & Moss, 2006).

Metrics and Performance Evaluation

As mentioned before company XYZ is currently preparing its project management systems to track and store additional metric data on e.g. the actual project duration against the planned project duration, the actual project costs against the targeted project costs or the actual production costs of a new product against the targeted production costs of the new product. Once these metric data are not only stored but also readily available for analysis company XYZ's NPD practices regarding the metric and performance evaluation dimension can be considered as being of good to best practice. What it is advised to do for company XYZ as well is the use/the development of a NPD evaluation software tool to simplify the read and the analyses of the collected data (Kahn, Barczak, & Moss, 2006).

Technology and Product Development

In terms of technology and product development company XYZ is advised to not only use different product modules per product category but also across its different product categories. The benefits of modularity are that it allows for cheaper customisation, a faster time to market for new products and technologies as well as a more reliable NPD (Gershenson, Prasad, & Zhang, 2003). Regarding the use of design rules the company has

identified itself the need for stronger design rules with regard to software and electronics. Here, research has shown that an inverted u-shaped relationship prevails between the existence of design rules and the performance of architectural innovation (Hofman, Halman, & van Looy, 2016). The company shall take this into account when thinking of introducing further design rules with regard to software and electronics.

Developmental Organisation

As mentioned in the previous section of this research paper (i.e. chapter 5.1) the fact that the product managers at company XYZ are the ones who are responsible for the timely execution of a NPD activity is the only aspect not in line with the suggestions made by Bünting et al. (2015) who suggest that the respective departments should be in charge of the timely execution of a NPD activity. Company XYZ is, therefore, advised to revisit that particular aspect of its NPD process.

Shop Floor Management

Next to the process dimension the shop floor management dimension offers the most room for improvement for company XYZ with reference to its current NPD process. To be able to directly act on project deviations such as a NPD project running late or missing the targeted development costs company XYZ is advised to implement a comprehensive visual management system beyond the use of Kanban boards. Visual management systems enable the illustration of NPD project related information such as NPD related KPIs and thereby creating transparency amongst employees so that these can directly act on the deviations. In addition to that, can employee performance be increased through training employees on leadership behaviour and leadership abilities. Because of that shop floor management constitutes one of the most important levers to ensure the timely execution of NPD projects (Bünting et al., 2015).

5.3.3 Steps to Optimise Company XYZ's Current NPD Process

In order to solve the problems company XYZ has oftentimes been facing regarding its current NPD process company XYZ is advised to restructure the process dimension of its NPD process to ensure a better flow of the process and to avoid any delays in the future. To do so, company shall move its pre-developmental NPD activities into the explorative phase of its NPD process and structure the development phase of its NPD process into three equal phases in terms of their timely duration i.e. (1) a conceptual phase, (2) a constructional phase, and (3) a validation phase. Apart from that company XYZ is advised to do the following to further speed up its NPD process without making any compromises concerning the quality of its newly developed products: (1) incorporate technology road mapping in its

strategy formulation process to develop a more sophisticated (development) strategy, (2) introduce a formal and systematic portfolio management process using ranking and financial evaluation methods altogether, (3) restructure its (development) process to ensure a better process flow and circumvent any process flow related problems in the manner described above, (4) make use of/develop a NPD evaluation software tool, (5) make use of product modules also across its different product categories, (6) make the respective departments responsible of the timely execution of a NPD activity and not its different product managers, (7) introduce a comprehensive visual management system to be able to react to NPD project deviations directly and to create transparency within the organisation, and (8) train its employees in terms of leadership behaviour and leadership abilities to increase overall employee performance.

5.4 Implementation Plan

In the next section an implementation plan will be devised answering the question of how company XYZ can successfully implement the changes to its NPD process described above successfully amongst its employees. To that end, it will be elaborated upon which concrete actions have to be taken by company XYZ when the proposed NPD process developed in the previous section of this research paper (i.e. chapter 5.2) is to be successfully implemented. The implementation plan also addresses the questions of which stakeholders and resources are involved in the implementation process and how, once successfully implemented, the new ways of working are sustained within the company. The implementation plan follows the eight steps plan of how to lead change as proposed by Kotter in 1995 (compare chapter 2.3 of this research paper).

The first step in successfully implementing the proposed solution is for the management team of company XYZ to create a sense of urgency of why the company does in fact need to optimise its current NPD process and practices (Kotter, 1995). In the case of company XYZ, a premium mechanical engineering manufacturer, an efficient NPD process nowadays constitutes the only way of how to differentiate itself from its competitors and even more specifically so to differentiate and stay ahead of the increasing competition from the Asian market. An efficient NPD process is, thus, needed to stay competitive, to grow and, in the end, ensure the long-term survival of company XYZ (Baumol, 2002) (Bünting et al., 2015) (de Visser, 2013) (Schumpeter, 1939).

Before progressing to the second steps of Kotter's eight steps plan of how to lead change the management team of company XYZ will also have to develop a new, more sophisticated (development) strategy with more specific NPD goals. The management team is advised to use technology road mapping in order to formulate a more sophisticated (development) strategy including more specific NPD goals and to further utilise technology road mapping when developing (development) strategies guiding company XYZ's NPD efforts in the future. One of company XYZ's new, more specific NPD goals shall be the use and the development of product modules across the company's different product categories and not only within each of its product categories (compare chapter 5.2 of this research paper).

The second step in the implementation process is for the company's management team to assemble a guiding coalition that has not only the capabilities but also the power to implement the proposed solution. In a first instance this involves the company's Chief Technical Officer (short: CTO), the technical and sales-related product managers and the department heads of product development and prototyping and testing. The CTO of company XYZ is involved with the guiding coalition to not only oversee the guiding coalition throughout the entire change process, but also because top managerial support is proven to be crucial to successfully implementing change in organisations (Kotter, 1995). The technical and sales-related product managers and the department heads of product development and prototyping and testing will be the ones that together with representatives of the company's competence team, the company's HR department and the company's order to cash department are preparing and executing company XYZ's change efforts.

While the different department heads of the company's research and development department together with the company's competence team and representatives from the company XYZ's order to cash department will have to determine which NPD evolution methods to include in company XYZ's future formal and systematic portfolio management process, which NPD related KPIs to include in the company's future NPD evaluation software tool and which NPD related KPIs and other information shall be visualised via the company's future visual management system, the representatives of company XYZ's HR department shall begin with developing an overall strategy concerning the training of the leadership abilities and the leadership behaviour of company XYZ's research and development employees (compare chapter 5.2 of this research paper). Communicating a clear sense of urgency of why the company is in need to change is key to get all these different stakeholders actively engaging in the change process (Kotter, 1995).

In the next step a vision/basic change message must be developed with the goal of minimising the resistance amongst company XYZ's employees concerning the proposed changes. Ultimately, those affected by the change shall become so-called agents of change who are in support of and committed to the desired changes (Armenakis, Harris, & Field, 1999) (Kotter, 1995).

For a vision/basic change message to be transmitted successfully it is of importance that not only the need for company XYZ to change, so that its employees can overcome their denial of the necessity of the proposed changes, is addressed but also the company's possibility to change, the benefits of the proposed changes for everyone in the company e.g. an increase in efficiency, principal support by change agents such as the CTO and the fact that the proposed changes are the right thing for company XYZ to do need to be addressed in the guiding coalition's vision/basic change message (Armenakis, Harris, & Field, 1999) (Jaffe, Scott, & Tobe, 1994). Since company XYZ's current NPD process is already undergoing change in the course of the company's 2020 vision it is advised to incorporate the proposed changes (i.e. the restructured NPD process, the use of a formal and systematic portfolio management process, etc.) into the company's 2020 vision, so that one desired state functions as a reference to the change efforts concerning the company's NPD process and strategies to arrive at that one desired state can be developed (Kotter, 1995).

The fourth step involves spreading the word within company XYZ to make sure everyone in the company knows about the changes and a uniform image is transported before and while the changes are finally rolled out (Kotter, 1995). This is, first and foremost, achieved through the guiding coalition leading by example. In addition to that, speeches by change agents, articles in employee newsletters, active participation or training and development programs constitute means of spreading the word and a uniform image within the company and to empower others to act on the vision whilst overcoming obstacles to the change efforts (step five of Kotter's implementation plan) (Armenakis, Harris, & Field, 1999) (Kotter, 1995).

The sixth step of any successfully implemented change, according to Kotter (1995), is to plan for and to celebrate short term wins such as the completed restructuring of company XYZ's research and development department which is planned to be finalized by the end of 2017 at the latest, the introduction of a formal and systematic portfolio management process or the implementation of a comprehensive visual management system. Planning for and creating short-term wins is important to successful change management because it reinforces the upsides of the change amongst a company's employees and creates momentum for additional change efforts. This can be achieved through e.g. visualising performance improvements once the future visual management system is in place and by rewarding those actively engaging in the company's new NPD process leading up to the improvements in performance (Kotter, 1995).

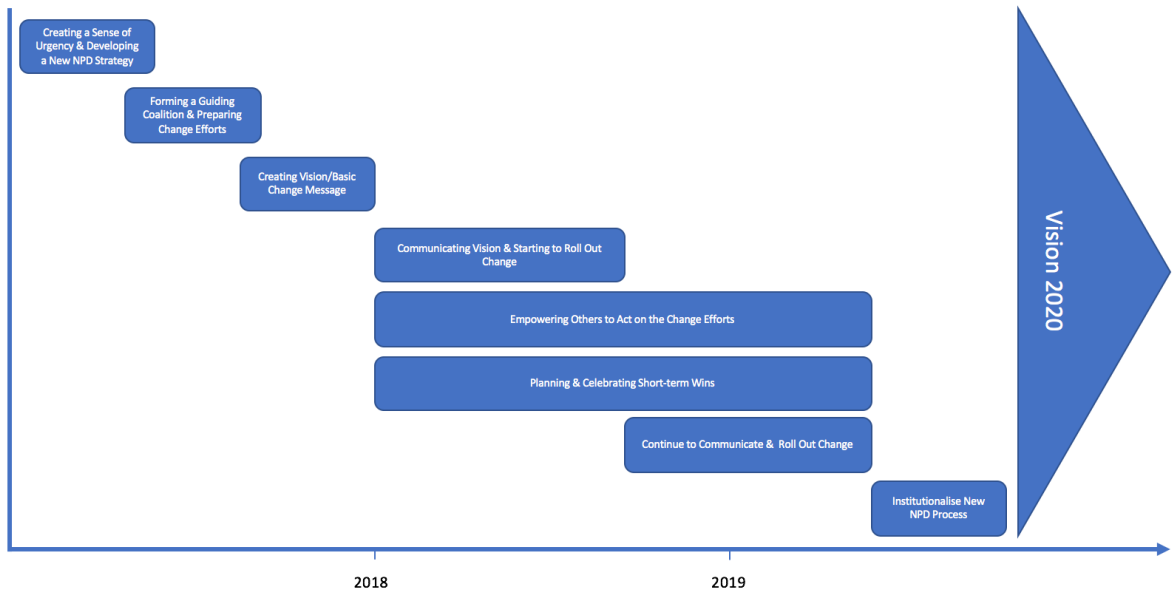
The last two stages of the implementation process involve the continuous implementation of change i.e. making sure the transformation does not end along the way and using the momentum created to do so, as well as the institutionalising of the new approaches through showing the connection between the improvements in performance and the new NPD process implemented (Kotter, 1995).

As this implementation plan shows, implementing the proposed solution does not only involve the development and the introduction of a new NPD process, but also steps to make the new NPD process and practices stick with the company and its employees. To achieve that it is of importance that company XYZ's organisational culture embedded in its rules and policies, customs and norms, ceremonies and events, etc. are also considered. For company XYZ this is particularly important as the company is not only owner-managed but is also having close ties with the communities it is operating in.

Furthermore, everyone that is part of company XYZ is seen as being part of one big family. Social responsibility is, thus, a significant and an eternal part of company XYZ's organisational culture. Further than that, ensuring that once employees start to explore the newly developed NPD process the experiences with the new NPD process are positive in nature is of importance which is why company XYZ's change efforts must be well prepared in their entirety before being rolled out. Otherwise further resistance is created amongst company XYZ's employees. In addition to that, company XYZ should avoid feelings of stress or lesser organisational commitment amongst its employees and pay close attention to cynicism being used by those affected by the change if it wants to ensure the successful implementation of the proposed NPD process (for more information see chapter 2.3 of this research paper) (Armenakis & Bedeian, 1999) (Clarke, Ellett, Bateman, & Rugutt, 1996)

(Galpin, 1996). Below a proposed 'project timeline' for the implementation of company's new NPD process can be found (i.e. Figure 3. Proposed Project Timeline).

Figure 3. Proposed Project Timeline



6 Discussion

This section elaborates on the limitations and the implications of this research paper. Moreover, directions for further research studies as well as directions for further NPD process analyses on part of company XYZ are provided in this section.

6.1 Implications and Limitations of the Study

One of the limitations of this research paper is that only three of company XYZ's employees participated in the evaluation of the company's current NPD process. For that reason, the results of the evaluation on their own are not very meaningful. The overall results of the evaluation concerning the sophistication of company XYZ's NPD process, however, were confirmed by the findings of the subsequent analysis of company XYZ's current NPD process. This indicates that at least the overall opinion of the company's employees on the sophistication of the company's current NPD process is valid to some extent. The validity of this research paper is further ensured by the fact that the evaluation as well as the subsequent analysis of company XYZ's current NPD process were conducted based on the findings of already established NPD best practices frameworks (Bünting et al., 2015) (Kahn, Barczak, & Moss, 2006).

Nonetheless, there are no additional data available yet to substantiate any of the claims made in this research paper on how company XYZ can optimise its current NPD process in terms of effectiveness and efficiency without having to make any compromises regarding its innovative capabilities. Neither is it possible to quantify any of the benefits/process improvements that may result from the changes to company XYZ's current NPD process proposed in this research paper due to the lack in data. Accordingly, the practical implications of this research paper should be considered with caution.

The advice on how to optimise the NPD process is also particularly tailored to company XYZ. The results, therefore, lack any generalisability as an accumulation of NPD best practices does not necessarily guarantee an increase in effectiveness or an increase in efficiency. Nor does it constitute an optimal NPD process for just any company (Ballé & Ballé, 2005) (Kahn, Barczak, & Moss, 2006). Ballé and Ballé (2005) depict this circumstance in relation to Toyota's production system as follows: 'as with implementing the Toyota production system, a more precise understanding of development practices does not necessarily help to improve the efficiency of engineering projects […] it is not a collection of best practices which can be implemented piecemeal, but a system. Furthermore, a clearer understanding of the system also shines a different light on the practices themselves, and, in many cases, changes their intended purpose. As such, many of the Toyota practices only make sense in the light of the overall system (Ballé & Ballé, 2005, p. 18).

They also go on stating that: 'Toyota's current development process is the result of the interaction between a set of practices and situational market conditions. To understand

Toyota's lean development process, it is necessary to identify the underlying core practices and attitudes. Any of the practices, worthwhile as they may be, taken out of the system will not yield significant efficiency gains in the development process. The system has to be visualised as a whole in order to understand each of its parts' (Ballé & Ballé, 2005, p. 19) to further illustrate that there is no one best way for just any company of how to approach NPD.

Along with that, the advice provided for company XYZ coincides with advice by other scholars who concluded that in general a company has to do the following to improve the sophistication of its NPD process if those practices are not in place yet: (1) instil a strategic, long-term orientation toward NPD, (2) have a formal portfolio management process, (3) implement a formal NPD process supported by a discipline to adhere to this process, (4) conduct market research proactively, (5) use cross-functional teams, and (6) utilise standardized criteria and metrics (Kahn, Barczak, & Moss, 2006).

Nevertheless, it has to be mentioned that while the best practices framework developed by Kahn et al. (2006) promotes the establishment of a formalised NPD process 'formalization may not be necessarily conducive for stimulating innovation, especially in radical or entrepreneurial contexts where informality over choice of direction manifests creativity and innovation. [On the contrary,] too much formalization also has the potential of stymieing the NPD process to a standstill, both in terms of novel ideas and speed. Hence, the conceptualization of formal activities representing level-four characteristics may be a misnomer. Indeed, a curvilinear relationship between formality and characteristics across the four levels of sophistication may persist, where formality is necessary up to a certain point in organizational NPD maturity, after which introduction of informal initiatives are needed for stimulating new product development and commercialization' (Kahn et al., 2006, p. 114). Similar conclusion were also made by other scholars in the past who also highlighted that there is no one best way to NPD and that each company's NPD should apart from certain practices be tailor-made to a company's specific needs (Davidson, Clamen, & Karol, 1999) (Loch, 2000).

6.2 Directions for Further Research

Company XYZ is advised to keep on revisiting its NPD in the future and to re-evaluate the changed NPD process once NPD related KPIs are tracked and stored for a sufficient amount of NPD projects using the changed NPD process. This will enable proper and deeper analyses which will provide more insight into the company's NPD process than this research paper was able to. Shall company XYZ still experience the kinds of problems dealt with in this research paper though, then the reason for why these problems do occur is not rooted within the process dimension and its flow of the company XYZ's NPD process, but somewhere else in the process or maybe even the overall organisation. Company XYZ is advised to then conduct further research into why these problems keep on disrupting the company's NPD efforts.

Other than that, more scientific research is necessary concerning the inclusiveness of the NPD process dimensions used in the different NPD best practices frameworks prevailing in the scientific literature at the moment, the importance of single NPD dimensions in the overall NPD process concerning NPD process efficiency for example, whether the characteristics an optimal/best practices NPD process is characterised by so far are likely to change given the rapidly changing environments certain companies are in, or into the presence of bottom-line benefits of sophisticated NPD processes (for a more comprehensive overview of further directions for scientific research regarding the operationalisation, the validation and the augmentation of NPD best practices see Kahn et al., 2006).

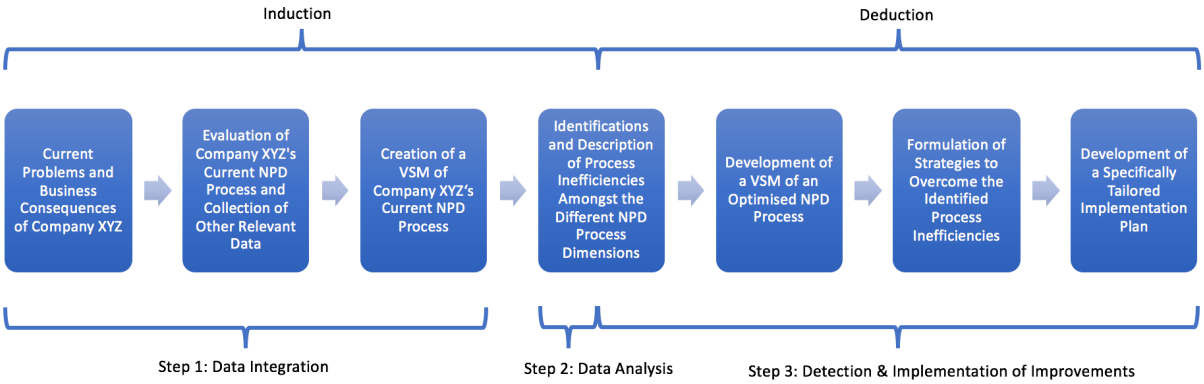
7 Conclusion

The primary goal of this research paper was to design a more effective and a more efficient NPD process for a German premium mechanical engineering manufacturer. Next to that, this research paper attempted at illustrating how to successfully implement the changes suggested to be made to the company's NPD process amongst its employees, so that the new process is actually used in practice as this poses a major challenge to German mechanical engineering manufacturers (Bünting et al., 2015). The company in question was looking for a way of how to optimise its current NPD process without having to make any compromises with regard to its innovative capabilities. It was also of importance to company XYZ that future NPD projects are brought to the market in time, adhere to the company's qualitative and functional standards and can be developed and the final product be built within the targeted cost brackets. To that end, the current NPD process of company XYZ was described and analysed before a future state was 'discussed to show how things should be done' (Seth & Gupta, 2005, p. 45) according to the findings of the current scientific literature. In a final step an implementation plan was devised for how to successfully implement the proposed changes to company XYZ's current NPD process amongst its employees.

As the findings of this research paper show company XYZ is employing a quite sophisticated NPD process already. Still, there is room for further process improvements. In order to optimise its NPD process and solve the problems the company has frequently been facing in the past with reference to its NPD process the company was advised to move its pre-developmental NPD activities into the explorative phase of its NPD process and structure the development phase of its NPD process into three equal phases in terms of their timely duration i.e. (1) a conceptual phase, (2) a constructional phase, and (3) a validation phase. Apart from that the company is missing the following aspects according to the contemporary scientific literature: (1) a sophisticated (development) strategy, (2) a formal and systematic portfolio management process using ranking and financial evaluation methods altogether, (3) a NPD evaluation software tool, (4) product modules which are used across different product categories, (5) a comprehensive visual management system to be able to react to NPD project deviations directly and create transparency within the organisation, and (6) employee trainings emphasizing leadership behaviour and leadership abilities to increase overall employee performance. Next to that, the current scientific literature suggests that a company's different departments shall be in charge of the timely execution of the different NPD activities and not the project/product manager in charge as it is the case at company XYZ at the moment. In the implementation plan devised at the end it was highlighted that the successful implementing of the proposed solution does not only involve the development and the introduction of a new NPD process, but also steps to make the new NPD process and practices stick with the company and its employees according to the current scientific literature on successful change management. Further than that, specifically tailored strategies were developed of how company XYZ is able to achieve the successful implementation of the proposed changes amongst its employees. The implementation plan also included a proposed project timeline for the successful implementation of the proposed changes to company XYZ's current NPD process.

Appendices

Appendix A. Methodological Procedure



Appendix B. Overview Current and Proposed Division NPD Activities Company XYZ

DIVISION OF NPD ACTIVITIES COMPANY XYZ	
CURRENT	PROPOSED
WP1: Demands & Capabilities	**WP1: Pre-Development**
A1.1: Determining Market & Customer Requirements	A1.1: Determining Market & Customer Requirements
A1.2: Defining Fields of Application	A1.2: Defining Fields of Application
A1.3: Analysing Market Potential	A1.3: Analysing Market Potential
A1.4: Analysis of Competition on the Market	A1.4: Analysis of Competition on the Market
A1.5: Setting Up a Business Case	A1.5: Setting Up a Business Case
A1.6: Establishing User Requirements Specification (URS)	**WP2: Conceptual Phase**
WP2: Concept, Design, Development	A1.6: Establishing User Requirements Specification (URS)
A2.1: Examining Feasibility	A2.1: Examining Feasibility
A2.2: Establishing Functional Specifications Document (FSD)	A2.2: Establishing Functional Specifications Document (FSD)
A2.3: Functions Analysis	**WP3: Constructional Phase**
A2.4: Construction/Development	A2.3: Functions Analysis
A2.5: Documentation	A2.4: Construction/Development
A2.6: Calculating Production Costs	A2.5: Documentation
A2.7: Checking Patent Situation (IPO)	A2.6: Calculating Production Costs
WP3: Prototyping & Testing	A2.7: Checking Patent Situation (IPO)
A3.1: Production/Assembly NPD Prototype	**WP4: Validation Phase**
A3.2: Planning Validation Phase/Determining Validation Criteria	A3.1: Production/Assembly NPD Prototype
A3.3: Validating NPD Prototype	A3.2: Planning Validation Phase/Determining Validation Criteria
A3.4: Analysis/Synthesis Validation Results	A3.3: Validating NPD Prototype
A3.5: Optimising New Product Concept (if necessary)	A3.4: Analysis/Synthesis Validation Results
A3.6: Internal Trainings	A3.5: Optimising New Product Concept (if necessary)
A3.7: Start of Production	A3.6: Internal Trainings
A3.8: Completion Necessary Documentation (e.g. Instructions)	A3.7: Start of Production
WP4: Market Introduction	**WP5: Market Introduction**
A4.1: Creating Brochures, etc.	A3.8: Completion Necessary Documentation (e.g. Instructions)
A4.2: Determination Retail Price	A4.1: Creating Brochures, etc.
A4.3: Internal Presentations	A4.2: Determination Retail Price
A4.4: External Trainings (i.e. Retailers & Customers)	A4.3: Internal Presentations
WP5: Management	A4.4: External Trainings (i.e. Retailers & Customers)
A5.1: Division of Work Packages	**WP6: Management**
A5.2: Timely and Monetary Coordination	A5.1: Division of Work Packages
A5.3: Target - Costing	A5.2: Timely and Monetary Coordination
A5.4: Analysing NPD Project Risks	A5.3: Target - Costing
	A5.4: Analysing NPD Project Risks

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