A Multi-Actor Approach to Conflict and Conflict Management in Cross-Functional Collaborative New Product Development

Case Studies within a Technology Firm

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Summary

The purpose of New Product Development (NPD) is addressing disequilibria in the market place through identification, development and deployment of suitable solutions as products, services or solutions. Fast paced changes in the environment of technology firms force such firms to adapt their development processes to the pace of external change. Teamwork, cross-functional collaboration, and conflict management in NPD are often described as leading factors in addressing such change and achieving market success of products. Especially cross-functional collaboration, defined as the involvement of multiple functions in a team, has been applied as an approach to higher efficiency in time and cost and customer value output by firms to counter competition.

The NPD process is deemed to be a good location to implement organisational changes. Despite decades of research on collaboration in general and in NPD, the occurrence location of conflicts and conflict management in the collaborative process between the key NPD functions Marketing, Development, Procurement, and Operations have not been clearly defined in the context of product development in the electronics industry. This topic and scope is addressed by this research.

Triggered by organisational changes within a large electronics firm, this exploratory research was set up to gain a better understanding of the collaboration dynamics, the role of conflict and its management in NPD. This research was planned and executed following a multi-method and multi-actor approach to determine the types and location of conflict in new product development. An initial literature study covering the topics of NPD, collaboration, conflict and conflict management was followed by empirical research through semi-structured interviews among members of NPD teams, project leaders, and higher management functions. Furthermore, workshop observations and reflective staff interviews were used to gather data on the NPD collaboration and decision making process, its dynamics and conflict within two separate NPD teams in two divisions of the research hosting firm. The research context was defined by the application of the Design for eXcellence (DfX) methodology in the context of both case studies.

The implementation of approaches like cross-functional collaboration in Cross-Functional Teams (CFTs) and the DfX methodology proofed to be positive to the integration of different perspectives into NPD. The DfX methodology has been found to be implemented both as a tool and as a structured project management process within the research hosting organisation. The tool combines several perspectives into analyses, whilst the project management process is created to provide clarity in planning, preparation, execution and result monitoring. Prior research regarding the DfX methodology revealed a large number of elements that can be taken into account to address NPD from different perspectives and stimulate organisational learning as a result.

Prior research shows that in setups of CFTs conflict is highly likely to arise due to the convergence of different perspectives. However, a misconception about conflict is that it is bad. The concept of conflict as non-personal disagreement on tasks, goals and objectives arises in different types. The main types of conflict identified in literature include content-based substantive conflict, unclear roles and responsibilities-based process conflict, and emotions-based interpersonal conflict. The impact of conflict is subject to a paradox; low and high levels of conflict relate to low levels of performance, while moderate levels of conflict are associated with high performance.

This research has found conflict to mainly occur at the initial stages of NPD projects with high uncertainty, also known as the Fuzzy-Front-End (FFE). Substantive and process conflict, the main types of conflict identified empirically matched the conflict types found in literature. Other types of conflict like

emotional and interpersonal conflict were left out of the research scope due to their subjective nature. The empirical findings confirm the paradox of conflict. Depending on the type of conflict and the approach to manage it, conflict can be beneficial to NPD performance and relations.

In this research, conflict of substantive nature is found to have a positive effect on NPD performance and relations between team members. Whilst moderate levels of substantive conflict have been found to allow for higher NPD performance. Low levels of conflict limit the questioning and challenging of ideas, solutions, and decisions, which is likely to lead to outcomes below the potential of the available knowledge and resources. High levels of substantive conflict also results in lower performance in time and relations due to the continuous questioning and challenging of ideas, solutions and decisions. Both extreme conditions tend not to stimulate sound progress and substance.

Process conflict relates to unclear roles and responsibilities, as well as unclear procedures. In cases of substantive conflict, process conflict is likely to increase the level of conflict to an extent that lowers the positive performance effects of substantive conflict. Reaching this potential with the sensitivity towards conflict requires effective conflict management.

This study has identified that substantive conflict through confrontation is perceived as positive in a collaborative atmosphere. This even applies under high workloads, while process conflict is perceived negatively and has been found to impact project performance in time and relations negatively. The main finding of this research is that escalation to higher management is chosen as a conflict management and resolution approach. The approach is chosen mainly under the conditions of process conflict and lower levels of informal interactions among project team members from different functions and between the project team and the management team.

With heavy competition and fast paced changes in the business environment of technology firms due to easier and cheaper access to (information) technology, research on the topic of NPD remains relevant. Especially as trade-offs in time and cost efficiency versus the effectiveness in meeting customer requirements have become perhaps more important than ever before. Following this research, it is recommended to continue research in the field of conflict and conflict management in NPD. Specifically, the role and moderating effects of Information and Communication Technology (ICT) in NPD, as well as in NPD collaboration and conflict management is suggested for future research.

The rapid pace of technological advances in ICT may provide beneficial effects on collaboration forms and performance in NPD. The topics that can be addressed by future research include:

- The different styles of collaboration on NPD performance and the effects on relations between NPD stakeholders,
- The relations between theoretical elements of collaboration and approaches to conflict resolution,
- The effects and implications of conflict management training on NPD performance and collaborative behaviour
- The effects and implications of shared key performance indicators, functional requirements and challenges on NPD performance and behaviour.

Key words: New Product Development, Conflict Management, Conflict, Cross-Functional Collaboration, Design for X

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1. Introduction

The survival of businesses in the long run depends on their ability to successfully introduce superior products, services or solutions into the marketplace. This is often described in the catch-phrase 'innovate or die'. With approximately one out of four products achieving market success, a successful business system needs to perform well at delivering a product. More precisely, a product that satisfies the needs of the customer at which it optimises costs (Leber, Bastic, Mavric, & Ivaniševic, 2014).

Technology-based organisations do not have another choice than to challenge their current paradigms. By challenging them, changing demands can be met in the swift-moving environment in which such organisations operate (Leonard-barton, 1992). Moreover, such organisations hold a strong dependency on technological development for their existence. Shortening product life cycles, faster technological developments and global coverage demand highly flexible organisations, often operationalised through cross-functional teams (CFTs) (Holland, Gaston, & Gomes, 2000).

It is critical that through challenging the "old fit be consciously disturbed" (Chakravarthy, 1982) as cited by (Leonard-barton, 1992). However, the only time to develop new core resources is when the current ones still work well. The New Product Development (NPD) process is an adequate vehicle to initiate such organisational change within technology-based organisations (Leonard-barton, 1992). These 'fit disturbing' conditions are likely to foster problems and conflict; characterised by collisions between people, and disagreements over goals, objectives and methods. Especially in NPD, conflict can have a profound impact on performance. Depending on the approach to its management, the impact of conflict can be either positive or negative (Dyer & Song, 1998). This paradoxical relationship will be further elaborated through this research on the study of conflict and conflict management in NPD.

1.1 Research Problem & Trigger

This study is triggered by an ongoing organisational transformation at Philips, a large multinational technology-based firm. In 2014, the transformation reached the organisation's NPD process. A process that is mainly characterised by interactions of collaboration and decision-making between the functions of Marketing, (Research &) Development, Procurement, and Operations. Problems, disagreements and conflicts are likely to occur among these functional departments as they operate in separated functional silos. Within such an organisational setup, interactions tend to be limited to the interfaces between functions during the NPD process.

Within Philips, the desire of integrating the holistic Design for eXcellence (DfX) methodology (Philips Procurement Design for eXcellence Strategy & Capability Center, 2014) into the NPD process has triggered the desire to explore and identify the occurrence of conflict in NPD. Specifically, the collaboration and decision making process up until the commitment of the NPD project plans. A phase in which the majority of decisions are required to be made and agreed upon for manufacturing and sales.

As most organisations focus on managing individuals rather than managing teams, this setting increases conflict sensitivity due to individual rather than team evaluation (Levi, 2007). Moreover, the milestone meetings throughout the NPD process tend to act as the interaction interfaces between the different involved functions. These meetings require the presence of all elements of the puzzle for their gradual convergence into the envisioned product, service or solution which the organisation decided to develop for the market place.

With expanding markets leading to a global scale of competition, it has become more difficult for companies to keep up with changes in technology and business using traditional function-oriented approaches to organisational design (Ries, 2011). Rather, organisations are forced by the changing business environment to change the way they operate towards higher levels of function integration. The higher level of function integration is deemed to deliver reduced costs, improved quality, reduced time spent on NPD, increased customer service, and an increased adaptability to an increasing competitive environment (Levi, 2007). New organisational characteristics increase the importance of teamwork (Mohrman et. al., 1995) as cited in (Levi, 2007), to reduce costs and increase flexibility through simplified organisation and hierarchy. It leads to teams becoming managers in various settings.

1.1.1 Cross-Functional Teams in NPD

Traditionally, functions like Marketing, (Research &) Development and Operations specialise in specific portions of the planning activities, often resulting in conflicts over expectations, preferences, and priorities (Oliva & Watson, 2011). External pressures to fast product development, global presence and flexible organisation are answered by many firms by implementing cross-functional teams.

In both young and established firms, the innovation effectiveness of an organisation is characterised by its responsivity to demands of the market place. The efficiency of innovation is characterised by the resources in time and costs it requires to develop and deliver an answer to the demands of the market place (Holland et al., 2000; Korhonen-Sande & Sande, 2014; Parker, 2002). Cross-functional collaboration, the involvement of multiple functions in a team, is one of the approaches of established firms to try to counter threatening competitive trends (Holland et al., 2000). The approach allows for a more time and cost efficient and customer value effective output. Effective implementation of CFTs has been found to be critical to the success of new products (Gemser & Leenders, 2011; Holland et al., 2000). However, it often occurs that groups choose premature commitment to the first acceptable solution instead of taking a constructed approach to problem solving (Levi, 2007). This approach matches rational problem solving rather than organisational learning. In the field of manufacturing, the creation of concurrent engineering teams that consisted of team members of design and manufacturing has addressed issues of misalignment early in the process (Levi, 2007).

A general tendency of firms is a too conservative approach to options in NPD projects. Rather, less risky and uncertain signals are pursued. Often the same signals pursued by competitors, resulting in very competitive market conditions (Gemser & Leenders, 2011). Cross-functional collaboration has proven to be an effective goal-oriented collaboration and decision-making approach to NPD in various industries (Holmes & Campbell, 2004; Tsai & Tiaojung, 2014). However, its application proofs not to be a matter of course in organisations that are divided by functional areas of expertise.

1.1.2 New Product Development and Conflict

The NPD process is a place where new ideas, new products, and new processes are created under the dependency of organization members challenging the status quo (Dyer & Song, 1998). NPD is defined as a critical strategic activity (Leonard-barton, 1992), and team-based structures with CFTs are being relied upon in this domain. However, the early involvement and integration of different functional perspectives carries a contradictory effect; it can increase performance, whilst also being able to deteriorate performance by provoking conflict between and within teams. Existing research shows that the phase of the NPD process affects the effectiveness and efficiency of cross-functional collaboration (Leonard-barton, 1992; Song, Thieme, & Xie, 1998). The involvement of multiple functions in NPD has been found to be most effective in the early NPD stages when uncertainty is at its highest level (Song et al., 1998). However, this collaboration comes at the cost of time-consuming consensus building between functions with differing goals and perspectives (Piirainen, Kolfschoten, & Lukosch, 2012).

Formalised processes within organisations may prevent rich interactive relationships between product development teams and management. Empirical evidence even suggests that formalised processes limit rather than enhance the interaction between team members and senior managers in NPD projects (Felekoglu, Maier, Anja, & Moultrie, 2013). It is evident that interactions between team members and management are limited when following a document-based structured process. The dichotomy of managing NPD is twofold; the process is risky and therefore necessary formalisation enables its management through authorisation, control and audit trails in decision making. However, the formalisation of processes seems to focus on control. Furthermore, it limits the perception of management's responsibility to document sign-off moments prepared by product development team members (Felekoglu et al., 2013).

This dichotomy is affected by organisational aspects too. In the case of an organisation whose design follows the common split along functional expertise, it raises the question which interests are leading in the process of managing NPD; the interests of the separate functions or those of the NPD process aiming for synergy. In a highly structured process, management takes on a roll of controlling, monitoring and approving. While in companies that follow a less structured approach to NPD, the top management plays a leading and motivating role in interactions that are more interactive and continuous (Felekoglu et al., 2013).

Conflict is emphasised as an important part of NPD. Conflict is a natural phenomenon in NPD (Lam & Chin, 2005 as cited in (Rese & Baier, 2005). The failing of one party to meet the agreed efficiency requirement, in spite of it possibly meeting the agreed effectiveness requirement appears to trigger conflict (Duarte & Davies, 2003). Conflicts in NPD are assumed to appear so often that they are labelled as an unavoidable feature of NPD (Kezsbom, 1992; Pinto & Kharbanda, 1995 as cited in (Rese & Baier, 2005), which can affect team performance and success positively or negatively.

The involvement of all functions has indicated to lack significant effects on NPD success and higher chances of counter productiveness and conflict (Song et al., 1998). It is suggested that a balance between effectiveness and efficiency can be achieved by involving the right mix of functions at function-specific and stage-specific collaboration and decision-making moments in NPD (Song et al., 1998). However, there are more aspects to take into account in the NPD process. Among them are the two crucial elements; creativity and adaptation, which are created out of tension, passion and conflict (Dyer & Song, 1998). Out of these elements, conflict has a profound impact on NPD performance, either positive or negative depending on the approach to handle conflict, and requires time and attention from managers (Dyer & Song, 1998).

Proposed actions include the integration of the Marketing, Procurement and Manufacturing functions as a solution for higher customer-centric performance and less negative conflict in NPD (Swink & Song, 2007). In managing conflict, communication management, trust and commitment to the collaboration have been identified as the most important factors (Lam & Chin, 2005).

Traditionally, interfaces between functions have been a place of conflict, originating from functional barriers and predominantly closed innovation systems of large established firms (Chesbrough, Vanhaverbeke, & West, 2006). Interfaces between functions, among which Development and Marketing, have been studies heavily and have been defined as important for innovation success. Research findings reveal barriers in communication and cooperating based on physical distance, differences in culture, personality, use of language, priorities, expectations of cooperation, and measures of success (Holland et al., 2000). In NPD, conflict occurs most between the key functions Marketing and Development (Auh & Merlo, 2012; Dyer & Song, 1998; Jacobsen et al., 2014; Souder, 1988). These conflicts revolve around the

tension between qualitative customer requirements brought in by Marketing and quantitative technical specifications required by Development.

Another conflict sensitive interface between functions in NPD is the interface between Marketing and Procurement. This interface is characterised by a weak recognition of the capabilities of the Procurement function. Furthermore, it concerns misalignment in procurable standardised materials, components and products that suit defined customer requirements and the urge for differentiating factors by Marketing (Atuahene-Gima, 1995; Sheth, Sharma, & Iyer, 2009). Increased competition and open innovation systems require organisations to meet market demands at the right time, quality and costs through an effective and efficient NPD process (Chesbrough et al., 2006). One of the methodologies that can be applied to reach such a process is Design for 'X' (Dombrowski, Schmidt, & Schmidtchen, 2014).

1.1.3 Conflict management

The understanding of conflict occurrence in NPD can contribute to the integration efforts of the DfX methodology into the organisation's way of working. The research trigger is supported by research findings on change within organisations. These findings revealed that more than 70% of all major transformation efforts fail due to a lack of a consistent, holistic approach to organisational change and to effective workforces engagement (Kotter, 1995).

Methods of dealing with conflict are often consolidated into conflict management. Practicing effective conflict management has been found to have a positive effect on both NPD performance and longer term collaborative relationships. And it has been defined as crucial for the success of collaborative NPD (Lam & Chin, 2005). Conflict management is deemed an important element for the market success of developed products. Conflicts that are not addressed properly do not lead to positive results (Souder, 1988). Not addressing conflict properly may even lead to negative business results. For example, statements and decisions of a function, not challenged by other functions in the project, are more likely to lead to the easiest or most difficult option without the exploration of all suitable and feasible options in crucial NPD decisions.

Although conflict is difficult to record, and the beneficial or negative effects of certain types of conflicts on team performance are still not clarified in literature (De Dreu & Weingart, 2003 as cited in (Rese & Baier, 2005), conflicts can have positive or negative effects. It can lead to cooperation barriers (Shaw, Shaw, & Enke, 2003), or contribute to the attainment of goals through the demonstration and understanding of different points of view (Jehn & Mannex, 2001 as cited in (Rese & Baier, 2005). This contrast in effect makes managing conflict one of the most critical success factors for projects (Gemünden & Lechler, 1997 as cited in (Rese & Baier, 2005). By investigating the NPD, the chances of delays and suboptimal behaviour in NPD projects are aimed to be minimised or prevented.

1.1.4 Design for X: Content and Tool

By combining deep insights about customers, competitors, and supply bases, firms are enabled to strengthen their organizational capabilities and competitiveness (Gatenby & Foo, 1990). A lack of integration between the different stages of the Product Realisation Process (PRP) have shown to result in an increase in issues regarding manufacturing, installation, service, maintenance, environment, safety and reliability (Gatenby & Foo, 1990). This lack can come at the price of redesign, additional production and deployment expenses and delays in market-entry (Gatenby & Foo, 1990).

Design for X (DfX) is a methodology in NPD that has proven to be effective as a vehicle to overcome functional barriers in cross-functional collaboration and decision-making in manufacturing enterprises (Dombrowski et al., 2014; Gatenby & Foo, 1990; Leber et al., 2014). It is deemed to break down barriers between functions by requiring cross-functional collaboration through its holistic nature. It takes a

holistic perspective over a range of different elements, the so-called X's in 'Design for X' taken into scope in the design and development process, include: Manufacturing and Assembly (DFMA), Reliability and Maintainability, Testability, Service, Disassembly, Recycling, Logistics, and Environment (Dombrowski et al., 2014; Gatenby & Foo, 1990; Leber et al., 2014).

As a prominent trend in effective collaboration in NPD, the DfX methodology is taken as a context and tool in this study to study the occurrence of conflict in NPD collaboration and decision-making between the key NPD functions: Marketing, Development, Procurement, and Operations.

1.1.5 Prior Research

In addition to the previously described elements that relate to the subject of collaboration and conflict management in NPD, this research takes more existing studies in the sphere of NPD into account. The most prominent subjects touching the scope of this research are listed below. Previous research in the fields of collaboration, conflict and NPD has covered the areas of organisational types (Mintzberg, 1989), the NPD process (Holmes & Campbell, 2004; Krishnan & Ulrich, 2001), types of teams (Katzenbach, 1993), effective collaboration (Bruijn & Heuvelhof, 2008; LaFasto & Larson, 2001), cross-functional collaboration (Oliva & Watson, 2011; Parker, 2002), team member selection in cross-functional teams (Feng, Jiang, Fan, & Fu, 2010; Holland et al., 2000), crisis in NPD (Lynch, O'Toole, & Biemans, 2014), the interaction process of teams with general management (Felekoglu et al., 2013), and the enabling methodology Design for X (DfX) (Dombrowski et al., 2014; Gatenby & Foo, 1990; Leber et al., 2014).

1.1.6 Problem Statement

The New Product Development (NPD) process is characterised by collaboration, decision-making and conflict between actors from different functions. In the process of planning, preparing and executing the defined product value proposition, its technical specifications, suppliers, and manufacturers, conflict has been identified as natural, unavoidable and required. The need for proper understanding and management of conflict is emphasised by a paradox. The paradox of conflict's impact on NPD project performance and collaborative behaviour between NPD functions. A deeper understanding of conflict occurrence and handling in combination with the Design for eXcellence (DfX) methodology is required in order to sustain the added value of a cross-functional collaborative NPD process.

Following the elements of the research context, problem and trigger, this research will address the following problem statement:

> The limited understanding of conflict occurrence and its management by the functions of Marketing, Development, Procurement and Operations has been defined by prior research to be a burden to the project time and cost performance of the New Product Development process, as well as to individual and team behaviour.

1.1.7 Summary

The findings listed below have been found from preliminary research into NPD and NPD related elements. These elements include organisational configurations, collaboration, problem solving, conflict, conflict management, and DfX as a prominent methodology.

- The NPD process within a technology firm is characterised by collaboration and decision-making between the functions of Marketing, Development, Procurement, and Operations.
- Organisations are forced by the changing business environment to change the way they operate, resulting towards more integration of functions. Cross-functional teams are used to gain more insights in dealing with competitive pressures, and rapid market and technology changes. The paradox of this approach is that it can increase and deteriorate NPD performance through conflict.(Dyer & Song, 1998)
- The uncertain nature of the NPD process makes it sensitive to problems, disagreements and conflicts. The process should therefore be dealt with in a way that caters for maximum utilisation of insights, knowledge and experience of different functions.
- Although conflict is difficult to record, it is deemed is natural, unavoidable and required in NPD. It can have both positive and negative effects on NPD performance in project timing, quality, and cost, as well as on collaboration performance.
- And although harmony and teamwork are often sought by management, a healthy dose of conflict has an important role in fostering innovation through its vital creative tension during NPD.

The NPD process involves multiple functions and consists out of multiple phases, from opinions and ideas to facts and figures, which go through a process of conflict to finally end in decision-making towards implementation. With limited knowledge on the location of conflict in NPD it is taken into account that conflict in NPD may require specific conflict management styles to be managed effectively; similarly to the different management styles. This study, performed in the context of the DfX methodology as a tool, is deemed to improve the understanding of conflict and its management in NPD collaboration and decision-making, by answering the main research question:

'How can conflict be dealt with to sustain a cross-functional collaborative decision-making process towards a committed new product development project plan?'

1.2 Research Context & Scope

Context

The research context of this case study is the implementation of the holistic and cross-functional Design for X (DfX) methodology and tool within the business divisions Philips Personal Health and Lighting Solutions. This methodology and tool addresses the nature of collaboration and decision-making in new product development by involving several relevant functions to optimize organisational resources over the entire product lifecycle. Studies have shown positive relationships between the Design for X approach and NPD performance, measured in the monetary market success of products (Dombrowski et al., 2014; Gatenby & Foo, 1990).

Cross-functional collaboration research has proven that the approach carries the potential to improve efficiency, effectiveness and quality in new product development (Dyer & Song, 1998; Gemser & Leenders, 2011; Holland et al., 2000; Korhonen-Sande & Sande, 2014; Oliva & Watson, 2011; Parker, 2002; Song et al., 1998; Tsai & Tiaojung, 2014). Consequently, these studies conclude that although this approach provides a platform to deliver positive results, its cross-functional nature bares risks of conflict. Conflict research suggests that conflict should not be perceived as negative in all cases. Substantive conflict, known in a business context as the act of challenging, affects business performance in a cross-functional setting positively as it provides valuable insights towards customer value or organisational costs from different perspectives. However, effective, or pro-active, conflict management is deemed crucial to reach the higher performance potential of cross-functional collaboration.

Research Scope

Figure 1: Research Scope: Integrated Product Development Process

The boundaries of this research are defined by the NPD process between the project start and the commitment to milestones of the project plan, illustrated in *Figure 1*. This phase of the NPD project is defined by detailed investigation to build the project's business case and to define and commit to the product design, product specifications, manufacturers and suppliers, factory cost price. The business case includes investments in capital expenses and personnel, product volumes, and product pricing. This phase involves the key NPD functions of Marketing, (Research &) Development, Procurement, Operations, and the Project Leads. This diversity of involved functions has proven to be prone to conflict. Therefore, the scope of this research is constrained to collaboration, conflict, and conflict management between the involved functions during the detailed investigation phase of NPD project.

The designer of a research project is often caught between the criteria of usefulness and feasibility in designing and executing the project (Verschuren & Doorewaard, 2010). With regard to the boundaries in time and data collection possibilities, the scope of this research is the face-to-face collaboration process of new product development in the context of Western-Europe. The new product development projects of which the author collected data all relate to electronic products for the consumer or professional market. Due to the complexity of the subject of collaboration in NPD and the large number of interdependencies, the scope of this research has geographical and cultural boundaries that are directly related to data availability towards the author. To ensure a proper understanding of the research topic and to meet the research objective in the limited research context and time of the author, the following effects are

excluded: the role of international and cross-cultural dimensions, and the moderating effects of Information and Communication Technology (ICT). These limitations are likely recommendations for future research in the domains of collaboration and conflict in NPD and other contexts.

1.3 Research Objective & Relevance

Research Objective

The purpose of this study is to create an understanding how collaborative behaviour and project outcomes in time, quality and cost can be positively influenced in a sustainable way through conflict management. The NPD context is prone to conflict due to organisational factors, uncertainties and behaviours of actors related to the process (Amason, Thompson, Hochwarter, & Harrison, 1995; Crittenden, Gardiner, & Stam, 1993; Duarte & Davies, 2003; Weinrauch & Anderson, 1982). The research objective is to recommend effective conflict management approaches to improve the collaboration and decision-making process leading up to a committed project plan in NPD projects.

The role of each of the functions is analysed in literature and empirically elaborated by functional experts of each of the functional departments within Philips. The deliverable consists of a number of recommendations on how to sustain cross-functional collaboration while reducing the negative impact of conflict on project quality, cost, time, and people in NPD projects. The results should increase process transparency and conflict understanding among NPD stakeholders. In this study, the concept of conflict is perceived in both a positive and negative context as both variations occur in the NPD context.

This study focusses specifically on the level of conflict at the interface between the five key functions in the early phases of new product development: Marketing, Development, Procurement, Operations and the (Integral) Project Leads. Each of these three functions has an important role to fulfil in the development and delivery of new offerings in the form of products, services or solutions. Although the overall goal of the organisation and all its functions is to successfully develop and profitably deliver new offerings, each of the functions has different functional interests.

By addressing the underlying issues of cross-functional collaboration and conflict management within the organisation, this research aims at delivering recommendations that contribute to the sustainable integration of the holistic cross-functional collaborative way of working into the organisation's DNA.

Research Relevance

This is not the first study within the scope of new product development. Previous studies have studied the performance of the new product development process (Browning, 2003; E H Kessler, 2000; Eric H. Kessler & Chakrabarti, 1999; Rosenthal, Tatikonda, & Notes, n.d.; Sánchez & Pérez, 2003), the effects of cross-functional knowledge (Feng et al., 2010; Gemser & Leenders, 2011; Holland et al., 2000; Korhonen-Sande & Sande, 2014; Oliva & Watson, 2011; Parker, 2002; Song et al., 1998; Tsai & Tiaojung, 2014), conflict management (Crittenden et al., 1993; Deutsch, 1990; Levi, 2007; Rahim, 2002; Souder, 1988) among other influences and outcomes.

In conflict management research, both low and extensive levels of conflict have been found to be hindering new product development performance and commercial market success. However, moderate levels of conflict have been found to increase the likelihood of commercial success of newly developed innovations and the time and cost performance of the new product development process.

This research takes conflict management to new product development and takes a multi-actor approach. This approach is chosen to gain a thorough understanding of the challenges that lead to conflict and the way conflict is dealt with from different perspectives across organisational levels.

Method literature prescribes qualitative research through literature review and interviews to be a suitable approach to gaining a thorough understanding of phenomena (Easterby-Smith, Thorpe, & Lowe, 2001; Verschuren & Doorewaard, 2010). A qualitative multi-method approach of literature review, semi-structured interviews, and participatory observations has been chosen to gain an in-depth understanding of the domains of new product development research, teamwork and collaboration research, cross-functional collaboration research, and conflict management research. Conflict management has not yet been researched as a structural element of the DfX methodology and cross-functional collaboration in new product development. This research aims to address this knowledge gap. This approach has been chosen to validate the empirical interview data with data from participatory observations of the same sample.

Prior research

Prior studies on conflict management within organisations have taken several directions, from understanding the causes of conflict through measuring its intensity or amount, to studies covering conflict handling styles and their effects on the quality of solutions (Deutsch, 1990; Rahim, 2002). Studies in this domain have shown low levels of conflict, which in many cases can be related to the level of contact between different functions. Little contact provides little opportunities for conflict to arise (Shaw et al., 2003). Furthermore, a high level of professionalism tends to have avoiding effects on emotional conflict.

The main limitations of previous studies have been identified in their limited geographical coverage, and the limited range of people questioned (Shaw et al., 2003). Often a convenience sample or a small sample of less than five people per company was used, with the tendency of a selection among senior positions of management to share their views and perception on cooperation and conflict within new product development. This provides a limited view to this research domain.

Knowledge gaps

The main identified knowledge gaps in academic literature on collaboration and conflict in NPD are:

- The influence of the Design for X approach to cross-functional collaboration (Dombrowski et al., 2014). How does the Design for X approach influence cross-functional collaboration?
- The role of middle management in the product development process (Nonaka & Takeuchi, 1995). What is the role of middle management in the product development process?

These questions are addressed in this research.

1.4 Research Questions

The objective of this research is to gain an understanding of collaboration and conflict management in cross-functional collaborative New Product Development. A thorough understanding and analysis of collaboration, conflict management and the interest of involved actors are used to mitigate the negative risks of conflict and to reduce negative effects on projects, time and people. The question at hand is how to improve the collaborative NPD process through conflict management. The following research question has been formulated to answer this question:

'How can conflict be dealt with to sustain a cross-functional collaborative decision-making process towards a committed new product development project plan?'

This research question is supported by the following sub questions in order to provide a solid answer.

SQ 1: Which characteristics define the collaboration process between marketing, development, procurement and operations in new product development?

SQ 2: Which types of conflict occur in new product oriented collaborative decision-making in the new product development process?

SQ 3: Where in the new product development process do conflicts occur?

SQ 4: How is conflict being managed in new product oriented collaborative decision making in order to safeguard the added value of the new product development process?

The research questions are defined to explore collaboration, conflicts and conflict management in new product development and conclude on suitable recommendations to conflict management in NPD that are derived from literature and empirical research.

2. Theory: Collaboration and Conflict Management in New Product Development

This chapter discusses theory from literature in the domains of collaboration and conflict management in new product development. The first section presents the organisational configuration. Collaboration dynamics and high performance are discussed in section 2.2, followed by problem solving. Section 2.4 presents the concept of conflict and its occurrence, continuing with the paradox of conflict in section 2.5. Section 2.6 discusses conflict management tactics. Section 2.7 addresses risks of conflict, followed by conflict sensitive uncertainties of New Product Development being elaborated in section 2.8. The theoretical model is presented in section 2.9, followed by the theoretical conclusion on collaboration and conflict management in New Product Development in section 2.10.

2.1 Organisational Configuration

2.1.1 Transformation pressure on Organisations

In order to stay relevant, organisations experience a constant pressure in enforcing organisational learning and development (Ahuja & Lampert, 2001; March, 1991; Ries, 2011). Mintzberg and Miller (1989) argue that organisations can adjust to changes by adopting continuously and gradually, or by engaging in quantum leaps from one integrated configuration to another. Mintzberg (1989) has defined configuration as harmony, characterised by consistency in characteristics, synergies, and fit in the context. The quantum leap move is argued to be more efficient and effective as it only encourages transformational efforts when the environment has changed extensively and the organisation's activities are not synchronised anymore. This configuration maintenance transition has been defined as strategic revolution (Mintzberg, 1989).

2.1.2 From tight structured towards organic Organisational Configurations

Organisational theorist Mintzberg (1989) has defined several types of organisational configurations, ranging from the hierarchical machine organisation to the flat entrepreneurial organisation. An organisational structure that is characterised by a variety of product lines and business units, operating in several geographical regions and markets relate to Mintzberg's divisional, or diversified organisational configurations. The divisional configuration is defined by several divisions which are linked by an overarching corporate organisation, while the diversified configuration is characterised by an organisation which is active is several, not directly, not related businesses and markets. The weakness of these configurations is the duplication of activities and resources per business unit, and the conflict sensitive relationship between divisions due to the competition for the resources that a headquarters has to offer. Due to its generally inflexible nature, such an organisational configuration tends to work best in stable and not too complex industries, including product and market diversification strategies.

Mintzberg's bureaucratic Machine organisational configuration is operationalised by organisations that are formalised through routines, procedures and predefined processes, functional departments and centralised decision-making. They operate in a tight vertical structure with a formal planning process that includes budgets, audits, and procedure analyses. The Machine organisation can be very efficient when relying on economies of scale. However, formalisation tends to turn into specialisation, which is likely to lead to functional classification and conflicting goals and inconsistencies between functions and the overall corporate objectives.

The Innovative – or adhocracy – organisational configuration suits organisations that are faced by constant changes and increasing dynamics and complexity in their environment. The innovative

configuration is characterised by a more organic and more decentralised organisational structure (Mintzberg, 1989). This organisational configuration is likely to have an ad hoc structure with decentralised decision-making, and power delegated to wherever it is required. These characteristics make the innovative configuration more difficult to control. Typically, companies with such an organisational configuration bring in experts from a variety of areas to form creative and cross-functional teams.

Ideally, these teams would move from project to project with the ability to quickly respond to changes by bringing in skilled experts to collaborate in timely meeting the challenges that arise. Such benefits arise when a more organic structure with fewer constraints of bureaucracy, complexity and centralisation is implemented. However, such a structure does have its challenges. Its challenges lay in its conflict sensitivity due to likely ambiguity in ambiguity and authority, and high pressure on workers for them to deal with rapid changes. This makes it more difficult for such organisations to find and keep talent. All in all, an innovative organisation is enabled by its structure to deal with changes adequately through flexibility.

2.1.3 Organic Organisation for complex environments

Another adaptation organisations face within constant changes in their environment is the urge to adapt to a more organic organisational structure as the environment becomes more dynamic, and to adapt to a more decentralised structure when the environment increases in complexity (Mintzberg, 1989). These changes have resulted in a significant increase in teamwork and collaborative effects (LaFasto & Larson, 2001). This trend has resulted from the evolution of social behaviour, transcending the individual's behaviour towards a greater capacity for cooperative behaviour (LaFasto & Larson, 2001).

Teamwork and collaboration are shaped by two societal forces; it is driven by the need for finding new and more effective ways of dealing with complex problems, and it has been enabled by the increasing social capabilities of using collaborative strategies by individuals and collectives when dealing with common problems (LaFasto & Larson, 2001). These societal forces relate to the three orientations of relationships by (Diesing, 1962 as cited in (Deutsch, 1990): economical-oriented, solidarity-oriented, and caring-oriented. Of these three orientations, the economical orientation is the most relevant for high technology businesses who operate with economically driven objectives.

The economic orientation is suggested to have four consequences: 1) the development of a set of values including competition, maximisation, means-end schema, neutrality or impartiality of means; 2) commoditisation of everything related to mankind, including labour, time, land, capital, personality, social relations, ideas, art, and enjoyment; 3) the development of measurement procedures enabling value comparison of different amounts and types of commodities; and 4) the tendency for economic activities to expand in scope and size (Diesing, 1962 as cited in (Deutsch, 1990).

The consequences emphasise the aim for exploitation of means, value comparison measurement, and growth. These high level factors could be addressed more effectively through collaboration by a team of people rather than an individual. The next section discusses the types of team that apply within an organisation.

2.1.4 Types of Teams

In general, activities are performed on either individual, team, departmental and interdepartmental levels of an organisation. By zooming into the departmental and interdepartmental levels, we come to a point for the need of identifying the configurations for collaboration among individuals within the organisation.

Teams within organisations are two-faced; they hold the potential for improving organisational culture and can be the source of hindrance for organisational advancements (Amason et al., 1995). Teams are seen as an organisational tool that expands the role of employees beyond their task performance by involving them in larger operations. Teams have proven to be useful in improving the quality of decision-

making, in building consensus and support for action, and assisting in the foundation of a cooperative and goal-oriented culture (Amason et al., 1995).

Prior research has identified three main types of organisational teams; functional teams, self-directed teams, and cross-functional teams (Parker, 2002). These types, their characteristics and the most common type of organisation for them to occur in are discussed in this section.

Functional teams consist of individuals which share the same background in discipline expertise. Such teams are common in traditional hierarchical organisations whom operate in stable or slow industries with predictable markets (Parker, 2002).

Self-directed teams are common in traditional organisations and start-ups, including an embedded base of participative management and employee involvement. Self-directed teams consist of trained individuals who possess technical skills and necessary abilities to complete tasks. They can only thrive when equipped with management delegated authority to plan, implement, control, and improve work processes. Obstacles to self-directed teams within hierarchical organisations often consist of limited levels of participative management and employee involvement (Parker, 2002).

Cross-functional teams have been defined as**:** "A group of people with a clear purpose representing a variety of functions or disciplines in the organisation whose combined efforts are necessary for achieving the team's purpose. The team may be permanent or ad hoc, including customers and vendors." (Parker, 2002). Such teams tend to be common in fast-changing market organisations which are characterised by the need for adaptability, speed and customer need focus. They are applied in situations of complexity, such as new product development (Levi, 2007). Their diversity, functional and possibly organisational, creates both benefits and problems. Benefits result in higher efficiency and effectiveness; efficiency measured in the use of the least amount of time, labour or resources. Effectiveness is measured by a team's ability to complete its task (Levi, 2007). The advantages of cross-functional teams are numerous; speed, early problem identification, better serving the customer through different insights and perspectives, and pooling of expertise from different sources (Parker, 2002). However, cross-functional teams do not fit in any organisation as they require decision-making authority to be able to coordinate change efforts quickly and effectively (Parker, 2002).

Cross-functional team members require two types of formal technical training for them to be able to perform well within the team (Parker, 2002); 1) tools and techniques training – with the entire team, as that would require teamwork; and 2) skills and knowledge training – to individual team members in order to teach them about other disciplines. To sum it up, Parker (2002) has identified six key success factors for cross-functional teams to succeed:

1) **Management Support** for tangible resources, encouragement of risk taking and empowerment
2) **Clear Overarching Goal** transcending individual priorities and commands commitment
3) **Team Awards** corresponding to and support team efforts
4) **Organisational Training** helping collaboration between colleagues and strangers, while encouraging an open learning environment.
5) **Right Team Composition** with the right players and leader
6) **Team Authority** to act consistent with their responsibilities

An industry example of cross-functional teams comes from the automotive manufacturer Chrysler. At Chrysler, cross-functional platform teams were charged with bringing a vehicle to market – on time, within budget, and with world class quality characteristics. These teams existed of engineers, manufacturing experts, marketing professionals, and suppliers. It is this diversity of functions and perspectives that made them effective in their work. Moreover, the early involvement of several functions allowed for the reducing of lead times due to early cycle pilots which allows for early problem identification (Vasilash, 1992 as cited in (Parker, 2002). This research takes cross-functional teams into

account as the main collaboration configuration as studies have shown they are increasingly applied in new product development processes and are likely to be found in the context of this research as well. The following section elaborates the concept of collaboration.

2.2 Collaboration Dynamics and High Performance

In this chapter, the concept of collaboration is examined on an individual, team and team leadership level, collaboration dynamics are discussed, as well as characteristics of high team performance.

2.2.1 Collaboration

A team is defined as a unique group with an objective, and is characterised by collaboration being required for reaching the team's goal (LaFasto & Larson, 2001). An objective is defined as a specific goal to reach, often a concrete or tangible performance objective. And the required activity of collaboration is described as a coordinated effect on the performance objective (LaFasto & Larson, 2001).

Teamwork, or collaborative efforts, has been defined as: "People with different views and perspectives coming together, putting aside their narrow self-interests, and discussing issues openly and supportively in an attempt to solve a larger problem or achieve a broader goal" (LaFasto & Larson, 2001). LaFasto & Larson (2001) argue that the way we work together and solve problems is shaped by deep-rooted habits and values. Moreover, these habits and values change at a slower pace than formal changes that are mandated by organisational structure and strategy. They continue with the notion that teamwork and collaboration are shaped by two societal forces:

1) Driven by the need to find new and more effective ways of dealing with complex problems.
2) Made possible by the increasing societal capacities of individuals and collectives to use collaborative strategies to deal with common problems

LaFasto & Larson (2001) conclude that doing too many things at the same time often results in not well results or nothing at all. Subsequently, they conclude that change is more likely to succeed if it is acted upon in a focussed and incremental way.

In theory, participation of all involved parties in decision making should result in better decisions. In product evaluation and new product development, a more diverse and higher number of individuals can provide more ideas for solutions to products, processes and solutions (Amason et al., 1995). Cross-functional integrated teams bring the ability to detect and act successfully upon high-risk signals through knowledge sharing and the combination of disciplines, resulting in a higher potential of sustainable competitive advantage (Gemser & Leenders, 2011). In reality, teams proved to cause compromised decisions rather than good business judgment, and slow decision-making with win/lose mentalities of political power struggles between individuals rather than the best interests for the organisation. A push towards a total agreement, also known as groupthink, stimulates the failure of self-evaluation of ideas for the sake of friendliness rather than challenging perspectives and assumptions (Amason et al., 1995).

Much of the existing research in the area of collaboration in NPD concludes that cross-functional collaboration improves NPD performance. Research suggests that less integrated project teams are able to achieve similar results as more cross-functional teams in tasks related to processing large quantities of knowledge and information, without incurring the costs of high levels of cross-functional collaboration (Gemser & Leenders, 2011). A study by (Gemser & Leenders, 2011) has shown that cross-functional collaboration increases NPD success in projects characterised by high levels of technological and market risks. Despite these findings, it is advised not to perceive cross-functional collaboration as the holy-grail of NPD success. The marginal effects of cross-functional collaboration on the success of NPD projects tend to only influence projects characterised by the pursuit of unknown technologies and markets, while effects decrease in projects with openness to a widely diverse range of external information sources. In

these riskier cases, the benefits of greater capabilities in processing and absorbing information resulting from the cross-functional nature of the collaboration outweigh psychosocial costs of higher levels of stress and conflict (Gemser & Leenders, 2011).

2.2.2 Performance

Performance can be hard to grasp when it comes to collaboration. One suggestion for measuring collaboration performance is context-based reasoning. In this approach, human performance is represented in a hierarchy of contexts that consists of decomposed knowledge of human behaviours (Gonzalez et al. 2008) as cited in (Knoll & Lukosch, 2014). Hackman (1987) as cited in (Knoll & Lukosch, 2014) constructed a general framework of group performance in dynamic collaboration processes, illustrated in *Figure 2*. The framework addresses the complexity of the collaboration process, its contextual factors and performance influences.

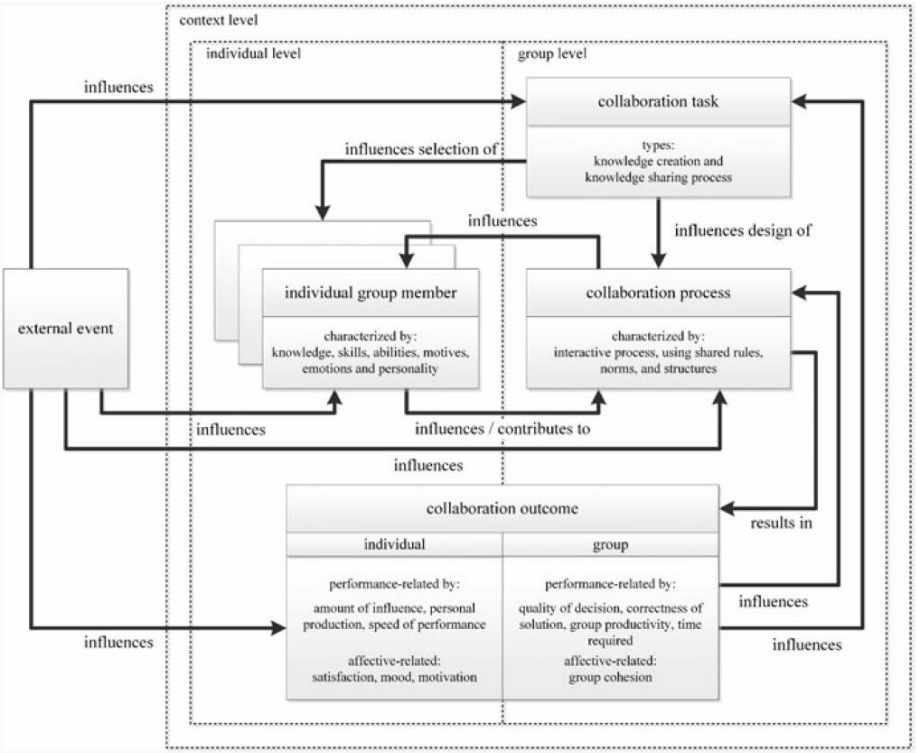

Figure 2: A general framework of group performance in dynamic collaboration processes (Hackman 1987) as cited in (Knoll & Lukosch, 2014)

The input-process-output framework consists of several collaboration elements, including collaboration task, individual group member, collaboration process, collaboration outcome and external event. It can be used to analyse group behaviour and performance.

The collaboration task influences the group composition and defines the resources which are necessary to complete the task. Knowledge, skills, and abilities of individual group members form these resources, in addition to personality, motives, and emotions.

The collaboration process is characterised by the use of external resources as task related information and technological support by individual group members. Interactively, group members contribute different resources to the group. The collaboration task influences the design of the interactive process, a process which defines norms, shared rules, and structures in order to create a collaboration outcome.

The outcome of a collaboration process has been found to be either performance-related or affective-related. Performance of an individual can be defined in terms of amount of influence during a decision-

making process, contributions in discussions, or personal performance speed. Affective-related outcomes are psychological, related to satisfaction, motivation, or the mood of an individual group member.

Group performance can be represented by the solution correctness, decision quality, group productivity, or the required time to achieve the intended goal. Affectively, outcomes relate to group cohesion.

Furthermore, several other elements have been found to be contributing to performance. These elements include: constructive feedback, the confrontation and resolution of performance issues, rewarding of results and recognition of superior performance. All of these elements contribute to performance in team collaboration (LaFasto & Larson, 2001).

Levi (2007) indicates that 8 characteristics relate to high performance teams. These characteristics, listed in *Table 1*, relate to clarity in objective, structure and standards, agreement and commitment, a pleasant collaboration climate, and leadership and external support. These characteristics match the dimensions of effectiveness that have been defined by LaFasto & Larson (2001).

Table 1: 8 Characteristics of High Performance Teams (Levi, 2007)

1) A clear, elevating goal	1) Collaborative climate
2) A result-driven structure	2) Standards of excellence
3) Competent team members	3) External support and recognition
4) Unified commitment	4) Principled leadership

Failures of collaboration relate to incapable ego and needs control, misaligned compensation or performance appraisal systems, openly displayed hostile attitudes by management, and lack of training and support in collaboration (LaFasto & Larson, 2001). These causes of failure result in; 1) dysfunctional settings, 2) individualistic and competitive values, and 3) rewards for capturing and controlling organisational resources.

2.2.3 Group Collaboration

Collaboration in a group setting has been studied by several researchers. This section elaborates a number of studies to clarify the developed theory. LaFasto & Larson (2001) argue that collaborative team relationships can be built and sustained through actions that relate to four characteristics. These characteristics correspond with the four dimensions of good collaboration that focus on processes of communication, tasks, coordination, and motivation (Burkhardt et al., 2009).

1. **Constructive**, for building a relationship.
2. **Productive** to make a difference
3. Embracing **mutual understanding** through understanding and appreciation.
4. **Constructively self-correcting** through commitment to improvement and monitoring of improvement activities.

The four dimensions of good group collaboration as defined by Burkhardt et al. (2009) are elaborated in Appendix 3.

Collaboration Dynamics

The act of collaboration can be classified in five levels of dynamics with elements that contribute to collaboration (LaFasto & Larson, 2001). These dynamics and elements are listed *Table 2* and elaborated below.

Table 2: Collaboration Dynamics and Elements (LaFasto & Larson, 2001)

COLLABORATION DYNAMICS	COLLABORATION ELEMENTS
TEAM MEMBER	Attributes and behaviours that help or interfere with team success
TEAM RELATIONSHIP	Dimensions of strengths and weaknesses of working relationships
TEAM PROBLEM SOLVING	Behaviours of teams defining successful problem solving
TEAM LEADERSHIP	Behaviours of team leaders that help lead to success or failure
ORGANISATION ENVIRONMENT	Organisational processes and practices that increase or decrease the likelihood of team success

Team Member

Attributes and behaviour of a team member have been found to relate to the core competency, defined as the quality of working knowledge. This core competency can be split into two aspects: having sufficient experience to perform the job at hand well, and having the necessary problem-solving ability to overcome obstacles (LaFasto & Larson, 2001). Four dimensions of the individual communication context in collaboration have been identified (Reiter et al., 2013) as cited in (Knoll & Lukosch, 2014):

- Task: as the activity in a process
- Location: as the workplace of an activity
- Presence: as the individual's availability for location or task-related communication
- Relation: between individuals

Janeiro et al. (2012) as cited in (Knoll & Lukosch, 2014) argue that group members can be supported in their task through prescribed or emergent collaboration. Prescribed collaboration through predefined processes and support tools is suggested at low individual levels of expertise, while emergent collaboration forms without guidance and coordination would fit high levels of individual expertise. These measures help group members in monitoring the collaboration context and adapting processes to new situations. In addition, four personal qualities, defined as teamwork factors by LaFasto & Larson (2001), have been found to contribute to teamwork. These are listed in *Table 3*.

Table 3: Personal Qualities and Elements

PERSONAL QUALITIES	QUALITY ELEMENTS
OPENNESS	Willingness to deal with problems, and surfacing of issues for discussion
SUPPORTIVENESS	Desire and willingness to help others succeed
ACTION ORIENTATION	Tendency to act or experiment, and encouraging others to take action
POSITIVE PERSONAL STYLE	Fundamental differences among people in attitude, described as energetic, optimistic, engaging, confident, and fun to work with

Despite these qualities, collaboration might be obstructed by other factors. In fear of negative evaluation, group members might withhold contributions during the collaboration process. This is described as the evaluation apprehension effect in group diversity by Gallupe et al. (1992) as cited in (Knoll & Lukosch, 2014). It has been argued by Milliken et al. (2003) as cited in (Knoll & Lukosch, 2014) that strong identification of group members with their group increases the likelihood of active group participation compared to groups with lower group identification. This connects to the social identity theory of Tajfel (1974) as cited in (Knoll & Lukosch, 2014) which proposes the tendency of group members to classify themselves and others in social categories. Categories representing behavioural, attitudinal, or emotional similarities between themselves and other group members.

Team Relationship

Although teams might look tidy and organised on paper, they may have undocumented characteristics in reality which include personalities, feelings, motives and agendas (LaFasto & Larson, 2001). Under these conditions, the development of trusting relationships with upper management is a key motivator. Healthy relationships have been identified as a characteristic of unusually successful teams, with bad relationships being a source of destruction to well-intentioned team effort. Four characteristics have been found to relate to relationships (LaFasto & Larson, 2001):

1) Mutual understanding
2) Constructive
3) Productive
4) Self-corrective

Good relationships have been found to hold the characteristics of trusting, caring, helpful, open, honest, and respectful. On the other hand, bad relationships have been found to hold elements that are unreasonable, unfair, selfish, threatening, and inflexible (LaFasto & Larson, 2001).

On a team relationship level, LaFasto & Larson (2001) argue that most people think of their relationship skills to be better than they actually are. Continuing, they view the ability of a relationship to be constructively self-correcting as its vital variable. Two consistent problematic behaviours of team relationship are giving feedback, and receiving feedback. Good feedback has been associated with a heightened sense of personal accountability, a wide range of worker satisfaction factors, and enhanced performance, mainly in groups with extensive interpersonal relationships demanding goals (LaFasto & Larson, 2001).

Collaborative teamwork is essentially the ability to identify, raise, and resolve issues in ways which integrate different perspectives (LaFasto & Larson, 2001). The most important behaviours in a team relationship are openness and supportiveness, with its main challenges being dealing with contention (LaFasto & Larson, 2001). For example, openness can be painful, time-consuming, and consuming emotional energy. These conditions make it difficult to manage contention without defensive behaviour. Reactions are likely to be extreme behaviours of counter attack or withdrawal. Poorly managed contention is likely to result in dysfunctional behaviour. Knoll and Lukosch (2014) argue that a group of participants moves through a sequence of activities. This workflow often relates to problem solving concerning predefined process phases like ‘problem definition’, ‘solution search’, ‘solution generation’, ‘solution evaluation’ and ‘solution implementation’ (Knoll et al. 2013) as cited in (Knoll & Lukosch, 2014). It is possible that a different group composition is requires at each phase, which is then connected to a group entity of individuals with specific roles. And each phase could concern a sequence of redefined activities that are related to predefined components (Knoll & Lukosch, 2014).

Team Leadership

In face-to-face team collaboration, it is not unusual to have a team leader. This individual supports the process by monitoring and redefining team goals and objectives, and outlining activities, tasks and procedures that lead to the accomplishment of goals (Sarin and McDermott 2003) as cited in (Knoll & Lukosch, 2014).

Leadership can be either a process or a set of functions that is performed by one or more team members (Day, Gronn, & Salas, 2004) as cited in (Levi, 2007). The type of leadership may differ in roles and power, but in most cases one person is assigned to the role of leader. Leaders can be assigned, selected, elected, in an increasing level of influence from others on the choice. A more flexible form is that of rotating leadership among team members.

Leadership concerns the act of ensuring the team to take responsibility over its tasks. This differentiates a leader from a manager. A manager is given power and authority over subordinates by the organisation, holds decision-power, and is responsible for the team's tasks (Levi, 2007). A leader lacks such power and holds a facilitating role instead. Criticism on leadership concerns the belief of people in the importance of leadership, but that that fact does not make it true (Meindl & Ehrlich, 1987) as cited in (Levi, 2007).

Such concerns could be addressed by the different approaches to leadership that have been defined in leadership literature, including situational leadership, self-managing teams, and functional approaches to leading teams (Levi, 2007; Parker, 2002). The essence of these approaches is defined in the three focus areas of direction, structure, and external relationships. These areas include situation monitoring, problem diagnosis, solution implementation, providing clarity, supportiveness and motivation to the team.

Suggested interventions for team leaders are suggested to be situational. Leadership roles include coaching interventions for team motivation at the beginning of the collaboration process, strategy-oriented coaching interventions during the collaboration to improve operations, and educational coaching after task completion for learning purposes. Performance improvement suggestions for team leaders are included in Appendix 4.

2.2.4 Collaboration in New Product Development

When more than two or more people are involved in an activity, especially in a complex work related setting of NPD, the thought can come to mind that they are collaborating. This raises the question of what activities fall under the concept of collaboration. Thomas (1992) as cited in (Jassawalla & Sashittal, 1998) argues that a process is collaborative when the concerns of all the participants are equally important, multiple experiences and perspective incorporated equally in decision making, and every participant's commitment and involvement is viewed as essential for effective implementation.

In comparison to integration, collaboration has been described as a higher intensity cross-functional linkage of greater complexity. It includes the sense of an equal stake in the outcomes of NPD, the absence of hidden agendas, and a willingness of participants to understand and accept differences while remaining focussed on the common organisational objectives. It also involves synergy; which is defined as the outcomes exceeding the sum of the capabilities of an individual participant in the NPD process.

Jassawalla & Sashittal (1998) suggest that cross-functional teams increase NPD-related inter-functional integration significantly when they are applied as structural mechanisms. Furthermore, they found that high levels of collaboration depend on openness to change, willingness to cooperate, high level of trust. The priority given to NPD by senior management and the level of autonomy afforded to NPD project members were found to be the main organisational factors that influence the level of collaboration.

In their research on collaboration as cross-functional linkages for integration in NPD, Jassawalla & Sashittal (1998) found five main collaboration elements that increase with high levels of collaboration: at-stakeness, transparency, mindfulness, synergy, and understanding. The definition of these elements is elaborated below.

- **At-stakeness**: an equitable interest in implementation with an equal stake.
- **Transparency**: a condition of high awareness as a result of intense communication and exchange of hard data that makes the agendas, motivations and constraints of all participants explicit.

- **Mindfulness**: condition where new product decisions and actions of participants reflect an integrated understanding of the motivations.
- **Synergy**: the accomplishment of cross-functional linkages of NPD outcomes reflecting capabilities significantly beyond individual input.
- **Understanding**: the acceptance, internalisation of differences that exist, and agreement on the focus on common objectives

2.3 Problem Solving

2.3.1 Behaviour and Problem Solving Approaches

Pokras (1995) as cited in (Levi, 2007) defines a problem as: "a dilemma with no apparent way out, an undesirable situation without a solution, a question that cannot currently be answered, the difference between the current situation and a desired state, or a situation group members must manage effectively".

Problems can arise from the group or come from the environment. Often surfacing as symptoms causing undesirable effects. Uncertain and complex processes influence the effectiveness of teams. The diversity of viewpoints that makes teams worthwhile also lead to teams experiencing collisions of people, motivation, and ideas during collaboration. Effectiveness in this sense is defined as having a clear goal and a positive attitude (LaFasto & Larson, 2001). LaFasto & Larson (2001) state that it does not matter how much team members are developing strategies and solving problems, as long as they follow a strategic strategy. They argue that a disciplined and structured approach contributes most to problem solving. A common approach is to identify an issue, analyse the issue, resolve it, and move on. Such an approach promotes sharp focus, analysis prior to a solution, and promotes good decision-making (LaFasto & Larson, 2001). Continuing, they have found three activities to be crucial for effective problem-solving:

1) The formulation of questions addressing the what and why of the problem at hand
2) The creation of a collaborative climate for discussion
3) Clarification of assumptions, biases, and underlying motivations

LaFasto & Larson (2001) argue that three factors differentiate effective from ineffective teams:

1) Degree of focus by team members in their efforts
2) Quality of climates in which team members operate
3) Extent to which team member communication is open or closed

Often occurring issues that hinder effective team problem solving concern communication, supportiveness, activeness or passiveness, positivity or negativity, control, coordination, understanding, feedback and connectedness among team members and management (LaFasto & Larson, 2001).

Pokras (1995) as cited in (Levi, 2007) argues that the first step in problem solving is the discussion and documentation of individual views until an agreement on the nature of the problem is reached by all participants. Teams are often provided with ill-defined problems and undeveloped evaluation criteria. Therefore, the definition of the problems needs to be challenged by the teams in search of the problems' root causes (Pokras, 1995) as cited in (Levi, 2007). In addition, the teams need to define the state of successful resolution when evaluating alternative solutions. It is therefore key to search for root causes of problems at hand at the beginning of the process in order to minimise time-consuming inconsistent problem solving. Another cause of problems is the final stage of solution evaluation being ignored. This stage concerns the evaluation or implementation, which tends to fall outside a team's responsibility or is ignored to prevent negative reporting to superiors (Levi, 2007).

Three categories of approaches to problem solving have been defined (Beebe & Masterson, 1994) as cited in (Levi, 2007):

- **Descriptive:**
  The descriptive approach is about examining how groups solve problems, separated in the four stages of forming, storming, norming, and performing. During forming the group examines the problem and discusses preliminary solutions. The storming stage is defined as a time of conflict in discussion of definitions. By norming, the group develops analysis methods for the problem, alternatives are generated and a solution selected. The development of solution implementation plans defines the performing stage.
  A very important statement is made by Laughlin & Hollingshead (1995) as cited in (Levi, 2007). They argue that many groups generate solutions at the start of the problem-solving process, select a solution out of the generated alternatives, and try to demonstrate that a solution is correct. Groups may invent new or novel solutions as well, or analyse the correctness of a solution, and accept a solution that is believed to be better than the proposed alternatives. This approach might hold a risk of addressing the wrong problem, as it does not address the problem's root cause.

- **Functional:**
  The functional approach concerns the act of identifying the behaviours of effective problem solving. This is applied by analysing the problem, developing alternatives, and selecting the best solution, without disruption of rational problem solving by social, emotional or political factors. Beebe & Masterson (1994); Janis & Mann (1977) as cited in (Levi, 2007) have defined the following characteristics to effective group problem solving: viewing the problem from multiple viewpoints, data gathering and problem research before decision-making, consideration of a variety of options in the selection solution process, management of both task and relational aspects of problem solving, problem focussed discussions, acknowledgement of minority opinions, established criteria based testing of alternative solutions. Here too groups have been found to go to the solution stage before performing a proper problem definition (Hackman & Morris, 1975) as cited in (Levi, 2007). A structured approach to problem solving has been found to improve decisions and problem-solving process satisfaction among group members. However, such an approach is not applied due to previous approaches being applied or due to process constraints in time, money and information. Therefore, so-called 'satisficing' rather than optimal solutions are sought by groups, as perfection is expensive and time-consuming (Simon, 1969). Trade-offs in costs versus effectiveness of a solution, probabilities of success, resource availability and implementation politics are among the factors that influence the choice for a problem solving approach.

  Groups would improve their problem solving abilities if they would spend more time on information sharing, planning and critical idea evaluation instead of discussing non-task related issues. However, often groups fail to ignore non-task related issues like politically driven support, desires to reduce uncertainty, or to avoid conflict (Jehn, 1997). In-group power differences and competition have been found to disrupt group problem solving abilities (Johnson & Johnson, 1997) as cited in (Levi, 2007). Political advocacy rather than selecting the best solution is caused by competition. While open communication and critical evaluation have been found to be encouraged by relative power equality among group members, or when power is based on knowledge or competence rather than on formal authority.

- **Prescriptive:**
  The prescriptive approach is about recommending techniques and approaches to improve group problem solving. This approach is based on the assumptions that rational problem-solving strategies should be used by people, and that better solutions result from using a structured approach. The structured prescriptive approach is most helpful with complex and unstructured problems (Van Gundy, 1981) as cited in (Levi, 2007).

The suggested approaches to problem-solving follow the essence that is illustrated by Dewey's rational problem-solving approach, illustrated in *Figure 3*.

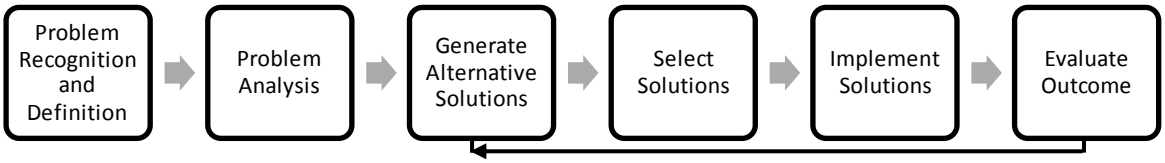

Figure 3: Rational Problem-Solving Approach by Dewey (1910) as cited in (Levi, 2007)

The desire of teams to develop solutions quickly often results in a focus on the symptoms rather than gaining an understanding of the real causes of the problem (Pakras, 1995) as cited in (Levi, 2007). But even if an understanding is gained of the real causes, their misinterpretation during problem analysis can cause trouble in solving the problem. Moreland & Levine (1992) as cited in (Levi, 2007) argue that the ability of successful problem identification and analysis depends on characteristics of the problem, the group, and the environment.

When it comes to handling conflict, there is a semantic difference between conflict resolution and conflict management (Robbins, 1978) as cited in (Rahim, 2002). The resolution of conflict implies its reduction, elimination, or termination. Research suggests that conflict is inevitable in top management and usually valuable and essential for strategic choice at senior levels (Eisenhardt, Kahwajy, and Bourgeois, 1998) as cited in (Rahim, 2002).

Rather than reduction or elimination, contemporary organisations can benefit from conflict through effective conflict management. Conflict management involves the design of effective strategies at macro-level to minimise conflict related dysfunctions and enhance the constructive functions of conflict to enhance an organisation's learning and effectiveness. Tension and conflict have been found to be essential characteristics of learning organisations due to the occurrence of activities that may lead to disequilibrium, including questioning, inquiry, and challenging the status quo (Luthans, Rubach, and Marsnik, 1995) as cited in (Rahim, 2002).

The yet unidentified relationship between conflict management strategies and organisational effectiveness suggests that encouragement of learning and effectiveness requires constructive conflict management (Pascale, 1990) as cited in (Rahim, 2002). A further exploration in the domain of conflict management approaches would provide insights that build towards identifying the relationship between conflict management strategies and organisational effectiveness. In order to work towards understanding the implications of conflict management, we need to expand our understanding of the concept itself. The following sections address two approaches to problem-solving: rational problem-solving and organisational learning, followed by a number of conflict management tactics which have been described in conflict management literature.

2.3.2 Rational Problem-Solving

In addressing problems, organisations whom understand conflict occurrence at the different levels within the organisation tend to follow the problem-solving process defined in the rational problem-solving process cycle intervention approach, illustrated in *Figure 4* below.

Problem solving has been defined as a behavioural process which makes a variety of response alternatives for dealing with a problematic situation available, and it increases the probability of selecting the most effective response from the response alternatives (D'Zurilla & Goldfried, 1971). Three stages to problem solving have been defined: Problem Recognition, Planning for Change, and Implementation (Rahim, 2002).

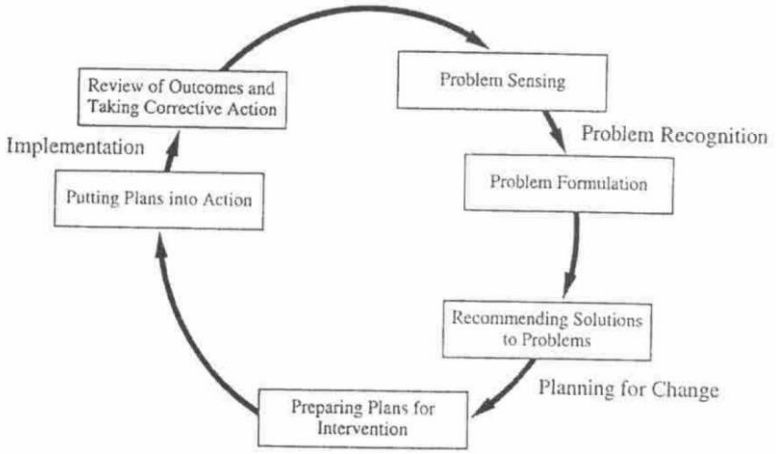

Figure 4: Rational Problem-Solving Process - derived from (Rahim, 2002)

Problem Recognition defines the problem and consists of problem sensing and problem formulation. This stage is followed by the preparation stage: Planning for change, which consists of recommending solutions to problems and preparing plans for invention. The third and final Implementation phase consists of putting plans into action, and the review of outcomes and taking corrective action. Often, organisational culture and institutional structures within organisations distort proper problem formulation due to sensitivity of the formulation of certain problems within the organisation related to organisational politics. Research by (Mitroff & Featheringham, 1974) as cited in (Rahim, 2002) has defined a Type III error to result from situations of improper problem formulation. A Type III error has been defined "as the probability of having solved the wrong problem when one should have solved the right problem" (Mitroff & Featheringham, 1974) as cited in (Rahim, 2002). Another potential error that could occur is the Type IV error. This error type implies that intervention plans have been put into action partly or not at all, resulting in a not properly implemented solution (Kilmann & Mitroff, 1979) as cited in (Rahim, 2002). Both error types can be minimised through effective conflict management, including the following five guidelines provided by (Mitroff, 1998) as cited in (Rahim, 2002); 1) Select the right stakeholders, including people who challenge your views; 2) Expand your options, by taking a multiple perspectives and problem formulations into account; 3) Phrase problems correctly, through language; 4) Extend the boundaries of problems, by enlarging the problem scope; and 5) Think systemically, including connections between parts.

In addition, literature suggests a common core of information to be provided across departments to reduce diversity in departmental perspectives, in order to understand the source of conflict, and manage the conflict-resolution process (Barclay, 1991). Problem-solving approaches tend to be problem type specific. Structured problem-solving approaches such as the rational problem-solving approach is more helpful with unstructured and complex problems (Levi, 2007). Although this systematic approach seems proper for identifying and resolving problems, it stays at the surface of the problem by identifying it while neglecting the underlying fundamental conflicts during the problem solving process steps. An approach which addresses the fundamentals is the organisational learning intervention approach.

2.3.3 Organisational Learning

Conflict management can address conflict situations at hand like with the rational problem-solving approach, but is also able to address issues for structurally. Rahim (2002) argues that one of the main objectives of conflict management within organisations is aimed at enhancing organisational learning; knowledge acquisition, knowledge distribution, information interpretation, and preserving information for future access and use through organisational memorisation.

Learning has been defined by Argyris and Schön (1996) as cited by (Rahim, 2002) as "detection and correction of error". Within organisations, they have identified two types of learning have been: single-loop learning and double-loop learning.

Single-loop learning involves cognitive and behavioural changes in the existing paradigm by covering the diagnosis of and intervention in problems with underlying goals, policies, and assumptions are left unchanged. Single-loop learnings tend to result from conflict resolution through approaches like negotiation, mediation, and bargaining. When changes in these underlying elements are required, double-loop learning occurs.

Double-loop learning involves cognitive and behavioural changes outside the existing paradigm. Effective conflict management interventions addressing double-loop learning are likely to be more effective.

The next section introduces and elaborated on the concept of conflict, its nature and occurrence with special focus on the NPD process within technology firms.

2.4 Conflict, its Nature and Occurrence

2.4.1 Conflict within High Technology firms

This study focusses on collaboration and conflict in new product in New Product Development (NPD) within a high technology environment. High Technology firms have been found to be a unique segment of organisations due to 1) their high levels of engineers, scientists, and technically qualified people; 2) higher rates of product obsolescence because of rapid advances in new technology coupled with intense competitive pressures; 3) their proportionately larger investments in Research and Development, with great focus on developing new product based on new technology, and 4) their reliance on rapid, efficient new product introductions to meet revenue and profit objectives, and to remain competitive (Von Glinow & Mohrman, 1990) as cited in (Jassawalla & Sashittal, 1998). These characteristics describe pressures on time, money, and the creation of 'innovative' novel products through a combination of technical knowledge, skills and ideas.

2.4.2 Conflict Definition and Conflict Types

The potential for conflict is present when two or more organisational departments strive for mutually acceptable choices or agreements on issues including product specifications and vendor capabilities (Sheth, 1973) as cited in (Barclay, 1991). Conflict is likely to occur in settings of collaboration, with collaboration being defined as "The action of working with someone to produce something" (Oxford Dictionary, 2015). And as "a process that occurs when a group of autonomous stakeholders of a problem domain engage in an interactive process, using shared rules, norms, and structures, to act or decide on issues related to that domain" (Gray & Wood, 1991). The challenge of design as defined by Kolfschoten & Vreede (2007), with design as an issue that can be addressed through collaboration, is illustrated in Appendix 5: Design Challenge Model.

Conflict has been defined by (Katz and Kahn, 1978, p. 613) as cited in (Barclay, 1991) as "the collision of actors". Conflict, seen as task conflict, is defined as non-personal disagreements over work goals, objectives, and methods (Dyer & Song, 1998). The outcomes of conflict can be constructive or destructive, depending on the management of conflict and the required emphasis on the discriminating understanding of its causes (Barclay, 1991). Some existing research in organisational behaviour has suggested that interdepartmental conflict is a consequence of the organisational context; its functioning as a social system, its structure, and the interrelations between its organisational subsystems (Barclay, 1991). Conflict may include the interference with other departments, exaggeration of a department's need to influence another department or the distortion of information (Walton, Dutton, and Cafferty, 1969) as cited in (Barclay, 1991).

Conflict within organisations occurs in multiple types. Dyadic or interpersonal conflict is characterised by the incompatibility or disagreement of between two or more members of the organisation on the same or different hierarchical levels (Rahim, 2002). Such conflict can occur between members of the same group – defined as intragroup conflict – or between members of different groups or units within the organisation – defined as intergroup or interdepartmental conflict. Roloff (1987) as cited in (Rahim, 2002) argues that; "Organisational conflict occurs when members engage in activities that are incompatible with those of colleagues within their network, members of other collectivities, or unaffiliated individuals who utilise the services or products of the organisation".

A study by (Zaltman, Duncan and Holbek, 1973, p. 149) as cited in (Barclay, 1991) concluded that "the structural characteristics of innovative organisations have a high potential for intra-organisational conflict." (Barclay, 1991). Prevention of missing out on trends and their impact on an organisation's business requires an organisation to take a critical position towards its own choices and activities. Although critical views are often expressed through constructive argumentation and discussion, addressing topics which are sensitive to organisational politics might be perceived as threat to an individual, group or organisation and therefore may result in conflict. In order to cope with such

situations between different units or groups, organisations may stimulate and facilitate mutual adjustment between parties (Mintzberg, 1989). The definition of conflict is broadened further by Rahim (2002) through its conceptualisation as an interactive process that is manifested in incompatibility, disagreement, or dissonance within or between social entities like individuals, groups, or organisations. This study follows this definition of conflict due to its relative neutral and simplistic definition and its articulated relation with interactions.

After definition clarification, it is important to identify the potential types of conflict that could arise in the context of NPD. Barclay (1991) argues that three types of conflict can be identified: 1) imagined or perceived conflict; 2) latent or substantive conflict, as in differences of interest or opinion, and 3) affective conflict, characterised by great anger or the lack of it(Barclay, 1991). These conflict types are accompanied by process related conflict; conflict caused by ambiguity in roles and responsibilities. Barclay's (1991) typology of conflict is chosen as a foundation for the typology of conflicts in this study of collaboration and conflict management in the context of NPD. Due to the scope of collaboration and conflict management, the imagined and affective conflict types relating only to a personal level are not taken into account in this research. The two conflict types taken into account in this research are therefore: substantive conflict, and process conflict.

2.4.3 Conflict on an Individual level

Conflict on an individual level is characterised by organisational members failing to take responsibility for their decisions. Such situations are usually followed by defensive routines like attempts to protect themselves against error complaints related to judgment, incompetence, and procrastination by blaming others in order to avoid embarrassment of and threat to oneself. Such behavioural patterns by organisational members have been found to be obsolete and destructive to the well-being of the organisation (Beer & Spector, 1993 as cited in (Rahim, 2002). Behavioural patterns leading to conflict include: "engagement in activities which are incongruent with needs or interests of the action taker, holding of behavioural preferences of which the satisfaction is incompatible with the implementation of another's preferences, the desire for mutually desirable resources in short supply, which cannot lead to the full satisfaction of everyone, the possession of salient attitudes, values, skills, and goals by parties that are perceived to be exclusive to a certain party, partially exclusive behavioural preferences by two parties regarding their joint actions, and the interdependence in performance of functions or activities of two parties" (Beer & Spector, 1993 as cited in (Rahim, 2002).

2.4.4 Conflict Misconceptions

The neutrality of the definition of conflict is important due to the common misconception about conflict that it is bad. This misconception should be avoided as conflict can also be resolved to the satisfaction of all related to it. Moreover, most organisations tend not to utilise the known functional effects of organisational conflict. A majority of recommendations of regarding conflict is still aimed at the reduction, resolution, or minimisation of conflict on a dyadic or group level (Rahim, 2002). Levi (2007) argues that conflict is a natural part of a team process with either healthy or unhealthy conflict, and that conflict can be beneficial if managed appropriately. This leads us to the paradox of conflict.

2.5 Paradox of Conflict

Research suggests that conflict management can be encouraged by two dimensions of conflict: task related disagreements – substantive, cognitive, or task conflicts –, and the occurrence of emotional or interpersonal issues leading to conflict – emotional or affective conflicts – (Guetzkow and Gyr, 1954) as cited in (Rahim, 2002). These two dimensions are positively related, as studies revealed that an increasing substantive conflict levels lead to increasing affective conflict levels. The danger of substantive conflict encouragement is the risk of generating affective conflict, resulting in worse situations than conflict avoidance (Amason and Schweiger, 1997) as cited in (Rahim, 2002).

The paradox of conflict covers two extreme effects identified by several studies; studies have shown that little or no conflict may lead to stagnating organisations, while dysfunctional effects may arise from leaving organisational conflict uncontrolled. A shared thought among organisation theorists is the essence of a moderate amount of conflict for attaining optimal organisational effectiveness. The relationship between conflict and organisational effectiveness can be visualised in an inverted-U function as illustrated in *Figure 5* (Rahim & Bonoma, 1979 as cited in (Rahim, 2002). This shape suggests conflict management interventions for substantive conflict may require the promotion of conflict when the level of conflict is limited, while interventions may require conflict reduction at high levels of conflict (Brown, 1983 as cited in (Rahim, 2002). This relation does not apply to affective conflict (Jehn, 1997);(Amason, 1996 as cited in (Rahim, 2002).

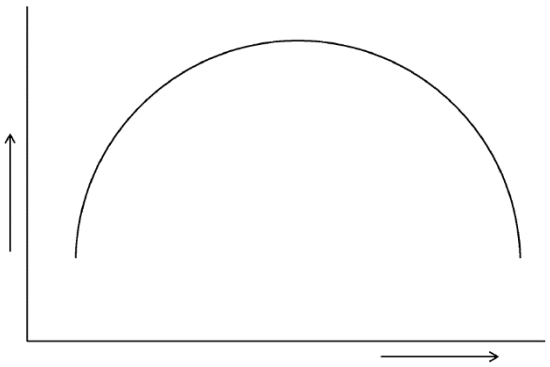

Figure 5: Inverted-U function of conflict and organisational effectiveness (Rahim & Bonoma, 1979 as cited in (Rahim, 2002)

2.6 Risks of Conflict

The previous sections have clarified conflict types and the NPD process in which they occur. This section discusses the risks of conflict which have been defined by Souder (1988). Although Souder did not present them similarly, the risks can be categorised to either being positive or negative. The risks have been subjectively ranking from most 'positive' to most 'negative' in *Figure 6* below.

← Positive Negative →

Too-Good Friends	Equal Partners	Dominant Partner	Lack of Appreciation	Lack of Communication	Lack of Interaction	Distrust

Figure 6: Risks of Conflict

Each of the identified risks may result from different conflict types and different conflict management approaches. These risks will be incorporated in the theoretical model that is presented in the next section to connect them to the earlier identified collaboration and conflict management elements from literature.

2.7 Addressing Conflict Sensitive Uncertainties of New Product Development

2.7.1 DfX: a holistic approach to New Product Development

The Design for eXcellence (DfX) methodology is a methodology that is applicable throughout the new product development process. The methodology takes a holistic approach to combining several aspects of new product development across functions, objectives, and product lifecycle stages (Dombrowski et al., 2014; Gatenby & Foo, 1990; Eric H. Kessler & Chakrabarti, 1999). All the aspects of the DfX methodology are illustrated in the *Figure 7*.

The core of the methodology has been divided into four main elements; 1) the technical core; 2) education and training; 3) managerial considerations, and 4) communication and teamwork (Dombrowski et al., 2014; Gatenby & Foo, 1990; Eric H. Kessler & Chakrabarti, 1999). These elements are present without exclusivity to a certain design category, these design categories, or X's of the methodology cover a variety of topics, including simplicity, testability, service, disassembly, recycling, logistics, environment, reliability and maintainability, manufacturing and assembly and materials logistics. This methodology has been found to address elements of friction between functions through its holistic approach of involving multiple functions and perspectives in NPD collaboration and decision-making.

The DfX methodology grew out of the combination of multiple methods for NPD, among which the value methodology Value Analysis (VA). VA, also known as Value Engineering (VE) or Value Methodology (VM), is one of the methods to reaching an optimal point in function, value and costs (Leber et al., 2014). VA addresses non-value adding characteristics in both internal issues arising from insufficient information in NPD decision-making and external issues regarding market changes in pricing, environment, technology and materials (Leber et al., 2014). The difference between VA and DfX lies in VA's limited scope on concept development and prototyping, whereas the DfX methodology covers the entire product development and maintenance spectrum.

Organisational learning aspects are addressed systematically by the methodology through the suggestions for knowledge systems and knowledge capturing procedures. The role of the management is emphasised by the methodology due to its impact on NPD process performance, its outcomes, and the behaviour of actors and their working relations in their NPD projects. The latter element of behaviour is addressed by emphasising the essence of teamwork and elaborating the communication means and methods to stimulate teamwork.

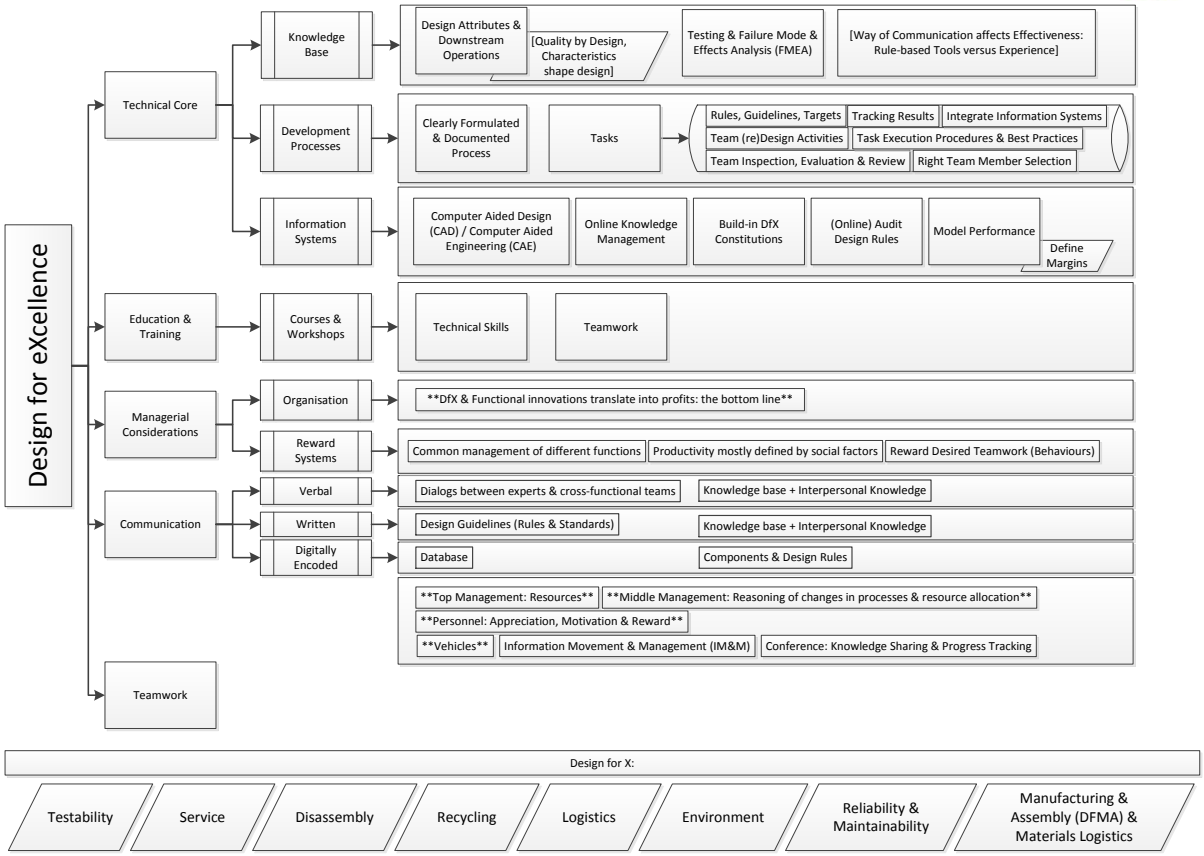

Figure 7: DfX Methodology Overview

The following section elaborates on the initial phase of the NPD process, the so-called Fuzzy Front End.

2.7.2 The Fuzzy Front End: Uncertainties in the New Product Development process

The Fuzzy front-end (FFE) is the phase during which a product concept is formulated and its investment potential is determined within an organisation (Moenart et al., 1995 as cited in (Kim & Wilemon, 2002). The three predevelopment stages idea generation, product definition, and project evaluation are defined based on Cooper's (1990) Stage-Gate System for NPD (Appendix 8**)**. The FFE is the phase during which an opportunity is evaluated for further ideation, exploration and assessment to decide upon its worthiness for investment, commitment of resources and launch (Cooper, 1993; Khurana and Rosenthal, 1998) as cited in (Kim & Wilemon, 2002)**.**

The end of the FFE phase is marked by the first formal go/no-go decision, which is critical for its further development into a committed and resource investment-worthy project. This decision moment is marked by Gate 3: 'Decision on Business Case' in Appendix 8. Kim & Wilemon (2002) argue that managing the FFE is based on three major elements: 1) Project Selection and Definition; 2) the Time Dimension; and 3) the People Dimension. Information about the NPD process and the Cooper's (1990) StageGate System can be found in **Appendix 8.**

Project Selection and Definition

The project selection and definition element includes decisions on the size of the market opportunity, the target customer, the alignment with the corporate strategy, and the availability of key technologies and resources (Smith and Reinertsen, 1992). Its important objective it to create an understanding of the project's requirements and executing predevelopment activities in order to select the right market opportunity. This process prepares for the development of a well-defined product concept to guide further product development requirements. The main risks in this phase originate from mistakes that relate to ill-informed and costly decisions (Murphy and Kumar, 1997 as cited by (Kim & Wilemon, 2002) and mistakes in the earlier phases can be disastrous for projects (Cooper, 1990). Therefore, critical problems should be addressed directly to avoid or minimise resistance and barriers in the development phase. It is important to achieve an initial well-defined product concept with clear requirements, and address issues at the FFE stage due to the costliness of killing an idea after it enters the development phase.

Time Dimension

The time dimension relates to the crucial element in NPD: project timing. Delays during the FFE phase and inefficient FFE processes are likely to result in lost opportunities or failures in development and commercialisation (Kim & Wilemon, 2002). Key performance measures on profitability are important to take into account due to the cost and time impact of market opportunity related screening activities, and the effectiveness of the screening process (Reinertsen, 1999) as cited in (Kim & Wilemon, 2002).

Conflict alike, time has a paradox to it. Although delays are often costly and raise the development costs more than expected by management, some cases have shown that delay might have a positive influence on the outcome of the NPD project. In some cases, delays are positive due to the tendency of information to improve as times goes by, which in its turn tends to affect decision-making positively as it reduces the level of uncertainty. However, the importance of speed depends on the market conditions. It can be very important when cost of delay is high and markets are moving fast, while opportunity choice can be more important when cost of delay is low with a high ability to forecast markets (Kim & Wilemon, 2002).

In their research, Kim & Wilemon (2002) have summed up the six most important barriers to effective and rapid FFE performance. They include a lack of vision (Murmann, 1994) a lack of perceived urgency (Kessler and Chakrabarti, 1999), a lack of formalisation (Choperena, 1996), a lack of effective project leadership (McDonough and Barczak, 1991), ineffective communication processes (Mabert et al, 1992) and ineffective people (McDonough and Spital, 1984).

People Dimension

The third dimension of FFE management is the people dimension, an often overlooked dimension in NPD. In this dimension, actions and attitudes of management can influence the morale and behaviour of project members (Ruekert and Walker, 1987) as cited in (Kim & Wilemon, 2002). Their actions and attitudes influence the effectiveness of transferring FFE learnings to the development team, and have an impact on the sustainability of the relationship between senior management, the project leader, and the project members during the FFE and development phase. Furthermore, conflict among functions can arise during the development phase when problems are not solved in the FFE (Kim & Wilemon, 2002).

Cooper and Kleinschmidt (1988) argue that limited amounts of time and money are devoted to the FFE, being the critical early steps of NPD. For new product development and commercialisation to be successful, it is important to adjust the project planning to the time required for FFE activities and address crucial problems that arise during this phase. This approach ensures a successful handover from the FFE team to the development team, clarifies the chosen trade-offs in speed and quality, and relates to the attitudes and commitment of the development team. The next section discusses the interests of the different actors in NPD.

2.7.3 Differing Interests of Actors in New Product Development

This section provides insights in the objectives and functional interests of the different functions involved in NPD. The NPD process requires the input of a number of organisational functions in order to bring ideas to actual products. Although a large number of actors are involved, four functions can be defined as most dominance and impactful; Marketing, (Research &) Development, Procurement, and Operations. Together, these functions are responsible for the definition, development and deployment process of new offerings; being products, services, or solutions, within development and manufacturing organisations. The main challenges regarding these functions will be elaborated below.

The marketing function is a function with a commercial perspective. It has a far larger impact on improving business performance, beyond its contribution to providing an organisation a market orientation (Auh & Merlo, 2012). Although the marketing function operates in the market and customer-oriented sphere of an organisation, earlier research shows contradicting findings regarding its contributions. Verhoef and Leeflang (2009) as cited in (Auh & Merlo, 2012) suggest that the function does not deliver significant variance in performance as many marketing responsibilities have been diffused into other functions, while Moorman and Rust (1999) as cited in (Auh & Merlo, 2012) suggest that the function contributes to the performance of business, customer relationships, and that of new products. However, some research questions its contribution to business performance (Auh & Merlo, 2012), while others suggest that the Marketing function should merge with the Procurement function. A merge between the two functions is argued to result in better alignment. Alignment which is required for meeting the sourcing requirements to deliver solutions rather than products to the customer, and to cater for the emerging customer-centric build-to-order business models (Sheth et al., 2009).

Research & Development (R&D), referred to as Development in this work, is a function that revolves around the precise work of definition, design, and development of technological solutions, defined as materials, components, or products (Shaw & Shaw, 1998; Souder, 1988). The Marketing / Development interface has been addressed extensively in research (Crittenden et al., 1993; Jacobsen et al., 2014; Shaw et al., 2003; Souder, 1988; Swink & Song, 2007; Tsai & Tiaojung, 2014; Weinrauch & Anderson, 1982), mainly addressing the differences in the mental models between marketers and engineers, and the symptoms of the conflicts and problems between them.

The Procurement function, also known as purchasing, is a function which orchestrates the match between requirements from the own organisation for materials, components, products, services, or solutions, and suppliers that are able to answer the request (Atuahene-Gima, 1995; Ragatz, Handfield, & Petersen, 2002; Sheth et al., 2009). The functional activities include having insights in the available

solutions offered on the market by other organisations, conducting cost price negotiations, and the development and maintenance of relationships with suppliers (Atuahene-Gima, 1995; Sheth et al., 2009). Trends regarding the Procurement function reveal a development towards a more technically knowledgeable function as a business partner to Marketing, Development, Manufacturing, and Operations and more involvement of Procurement in NPD is argued to have its benefits in business performance (Atuahene-Gima, 1995; Barclay, 1991; Mocker, Ross, & van Heck, 2014). Similarly, suggestions are made for improving business performance through tighter involvement of the Operations function (Oliva & Watson, 2011). However, integration of Operations with Marketing, the so-called Marketing-Manufacturing Integration (MMI) has been found to impact NPD performance negatively as a MMI lengthens the NPD process despite its higher project return on investment (ROI), and significantly longer product commercialisation (PC) period (Swink & Song, 2007).

Hayes and Wheelwright (1984) as cited in (Crittenden et al., 1993) argue that the Marketing / Manufacturing interface is the focal point of substantial more frequent and heated disagreement than between other pairs of functions. This is hardly surprising given the often conflicting goals of the two functions; demand simulation for the company's product versus supply regulation, which satisfies market demand. Marketing aims at reaching customer satisfaction, often through a diversity of variants, while Manufacturing puts efforts into making its production more efficient and effective. The main finding on resolving issues at this interface is that Marketing should promise what manufacturing can produce and manufacturing should deliver what marketing promised. An overview of the main conflict areas between Marketing and Manufacturing can be found in Appendix 6: Major Marketing / Manufacturing Interface Conflict Areas.

2.8 Conflict Management Tactics

Following the elaboration of problem-solving approaches, this section addresses conflict management. The tactics of managing conflict may depend on the type of conflict. Furthermore, conflict interventions should be undertaken by the right person, which might depend on the specific occurrence of conflict. In this section, a number of strategies identified in literature are discussed.

Under the conceptualised definition of conflict by Rahim (2002) as 'an interactive process that is manifested in incompatibility, disagreement, or dissonance within or between social entities like individuals, groups, or organisations', conflict management tactics are meant to address this incompatibility between social entities. Pinto & Pinto (1990), as cited in (Rese & Baier, 2005) argue that intensive inter and intra-team communications have positive effects on the NPD process. But they could be a source of conflict when they relate to divergent points of views, interests, goal orientations, and socio-emotional tensions (Lawrence & Losch, 1967 as cited in (Rese & Baier, 2005).

Five organisational conflict handling methods have been classified in literature; Domination, compromise, integration, avoidance, and suppression (Follet, 1926/1940) as cited in (Rahim, 2002). On an interpersonal conflict level, five conflict handling styles have been described; forcing, withdrawing, smoothing, compromising, and problem solving (Blake and Mouton, 1964) as cited in (Rahim, 2002). When both own concerns and those of other parties are taken into consideration, four conflict handling styles become relevant; yielding, problem solving, inaction, and contending (Pruitt, 1983). The dual concern model of styles of handing interpersonal conflict by (Rahim & Bonoma, 1979) as cited in (Rahim, 2002) puts these two dimensions against each other, resulting in five handling styles: integrating, obliging, compromising, dominating, and avoiding. These styles have been found to be similar to the five conflict resolution approaches defined by Thomas & Kilmann (1974), and derived from (Levi, 2007); 1) Collaboration; 2) Compromise; 3) Accommodation; 4) Confrontation; and 5) Avoidance, illustrated in *Figure 8*. The styles and approaches are matched in *Table 4*.

Table 4: Conflict Handling Styles (Rahim, 2002) and Conflict Resolution Approaches by (Thomas & Kilmann, 1974)

Rahim's (2002) Styles	Integrating	Compromising	Obliging	Dominating	Avoiding
Thomas & Kilmann's (1974) **Approaches**	Collaboration	Compromise	Accommodation	Confrontation	Avoidance

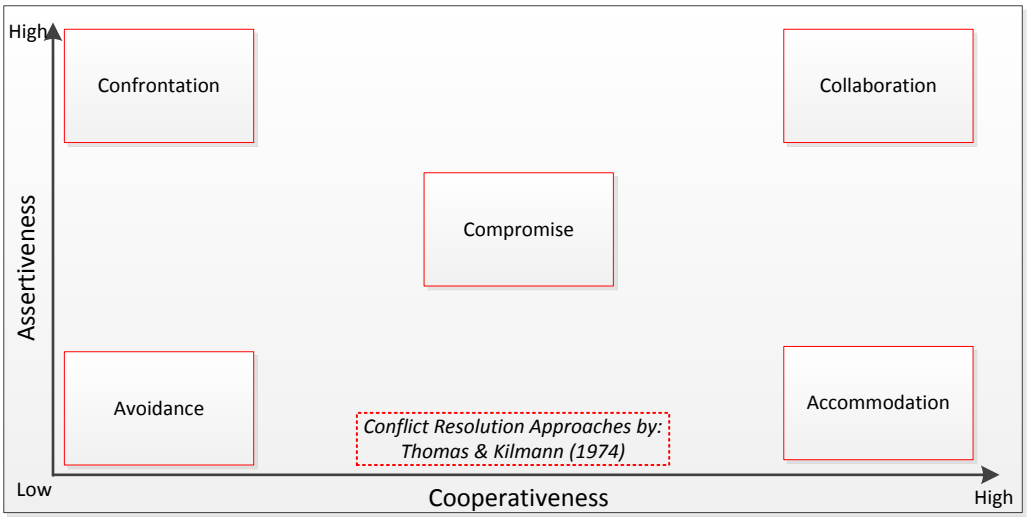

Figure 8: Thomas-Kilmann's Five Conflict Resolution Approaches, derived from (Levi, 2007)

Thomas & Kilmann's (1974) conflict resolution approaches are modelled to two dimensions of behaviour: on the vertical axis: Assertiveness, defined as the extent to which the person attempts to satisfy his own concerns, and on the horizontal axis: Cooperativeness, which is defined as the extent to which the person attempts to satisfy the other person's concerns. Thomas & Kilmann (1974) have given the following definition to each of the five conflict resolution approaches they have defined.

- **Confrontation** – *assertive / uncooperative* – A "win-lose" approach of an individual pursuing own concerns at the expense of those of others. It is a power-oriented mode in which whatever power seems appropriate to win an own position is used. Powers include the ability to argue, personal rank, or economic sanctions. Confrontation, sometimes referred to as competition, is understood as the defence of a position which one believes is correct, or simply trying to win. This approach may be appropriate in case of time essential moments like emergencies, when quick, decisive action is required, and people are aware of and support the approach.
- **Accommodation** – *unassertive / cooperative* – At the other extreme of competing, this approach lets an individual neglect own concerns to satisfy the concerns of the other person. The approach holds an element of self-sacrifice, and can be seen as a form of selfless generosity or charity, obeying another person's order when one prefers not to, or yielding to another's point of view. At own expenses, it can work against one's own goals, objectives, and desired outcomes. This approach is deemed effective when the other party is the expert or has a better solution, or when future relations with the other party need to be preserved.
- **Avoidance** – *unassertive / uncooperative* – Avoidance is characterised by a person neither pursuing one's own concerns nor those of the other individual. Thus, not dealing with the conflict. Avoidance can take the form of diplomatically sidestepping an issue, issue postponement until better times, or

withdrawal from a threatening situation. It can be applied at trivial issues, in situations of no chance of winning, or when an issue is very costly. It can also be effective with an emotionally charged atmosphere and a need for some space. Although some issues will resolve themselves, in general avoidance is not perceived as a good long term strategy.

- **Collaboration** – *assertive / cooperative* – At the other extreme of avoiding, the collaboration involves an attempt to work with others with the common goal of finding solutions that fully satisfy all concerns. It requires in-depth study of an issue in order to pinpoint underlying needs and wants of the involved individuals. Collaboration can take the form of exploring a disagreement for mutual learning from each other's insights. It can also be used as an approach to try to find a creative solution to an interpersonal problem. The approach is effective when both parties aim to achieve both their goals in a win-win situation. It can also be effective in complex scenarios that require a novel solution, or the creation of a bigger space and room for everybody's ideas by re-framing the challenge. Its downside is the required high-degree of trust, and the time and effort consuming act of involving all stakeholders, synthesising all ideas and reaching consensus.
- **Compromise** – *moderate assertive / moderate cooperative* – With the objective of finding mutually acceptable solutions that partially satisfy both parties, the approach falls intermediately between confrontation and accommodation. The sacrifice lays between confrontation and accommodation and it addresses an issue more directly than avoiding it. However, it does not explore the issue in as much depth as collaboration. In some situations, compromise can be splitting the difference between two positions, exchanging concessions, or looking for a quick middle-ground solution. It can be perceived as a 'lose-lose' scenario where neither party achieves their objective. The approach can be appropriate for scenarios with the need for temporary solutions, or where both sides have equally important goals. Its weakness it the trap of it being an easy way out while collaboration would produce better solutions.

The approaches have been used in conflict management for over 40 years and have been named the Thomas-Kilmann Conflict Mode Instrument (TKI). The instrument enables quick administration and interpretation of conflict through its simplicity. The weakness of this characteristic is that the approach does not provide support for extensive conflict analysis.

Rahim (2002) suggests after consolidation of a range of conflict management studies that conflict management can be categorised in three main tactics; 1) Minimising affective conflicts at various levels; 2) Attaining and maintaining a moderate amount of substantive conflict; and 3) Selecting and using appropriate conflict management tactics. Due to the defined scope boundary to substantive and process conflict in this research, the latter two tactics are looked into with Thomas & Kilmann's (1974) five conflict resolution approaches. These approaches have been chosen due to their unambiguous definition and their clear classification on the dimensions of assertiveness and cooperativeness, as illustrated in *Figure 8*. The studies that elaborated the definitions of conflict and conflict management approaches did go into details with regard to the outcome of conflict and conflict management. The following section elaborated seven risks of conflict which have been defined in prior research.

2.9 A Theoretical Model of Collaboration Elements and Conflict Management

The concepts of collaboration and conflict management have been studied and modelled in studies within their research domains. After analysis, two approaches have been selected out of these studies. The conflict resolution approaches of Thomas & Kilmann (1974) and the collaboration elements that apply in NPD projects as argued by Jassawalla & Sashittal (1998).

Thomas & Kilmann's (1974) conflict resolution approaches are modelled to two dimensions of behaviour: on the vertical axis: *Assertiveness*, defined as the extent to which the person attempts to satisfy his own concerns. And on the horizontal axis: *Cooperativeness*, defined as the extent to which the person attempts to satisfy the other person's concerns.

The theoretical model relates the collaboration elements and conflict resolution approaches to each other. These elements and approaches are not linked. Instead, they are underlying elements of collaboration in NPD. The NPD collaboration elements stand for collaborative behaviours that occur in NPD. These so-called collaboration elements define the behaviours that can lead to one or more conflict resolution approaches when collaboration encounters conflict. Both the approaches and elements are used in this study to determine the collaboration elements and approaches to conflict resolution within the NPD context of the studied organisation. These concepts will be applied to the empirical data to form an understanding about and conclude on conflict management within NPD.

The level of information transparency can determine stakeholder behaviour. Behaviour is impacted through the raise of awareness and explicit agendas, motivations and constraints through intense communication and exchange of hard data. Information can accommodate behaviour of stakeholders with strategic intent towards their own goals, independent of the possible common goal.

A stakeholder's level of stake in collaboration can influence the choices made when conflict occurs in NPD. The choice of a conflict resolution approach depends on one's stake and the synergy of stakes between stakeholders. Synergy in the goals or directions of stakeholders can promote cooperativeness through its cross-functional linkages among stakeholders.

Understanding as an element of collaboration can influence the choice of conflict resolution approaches. Higher levels of understanding could stimulate higher levels of cooperativeness in conflict resolution through its nature of acceptance and agreement on the focus on common objectives. The element of mindfulness in collaboration can influence conflict resolution choices through its nature of integrated understanding of motivations of another. Future research on the relation between the collaborative elements and conflict resolution approaches is required to determine the relation between them.

The approaches and elements have been modelled into the theoretical model illustrated in *Figure 9*.

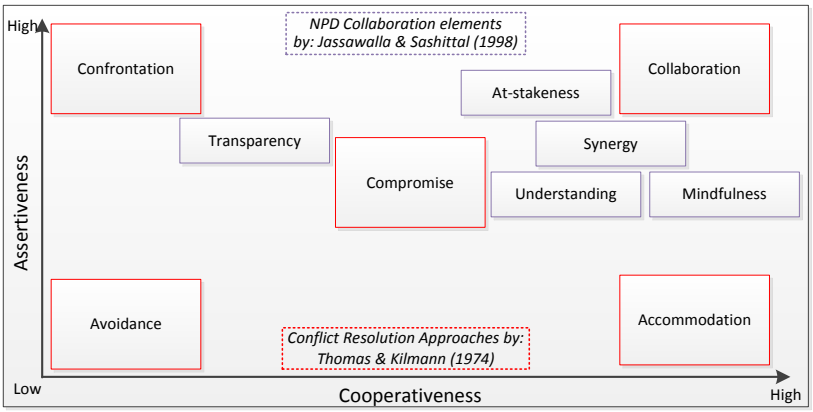

Figure 9: Theoretical Model of the relations between collaboration elements and conflict resolution approaches.

2.10 Theoretical Conclusion

"Conflicts imply that choices must be made." *(Allen, 2005)*

The literature analysis on collaboration, conflict, and conflict management in the domain of New Product Development (NPD) has examined a range of topics which support the message of the quote above. Choices must be made in every aspect of an organisation and at every stage of NPD. These are the main conclusions:

- Cross-Functional Teams (CFTs) are commonly applied to complex situations such as NPD as they increase awareness, improve skills, and improve organisational issues with multidisciplinary insights.
- The desire of teams to develop solutions quickly result in problems and conflict despite guidelines for high performance in collaboration.
- Substantive conflict and process conflict are likely to arise in the complex context of uncertainties and multidisciplinary involvement in collaboration of NPD projects.
- Conflict is perceived as a natural part of the team process which can be either healthy or unhealthy, but either way beneficial if managed in a structured and consistent way.
- The Inverted-U function of the conflict – organisational effectiveness relationship suggests that a moderate amount of substantive conflict early in the NPD process correlates with the highest organisational effectiveness.
- The combination of NPD collaboration elements and conflict resolution approaches increases the understanding of the conflict sensitive and performance impacting collaboration behaviours and phenomena in NPD.

In order to stay relevant to clients and consumers, organisations experience a constant pressure in enforcing organisational learning and development gradually, or in quantum leaps of integrated configurations.

Cross-Functional Teams (CFTs) are a common approach within fast-changing market organisations for dealing with external changes and competitive pressures. CFTs increase awareness, improve skills, and improve organisational issues. With multidisciplinary insights, they deal with complex situations requiring adaptability, speed and customer need focus such as NPD. However, their diversity in functions and organisation creates both benefits and problems. Six factors determine their success: Management support, a clear overarching goal, team awards, organisational training, the right team composition, and team authority.

In collaboration, problems tend to surface as symptoms causing undesirable effects. They affect teams' effectiveness in having a clear goal and a positive attitude. Three factors differentiate effective from ineffective teams: degree of focus by team members in their efforts, quality of climates in which teams operate, and the extent of openness in team member communication. When looking to performance, high performance team are characterised by 8 elements: goal, result structure, competent team members, unified commitment, collaborative climate, standards of excellence, external support and recognition, and principled leadership.

The desire of teams to develop solutions quickly often results in a focus on the symptoms rather than gaining an understanding of the real causes of the problem. This is one of the causes of conflict. Common clarification of the nature and definition of the problem is essential for teams. Late time-consuming inconsistent problem solving is minimised by teams through early substantive conflict, or challenging, in the search for root causes of problems in the NPD process. Teams must define and agree upon evaluation criteria and execute the final stage evaluation. This contributes to minimising problems and their effects on project time, cost, or quality, and on behavioural mind-set and relations.

Conflict is defined as an interactive process that is manifested in incompatibility, disagreement, or dissonance within or between social entities like individuals, groups, or organisations (Rahim, 2002). Collaboration is a likely context for conflict to arise. In the context of NPD, substantive conflict and process conflict are the two main relevant types of conflict.

The misconception about conflict is that it is bad. However, conflict is perceived as a natural part of the team process which can be either healthy or unhealthy, but either way beneficial if managed appropriately. The paradox of conflict relates to the inverted U function in the relation between conflict and organisational effectiveness. Both high and low levels of substantive conflict have been found to result in low organisational effectiveness compared to moderate levels of conflict. This finding emphasises the need for effective conflict management to balance the level of conflict in order to maximise organisational effectiveness.

Conflict often occurs as task conflict; non-personal disagreements over work goals, objectives, and methods. Depending on its management, conflict outcomes can be constructive or destructive. A paradox of conflict is uncovered as tension and conflict are found to be essential characteristics of learning organisations. These are organisations which stimulate or encounter disequilibrium, questioning, inquiry, and challenging of the status quo.

The paradox of conflict covers two extreme effects. Little or no conflict may lead to stagnating organisations, while dysfunctional effects may arise from leaving organisational conflict uncontrolled. A moderate amount of conflict attains optimal organisational effectiveness. The conflict and organisational effectiveness relationship is an Inverted-U function which suggests that substantive conflict may require its promotion when limited, while interventions may require conflict reduction at high levels of conflict.

By taking the main collaboration elements into account in the NPD process, functional experts collaborate to address NPD uncertainties the Fuzzy Front-End (FFE) phase through for example Cooper's (1990) structured Stage-Gate System of evaluation milestones. Design for eXcellence (DfX) addresses NPD process and output performance by combining a variety of topics and disciplines.

The five key collaboration elements in NPD are: at-stakeness, transparency, mindfulness, synergy, and understanding. NPD behaviours and phenomena can be studies by combining these elements with conflict management; the design of effective strategies to minimise dysfunctions and enhance its constructive functions of conflict. Five main approaches to conflict resolution are: 1) Collaboration; 2) Compromise; 3) Accommodation; 4) Confrontation; and 5) Avoidance (Thomas & Kilmann, 1974).

The conflict sensitive collaboration behaviours and phenomena impacting NPD performance are not yet understood in the context of cross-functional collaboration and DfX. A better understanding of collaboration and conflict management within NPD would allow NPD team members, team leaders and their management to increase NPD performance. In this study, the combination of five NPD collaboration elements and five conflict resolutions approaches form the foundation for increasing this understanding.

3. Research Methods: A Multi-Method Approach

This chapter elaborates the research methods and discusses the empirical research context. Section 3.1 discusses the research methods.

3.1 Qualitative research case study

A multi-method approach of literature review, interviews, and workshop observations was chosen for this research. The business context of this research led to the management research approach by Easterby-Smith, Thorpe, & Lowe (2001). The insights gained from Easterby-Smith, Thorpe, & Lowe clarified a suitable approach to address this research topic within its context. It led to the choice of the qualitative research approach for the conduct of this research. The empirical case study approach has been chosen due to the recommendation for in-depth examination of a complex case through literature review, interview techniques and data analysis (Verschuren & Doorewaard, 2010) and for its application when little is known about the phenomena and when the research is exploratory (Yin, 1989). Qualitative research was specifically chosen as a method due to its ability to allow for a research to evolve throughout the process as empirical research provides more insights, and it allows for an in-depth study and understanding of complex phenomena. The author chose this method to gain an understanding of how actors in the new product development process deal or collaborate with one another. The second purpose is: understanding how these actors from differing functions management conflict in new product development within the context of a large engineering firm. The subject and context of this research carry a high level of complexity that is related to the independent nature of conflict and conflict management and the high number of stakeholders within the research context in the organisation where the research has been conducted. The research process proofed to be similar to Yin's (1989) iterative process of qualitative research, illustrated in *Figure 10*.

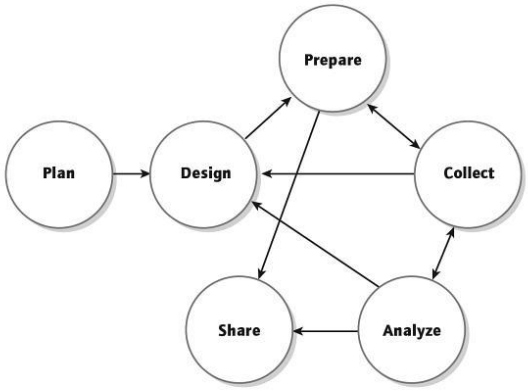

Figure 10: Iterative process of qualitative research, derived from (Yin, 1989)

3.2 Preliminary research phase

This research follows an eight-month period of preliminary research within the organisation where this research has been conducted. During this period, the author was involved in several operational tasks in the scope of a newly introduced new product development oriented improvement initiative: Design for eXcellence (DfX). Although the DfX methodology already existed to a limited extent in the world of business and has been described in academic literature, its set-up was new to the organisation. The author gained a thorough understanding of the methodology and gave trainings in the methodology to members of the organisation from differing functions and disciplines. Moreover, the author coached and supported organisational members that led DfX-based improvement initiatives within their business unit. This experience resulted in frequent contact with organisational members of all functions, an increasing understanding of the processes, challenges and different perspectives throughout the new product development process within the organisation. One of the new product development projects in which the

author was involved has laid the foundation for this research and has been used as a case study in this research.

During the involvement in this project, the author started a preliminary literature review within the domain of new product development and cross-functional collaboration within the new product development domain. This review provided the author with insights and improved understanding of the complexity of the domains and their challenges.

3.3 Exploratory interviews

Following this preliminary phase, the involvement of the author with tasks and activities within the organisation came to an end and marked the beginning of this research project. The initial scope of cross-functional collaboration in new product development proofed to be a too broad domain for the time constraints of this research. Therefore, after the operational involvement with the organisation was terminated, the author reached out to fifteen individuals within the organisation known to the author for preliminary interviews to further narrow down the research scope. These individuals were either involved in new product development projects, one of which the author was involved in prior to the research phase, or were in the supportive systems and processes or change management functions. Exploratory interviews were conducted with ten out of the fifteen individuals that proofed to be relevant for this research. The others proofed to be not relevant to or not interested in providing input for this research. This interview phase was the first of three conducted interview stages: beginning with exploratory interviews, followed by in-depth interviews after the research scope was defined, and reflective interviews after the empirical data was gathered.

3.4 Literature review

During the preliminary research phase, the author intensified the literature review. Literature was searched for on the academic literature portals Science Direct and Google Scholar. Used key words included "new product development", "NPD", "cross-functional collaboration", "cross-functional collaboration in NPD", "conflict", "conflict management", and "conflict in NPD". Additionally, several books addressing the topic of new product development (Trott, 2008), trends in new product development processes (Ries, 2011), (cross-functional) collaboration (LaFasto & Larson, 2001; Levi, 2007; Parker, 2002), and decision-making in multi-actor networks (Bruijn & Heuvelhof, 2008; de Bruijn, ten Heuvelhof, & in 't Veld, 2010) were used. NPD related collaboration aspects, conflict management approaches, and conflict resolution risks identified in literature were operationalised as a construct in a consolidated theoretical framework which provides a generalised view of what emerged from consolidating the findings from literature. Finally, the creation of the framework was followed by a conclusion on the theoretical findings.

3.5 Research Framework

A high level overview of the relevant constructs in this research is provided in the methodological research framework illustrated in Figure 11. This framework clarifies the relations between the variables within the scope of this research. The model focuses on conflict management approaches that allow for sustainable project outcomes and stakeholder behaviour in NPD, while dealing with the tendency of conflict occurrence.

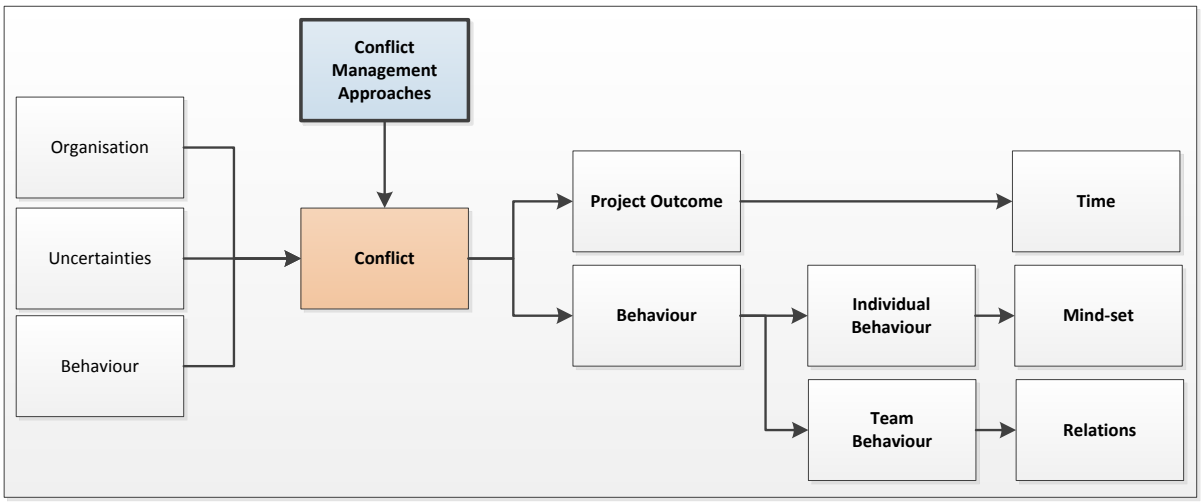

Figure 11: Conceptual Model

The independent variables are related to three constructs; organisation, uncertainties, and behaviour. The organisational variable includes the organisational configuration and the types of teams. The uncertainties variable is mainly defined by technological, market, and process uncertainties. Behaviour, the third independent variable relates to the behavioural aspects and collaboration of organisational stakeholders.

Conflict is the mediating variable, influencing project outcome and behaviour. Project outcome is measured in time, although the project management variables of quality and cost apply as well. Due to the complexity in measuring these variables within the time and scope limitation of this research. Behaviour is divided into an individual and a team level. On an individual level, the mind-set of the NPD stakeholder towards conflict and conflict management is captured. While on a team level, behavioural relations are captured between NPD stakeholders in NPD teams. Time, and behaviour related mind-set and relations are taken into account as dependent variables. Conflict management approaches form the moderating variable that affects the relationship between the independent and dependent variables.

The key concepts and the theoretical framework of this research, illustrated in Figure 12, cover the two key concepts of effective collaboration and conflict management. The concept of effective collaboration relates to theories on effective collaboration and decision-making, while the concept of conflict management relates to theories on conflict management and conflict resolution.

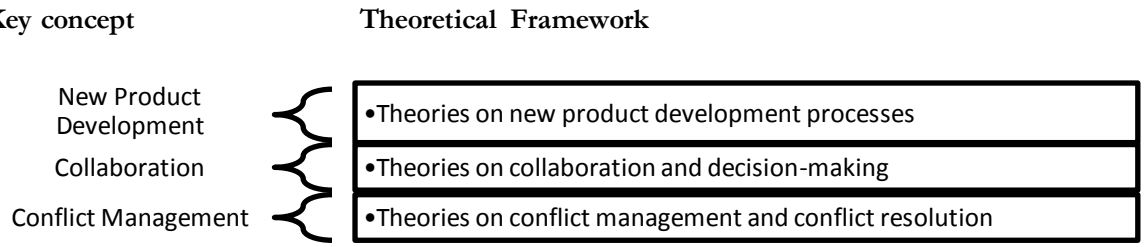

Figure 12: Key Concepts and Theoretical Framework

3.6 Sample and data collection

The literature analysis improved the author's knowledge and understanding of the new product development process, cross-functional collaboration, and conflict management. Through iterative cycles during the research process, the research gradually developed towards a combination of deductive and inductive research.

The Lighting and Consumer Lifestyle divisions of the organisation were chosen as the research context due to the high intensity of new product development projects, while each focusses on a different customer segment. In both sectors, a widespread use of project management was identified as a decision-making and operating method. The sample of functional experts covered project teams of four different business units.

Research data was collected from previous research through literature analysis, project documentation analysis, project learning documentation, five workshop observations, and semi-structured empirical interviews at multiple levels within the organisation. The collection of data was conducted between January and May 2015 among functional stakeholders involved in the NPD process, based on the high relevance of their knowledge and experience in the collaboration and decision-making process with other functions in NPD projects to the research topic. The commonality of the sample of interviewees within Philips is the employment within the same organisation, and the partial compliance to systems, processes, and procedures for new product development. Differences in these elements may depend on the business, department, project team, and the individual's personality.

3.7 Interviewee sample selection

The chosen approach to sample selection was based on gaining insights from a multi-actor perspective across functions and organisational levels. Therefore, an initial sample of at least three interviewees per function was planned for. The defined functions included: Integral Project Leads (IPL), Product/Consumer Marketing Managers (CMM), Architecture and Industrial Cost Engineers, Procurement Engineers, Business Process Experts (BPEs), and finally the functional managers of the Marketing, Engineering, and Procurement functions.

As planned, the actual interview sample consisted of the intended mixture of functional experts within the organisation. Interviewees were selected based on their function and their role within the organisation. The sample consists of functional experts referred to by other functional experts within the organisation and people which the researcher has met prior to the research. A snowball effect occurred by the request of the author after each interview to name colleagues within the project team or business and other experts within the organisation that dealt with new product development projects and could provide a valuable contribution to this study.

This snow-balling effect approach was chosen to expand the reach within the organisation, to reach the counterparts from other functions who are involved in the same NPD process, and to minimise the number of less relevant or irrelevant interviewees. Furthermore, it provided the ability to address the topic from a multi-actor perspective by gathering insights from several interdependent functional experts.

The diversity of initial interviewees led to recommendations to functional experts from different functions, and gradually enlarged the sample to a total of forty. Eventually, 35 out of the 40 individuals were willing to share their knowledge and experience in semi-structured interviews which lasted approximately 45 minutes. 6 of the interviews were reflective of nature and conducted with experts from supportive corporate functions and senior management from marketing, development, and procurement related to interviewed NPD project members. These interviews provided valuable outside-in insights, root causes analyses of observed behaviour and research findings within the organisation.

The empirical data collection process was completed after these interviews due to time constraints, and indications of data saturation noticed from the increasingly repetitive content from interviewees and clarity in the overall research findings. In total, 25 of the interviews were conducted face-to-face, with the author taking extensively detailed notes, while 10 out of the interviews were conducted digitally through teleconferencing software Microsoft Lync. An overview of the interviewed functions is presented in Appendix 1: Interview Overview.

3.8 Interview questions

The development of the research questions for the interviews began after conducting the 10 preliminary interviews and after conducting an extensive part of the literature review in the domain. Gradually the interview questions evolved from cross-functional collaboration and decision making towards a more specific focus on conflict and conflict management that are applied within the organisation's NPD process. This evolvement in the qualitative research led the research to a narrower and more specific research scope and findings. The interviews included 16 open-ended questions, all which were checked on relevancy with a functional stakeholder and an experienced researcher. The questions of the preliminary interview and the data collection interviews are presented in Appendix 2: Interview Questions.

The interview questions were largely derived from the broadly scoped questions of the preliminary interviews. The questions were concerning; the functional objective of the interviewee, the characteristics and challenges of the collaboration and decision-making process in NPD, the influence of the DfX methodology on the NPD process, the type of conflict during the process, their location during the process, the functions involved in them, and their impact on the NPD process. Furthermore, interviewees were asked about which types of conflict usually are escalated, to which project milestone or deliverable they relate to, to whom they are escalated, the influence and involvement of management throughout the NPD process, the views of the interviewee on the perception and challenges of their counterparts from other functions, and finally potential improvement suggestions.

The interviewees gave detailed information about their position, views and experiences regarding collaboration, decision-making, conflict occurrence, conflict management, and the implication of the application of the Design for eXcellence (DfX) methodology within the firm. To a large extent, the interviewees were familiar with the DfX methodology or even involved in its application within their project or business unit.

All conducted interviews have been anonymised. This method was chosen due to the sensitive nature of the research topic and the shyness of participants for recording, possibly due to a fear of traceability of statements. For the same reason, the author has chosen to not record and transcribe the interviews. Instead, extensive notes were taken by the interviewer during the interviews. These notes have not been included to this report due to their length. Instead, the notes are available on request.

3.9 Workshop observations

The empirical research was conducted through interviews, and through participative and non-participative observations of cross-functional DfX and Value Engineering workshops within the organisation. The workshop observations were related to three different projects, two within the Personal Care business unit and one within the Lighting business. All projects were related to more than one individual from the interview sample. The participative observations took place during four workshops within the Personal Care business, of which one covering a three-day Value Engineering workshop, and each of the other three covering one of the following analysis tools: product teardown, Feature-Value Analysis, and Value Stream Mapping. The non-participative observation took place in the Lighting business (case B) and concerned a two-day Value Engineering workshop. The key findings of the workshop observations of case B and additional observations from the shaving Personal Care business are presented in **Appendix 7: Workshop Observations**.

3.10 Content Analysis

Content analysis was used as a method to identify, code and categorise patterns in the qualitative data in order to make sense of the interview content. It proofed to be an iterative process of looking into the data multiple times to gain new insights in order to come to sufficient evidence to support the chosen themes of NPD collaboration, conflict types and occurrence, and conflict management. The analysis of the interview notes was performed in Microsoft Excel. The interview notes were given a custom label to indicate their origin. The gathered content organised in the order of the interview questions. Content analysis on the interview data was conducted to verify the relevance of the data to certain interview questions, which relate to the defined main and sub research questions.

A simplified description of the conducted content analysis is included below:

First, the interview notes were examined to check their completeness and potential mistakes in documentation. A second data examination round was conducted to identify data consistency between functions across the case studies. Responses were coded based on their origins related to the NPD function and case study. Where applicable, the coding included the types of conflict and conflict management approaches as articulated by the interviewees or interpreted by the author when identified but unarticulated. This categorisation was conducted in preparation for a content analysis across all interviews. Notes about learnings, themes and patterns were taken during the process to provide the data with its context and relations.

Second, a content analysis structure was created following the defined research questions and all the content was moved to the location of most relevance. An examination of the content was conducted to correct the location of misplaced content to the research structure.

Third, an in-depth analysis of the structured content was conducted to summarise, conclude and present the empirical research content. Following the presentation of the research findings, the theoretical model was examined to analyse the empirical research findings and find commonalities and potential model extensions from the empirical findings. Finally, the theoretical and empirical research findings were reflected upon. The following section will elaborate on the research validation.

3.11 Validation

The trustworthiness, or validation, of this research is aimed attained through an iterative multi-method approach. Validation was done through verification of the fit between the theory and the empirical research data through the creation and application of a conceptual methodology model and a theoretical framework of the main constructs of collaboration, conflict resolution approaches, and risks of conflict management and resolution approaches.

The literature review was validated by taking the number of article citations into account, and by reviewing the most recent publications and literature reviews in the research domains to verify the used sources. Fortunately, most of the applied sources were cited by more recent publications. Descriptive validity was performed through accurate representation of factual events throughout the research and during the empirical interviews and observations. During data collection, the accurate interpretation of the meaning of statements made by interviewees was taken into account through reflecting the answers back to the interviewee. In some of the interviews, the interviewees suggested corrections to the interview notes that were presented to them on a screen during the interview session. During the interviews, the author ensured the consistency of questions and responses related to the topic by restating the question when responses went out of scope.

Measure validation of the empirical research findings was performed through workshop observations. The observed workshops were of both a part of the interview sample and two other project teams that were not interviewed. During these validation-oriented observation sessions, the author clarified the

purpose of his attendance to be related to organisational learning purposes related to collaboration, and conflict management in a cross-functional NPD setting. Additional validation was performed through reflective interviews on the empirical research findings with internal corporate staff functions and members of other NPD teams. These interviews provided enrichment to the organisational context and clarified a number of potential root causes to institutionalised organisational aspects and identified behaviours among NPD functional experts. Some were observed during the attended workshops, while others have been articulated during the interviews.

3.12 Reflection

Reflecting on the conducted research methods, the author identified a number of learnings. First, the author beliefs the choice for the multi-method approach was justified regarding the complexity of the topic and the strong interest in taking a multi-actor approach to address the research questions. Despite a few less relevant interviews, the choice for a snow balling research sample approach is perceived as positive due to the content and team relevance of the interviewees that have been reached through this approach. The preliminary interview round was a great approach to narrow down the research scope while asking for phenomena that are not or not fully understood and make an interesting research topic.

Second, the research findings were affected by a strong dependency on the interviewees' descriptions and recollection of events from their memories during the relatively short duration of the conducted interviews. Some interviews might have delivered more insights if more time was planned or all the interview questions were shared and studied before the interview. However, many interviewees indicated not having had the time to prepare for the interview by reading through the document containing the purpose, scope, and the relevance of the research for the interviewee and the organisation, along with the research questions, and the interview questions. Third, the conducted content analysis was very time consuming due to the approach of using Microsoft Excel as coding software. The author expects that a lot of time could have been saved if dedicated coding software was used instead. The raw interview data is available on request.

4. Organisational Configuration and the Characteristics of Collaborative New Product Development

In this chapter, the performed case studies will be introduced. Furthermore, the organisational configuration, and aspects of the new product development process will be addressed and concluded upon from a multi-actor perspective. Through this approach, an answer is formulated for the following research question:

SQ 1: Which characteristics define the collaboration process between marketing, development, procurement and operations in new product development?

4.1 Organisational Configuration and Case Study Characteristics

This research on conflict and conflict management was initiated and conducted within two entities of the technology company Philips as two empirical case studies. The organisational configuration is defined in this research as: all institutionalised organisational aspects related to the conduct of business within the company, including systems and processes. The conducted case studies in this empirical research were characterised by several organisational differences that might have influenced the differences in the research findings. The case studies were conducted within two different entities of an overarching corporation: Consumer Lifestyle and Lighting, both part of Royal Philips. Both entities have been found to follow the same project management approach and process to NPD. A process defined by several key milestone decision moments involving both the cross-functional project team and the business category's management team. The overview in *Table 5* provides insights in the main characteristics and differences between the two case studies.

Table 5: Case Study Characteristics Overview

CONDITION \ CASE	CASE A | CONSUMER LIFESTYLE	CASE B | LIGHTING
NPD APPROACH	Project Management-based New Product Development Process	
NPD KEY FUNCTIONAL ACTORS	Marketing (Product Management in Lighting), Development, Procurement, Operations, (Integral) Project Lead	
BUSINESS	Personal Care Consumer Electronics	Business to Business Lighting Products
PROJECT PERFORMANCE	Relatively Lower in time & relations	Relatively Higher in time & relations
PRODUCT DIVERSITY	Relatively Higher	Relatively Lower
PRODUCT NOVELTY LEVEL	Relatively Higher (Product & Components)	Relatively Lower (Design & Component)
NPD PROCESS MATURITY	Relatively Lower	Relatively Higher
NPD TEAM STABILITY	Relatively Lower	Relatively Higher
BACKGROUNDS OF STAKEHOLDERS	Mixed; Technical & Non-Technical	Generally Technical
LEVEL OF INTEGRATION (NPD FUNCTION & ROLE)	Relatively High within Development	Relatively High within the NPD Team

Similarities in the empirical findings between the two cases can be classified in project management based approach to NPD (*Figure 13*), and the key functional actors involved in the process. Differences between the cases relate to the type of products, type of markets, product diversity, technological product novelty, NPD process maturity, and NPD team stability. Other differences concern the educational background of stakeholders, and the level of integration among NPD functions.

In both cases, the NPD process prescribes the involvement as illustrated in *Figure 13*. However, deviations to this structure have been noticed throughout the studies. The subjects of discussion and the timing of these discussions varied from taking place before or around the Project Start milestone at Lighting, to later in the process up until the Project Plan Commitment milestone at Consumer Lifestyle.

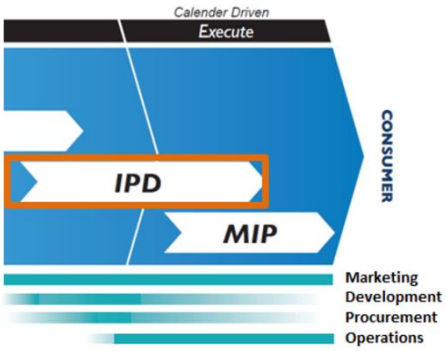

Figure 13: Involvement of Functions during the IPD Process

Case A was conducted within the Consumer Lifestyle entity of the organisation. The Consumer Lifestyle entity is characterised by the research, development and sales of a diversity of consumer-oriented products. The research findings reflect observed and stated differences within the business units and project teams of this entity that relate to the maturity of organisational processes, product category maturity, the level of grated freedom in decision-making to project teams, and the institutionalised interactions with the management team.

The activities of the studied teams are characterised by the development of electronic personal care products for consumers. The diverse business-to-consumer markets of this entity result in a high level of product diversity, mainly through different product models in functionality and appearance for different geographical markets. The studied business category is characterised by a relatively high level of technological product novelty in this product category. Furthermore, the development activities of these products on the studied location have been initiated only half a decade ago. This relatively short time of operation is identifiable in a relatively low NPD process maturity level compared to the other businesses within the whole company. Moreover, the business experiences a relatively high level of changes in personnel. Mainly change in the project team member from the Marketing function. The NPD teams tend to be a mix of individuals with a diversity of educational backgrounds, and integration among NPD functions is only found in the Development related functions, including system architecture, industrial cost engineering, and the product research centre.

Case B was conducted within the Lighting entity of the organising. The Lighting entity is characterised by the research, development and sales of both consumer and professional business-to-business lighting products, services and solutions. The case study within this entity was carried out in a lighting component business category with clearly defined processes, milestones, milestone deliverables, roles and responsibilities, and experienced project team members with a technical educational background. This commonality across the functions in the cross-functional project teams showed lower levels of misunderstandings that are related to differences in mental models. Differences that relate to more precision-driven engineers and more customer experience and emotion-driven marketers, as in case A.

The product diversity of the business is relatively lower, with a lower amount of different versions compared to case A. And although the business innovates in its product development, its products have a relatively lower level of technological novelty compared to case A. Furthermore, the studied business unit in case B has been executing its NPD process for a longer period of time than in case A. It has been able to implement improvements to the process over the past years, among which Value Engineering and DfX workshops. These improvements are possibly allowed by the relative stable nature of the NPD teams within the business. This stability has been expressed by participants throughout the interviews in this this

business. In general, a majority of the functional experts have a technical educational backgrounds and the integration among the functions of a NPD team is relatively high.

The empirical research context follows in the other sections of this chapter. The organisational configuration is discussed in section 4.2., the New Product Development Process within Philips in section 4.3, and the application of the Design for eXcellence (DfX) methodology and programme in section 4.4.

4.2 Organisational Configuration

Royal Philips is a diversified health and well-being company, focused on improving people's lives through meaningful innovation in the areas of Healthcare, Consumer Lifestyle and Lighting. Headquartered in the Netherlands, the company employs over 100,000 people in more than 100 countries. The company holds a leadership position in cardiac care, acute care and home healthcare, new lighting applications and energy efficient lighting solutions, as well as male grooming and shaving and oral healthcare. The company's procurement department has transformed itself to a valuable business partner to the other main functions within the company; marketing, development, and operations. By providing the functions with supplier market insights, it achieved savings throughout the company's portfolio of products and services through the Design for eXcellence (DfX) programme (Philips Procurement Design for eXcellence Strategy & Capability Center, 2015). Details of the DfX programme will be elaborated later in this chapter.

4.2.1 Towards a more Innovative Organisational Configuration

The organisational structure of Philips is characterised by a variety of product lines and business units, operating in several geographical regions and markets, and being supported by a central headquarters. These characteristics relate to the divisional and diversified organisational configurations of Mintzberg (1989). The business units are in charge of day-to-day decision making, while the central headquarters defines, designs and executes strategic plans. The duplication of activities and resources per business unit as the weakness of such configurations leads to conflict sensitive and competitive relationships between business units on high organisational levels. However, the competition for resources that the headquarters has to offer does cascade down into the organisation's layers, affects the new product development process.

The business units of Philips tend to work in formalised ways through routines, procedures and predefined processes, functional departments and centralised decision-making. The business units operate on a formal planning process with a tight vertical structure, including budgets, audits, and procedure analyses. These characteristics relate heavily to Mintzberg's bureaucratic Machine organisation, which can be very efficient when relying on economies of scale. In the case of Philips, the business units have specialised in specific products and markets with internal functional classifications. These configurational characteristics are likely to allow for conflicting goals and inconsistencies between the functions and between the functional and the overall corporate objectives. The inflexible nature of the current organisational configuration does not relate successfully to the unstable and complex industries the firm operates in, and product and market diversification strategies the firm is pursuing.

The constant changing and more dynamic and complex environment that the organisation is facing is urging it to transform to a more organic organisational structure, and adapt a more decentralised structure. In 2012, Philips has adapted a strategy which incorporates a quantum leap in organisational configuration from its Divisional and Machine organisational configuration to a more Innovative organisational configuration. This organisational configuration is more difficult to control due to its ad hoc structure with more decentralised decision-making and the cascading of power delegation into lower organisational layers. The transformation towards the more innovative configuration is accompanied by the influx of experts form a variety of areas to stimulate creative processes that stimulate innovation. Improvement initiatives in the domains of organisational efficiency and effectiveness and customer-driven new product development were introduced and the creation of cross functional new product development teams was stimulated.

(Philips Business Transformation, 2012)

4.2.2 Transforming the business

The organisation has taken measures in order to ensure its adaptability to the constant changing business and market environment in its 'End2End Business Excellence' programme. The measures are combined in an organisation-wide programme aiming at redesigning customer value chains to deliver superior customer value and to enable excellent process execution by increasing their speed, agility and simplicity.

However, achieving higher levels of speed, agility and simplicity in process execution requires the organisation to transform its organisational set-up from a functional to a process-oriented set-up. To reach a more effective and efficient state of delivering value to customers and consumers, such a transformation requires the breakdown of functional silos between functions like marketing, development, procurement, operations, and sales. The focus on the output and processes instead of the functions is deemed to result in a structured customer value-centric way of working that enables the organisation to strengthen its market innovation leadership position. A functional-oriented organisation tends to optimise its activities for a functional department, which carries a high likeliness of negatively impacting other functional departments. A process set-up enables an organisation to be more efficient and more market-oriented in its activities by coordinating its activities across functional departments. Compared to a functional-oriented organisation, a process-oriented organisational setup lowers the risk of sub-optimisations or even the diminishment of efficiency and effectiveness of business processes. Although this orientation does carry the risk of lowering the efficiency of functional departments, the goal is to achieve higher benefits across departments compared to the efficiency decrease on a functional department level (Philips Business Transformation, 2012).

The business transformation programme within Philips is organised in four pillars; 1) Five core Business Excellence competencies, which define the main capabilities which enable an effective process-oriented way of working; 2) an End2End Business Excellence Academy / University, as an internal institute to build and offer the capabilities within the organisation; 3) Business Transformation, focussing on the optimisation of processes across all departments; and 4) IT Transformation, to optimise the facilitation of all information technology systems across all departments. The most relevant elements of the programme to the research context; the core competencies and the Business Transformation will be elaborated to generate a better understanding of the organisational context (Philips Business Transformation, 2012).

The transformation from a functional to a process-oriented organisation is enabled by the following five core competencies: Change Management, Project Management, Performance Management, Continuous Improvement Management in products, services and processes, and Process Management in business processes and IT. These core competencies are combined with an education programme of the Business Excellence University to ensure the presence of the required capabilities for the business transformation. The actual business transformation is organised by the combination of specific business and markets, also known in business as Business Market Combinations (BMCs). To ensure the right value chain for each BMC, the business transformation specified three main process domains in the value chain: 1) Idea to Market; 2) Market to Order; and 3) Order to Cash. These customer-oriented processes ensure a faster time to market process from technology creation to market availability, increasing the reach to and conversion of customers into loyal promotors of the organisation, and offering superior customer and consumer service in efficiency and responsiveness (Philips Business Transformation, 2012).

The product development related content of the DfX methodology and Procurement being the DfX programme's owner within the organisation has been found to be subjected to conflict between different programme managers within the organisation. Discussions between programme owners and managers relate to the nature of the programme and the involvement of the Procurement function is questioned by the Development function. The root cause of these discussions can be traced back to the appraisal of the programme owner for programme results, wherever they may be achieved. The possibility of

Procurement receiving credit for product development related improvement initiatives seems to be a sensitive issue with regard to the Development function.

4.3 New Product Development within Philips

The new product development process is predefined by a structured approach in transforming ideas into products through a number of milestones. The new product development process will be elaborated in this chapter.

4.3.1 From insights to Market Introduction Process

The new product development process within the organisation is shaped in a three-stage process with five main activities as illustrated in Figure 14. The scope of this research is limited to the Integrated Product Development (IPD) activities marked below. During this phase, market insights and created technologies and functions converge towards a final product in a process that is executed by a cross-functional IPD team.

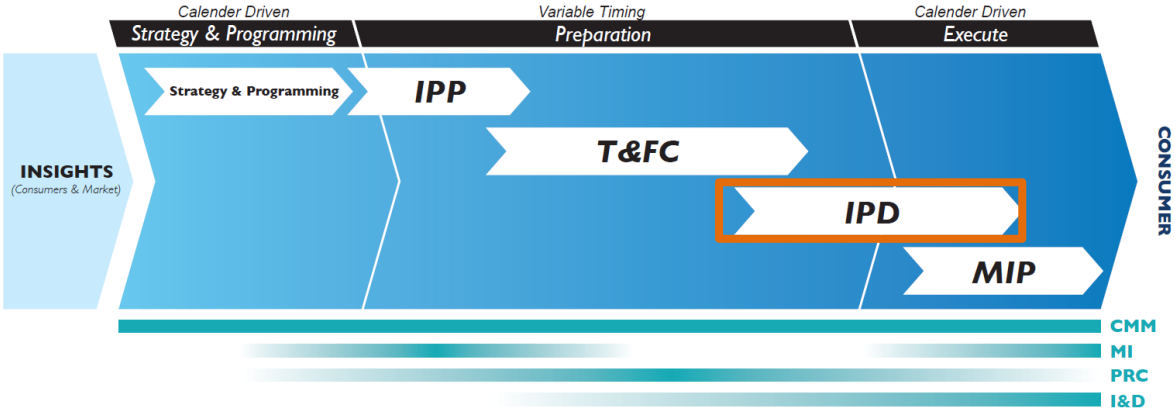

Figure 14: The New Product Development Process (Umaritomo, 2013)

The new product development projects start with market analysis, which is executed by marketers to gather information on the needs and preferences of the customer and the potential for using a product. Through this analysis, and with the support and guidance of other functions, the new product development team is able to increase the chance of the actual development of a successful product. Supported by an engineering design and contributions from development, a design and suitable manufacturing process design can be created based on the gained information on what the customer values in the functions and features of a product (Tsai & Tiaojung, 2014). The scope of this study is defined within the IPD phase of the new product development process.

The IPD process is defined by key decisions within the Integrated Product Development (IPD) project team. During the IPD process, the cross-functional team expands with the emphasis of the (Innovation &) Development (I&D) function. During this process, collaboration and decision-making within cross-functional teams aim to combine market insights with created and validated technological and functional elements into a value proposition that meets the identified demands of the customers. The process includes several milestones that converge the proposition into a final product that is prepared for its market launch during the Market Introduction Process (MIP) (Umaritomo, 2013). These milestones are illustrated in *Figure 15*.

Other steps in the new product development process

After the gathering of consumer and market insights, a calendar driven strategy and programming is followed. This stage is marked by the activity of determining which ideas, initiatives, and directions to pursue for products, services or solutions. This process is led by the project's Commercial Marketing Manager (CMM). Once an initiative is approved to be further investigated, the preparation stage begins and the Innovation Planning Process (IPP) is initiated. During this customer-centric process, initiatives are further developed into concrete and tangible propositions, which may lead to the initiation of several projects to study the technical feasibility and customer value of the propositions. The IPP process mainly involves the marketing and Market Intelligence (MI) functions among a broader cross-functional team, and is defined by the creation of the Value Proposition House (VPH) deliverable. This documented deliverable includes all the key customer needs and preferences of the initiative in several propositions (Umaritomo, 2013).

The IPP process is followed by the Technology and Function Creation (T&FC) process, which focusses on experimenting with the engineering design to verify the technical feasibility and functionality of a proposition. This phase is characterised by its customer centricity and the involvement of both technical and commercial functions, and the specific involvement of the Product Research Centre (PRC) function. The PRC leads the investigation regarding the proposition's technology and features in close cooperation with the marketing and development functions. PRC specifically focusses on the real life interaction between the product and the customer, including the why they interact and how the interact. During this process, MI gathers and provides data from a business perspective, including market size, strategies and customer attraction issues. During this collaborative process driven by MI and PRC, the VPH is complemented by the Ideal Product Model (IPM) deliverable, which provides a structured cross-functional approach to translate customer benefits into actionable product requirements (Umaritomo, 2013).

The following section will provide a better understanding of the main scope of this research: the cross-functional IPD process.

4.3.2 Inside the Integrated Product Development Process

The Integrated Product Development (IPD) Process is characterised by the involvement of several functions and several milestones that converge to the creation of a final product that is commercially made available in the market to address the identified needs and preferences of consumers.

The IPD process involves a cross-functional team, consisting mainly of marketing, development, procurement, and operations, and is led by the Integral Project Leader (IPL). Together, the members of the IPD team are expected to collaborate and decide on key elements of the product and value proposition at certain milestones, illustrated in *Figure 15*. These milestones mark moments during the project during which certain decisions are taken in the scope of commercial and technical requirements, the technical solution, and the business case; including product and labour costs, required investments and the return on investment. The main milestones will be elaborated briefly in the section below.

Figure 15: Integrated Product Development Milestones

VPD: Value Proposition Definition

The Value Proposition Definition (VPD) milestone is the first milestone of a new product development project after the Project Start moment. It is characterised by the convergence of commercial and technical requirements into a value proposition which fits the known market and customer requirements and preferences. During this milestone meeting, the project team updates the management team on the business opportunity, the proposed value proposition based on marketing insights, the points of differentiation from competitors, the latest status of the business plan, ongoing improvement initiatives, the product's design, the proposed markets to address, project planning, product functions, investment and return on investment, proposed suppliers and product quality levels, and a risk assessment overview. The output of the process is the agreement and approval of the proposed value proposition in product functions and features, product variations, and volume and pricing by the management team.

AA: Architecture Agreement

The VPD milestone is followed up by a technical milestone, the Architecture Agreement (AA) milestone. This milestone defines the decision moment on the technical aspects of the product; the product design, product specifications, product differentiation and portfolio build up, a breakdown of the Factory Cost Price (FCP) into the different components it consists of. Additionally, the project team provides the management team with the latest update on the project related elements discussed at the VPD milestone. Passing this milestone marks the approval of the technical elements related to the product by the management team.

PPC: Project Plan Commitment

One of the most important milestones during a new product development project is the Project Plan Commitment (PPC) milestone. This milestone marks the transition moment from development to manufacturing. It is characterised by the commitment to, and agreement on the final commercial price setting and volume estimates, the final technical proposition and the final selection of suppliers, the final required overall investment, and the planning and risks regarding manufacturing and launch execution. The passing of this milestone marks the commitment of all stakeholders, both the project team and management team, to execute all plans to manufacture and launch the product.

RFA & RFD: Release for Acquisition and Release for Delivery

The Release for Acquisition (RFA) milestone follows during the industrialisation phase of the product, which includes manufacturing and testing. The Release for Delivery (RFD) milestone is passed once the quality requirements of the product and its manufacturing process are met, and the planned launch date can be met. After this milestone, the product is launched at the Launch Date (LD) milestone, followed by the Project End (PE) milestone one year later. The product maintenance process and optional Mid-Life Update (MLU) of the product is handled by a lifecycle management team.

4.4 DfX: Cross-Functional Collaborative Decision-Making

4.4.1 Design for eXcellence as an Improvement Programme

The Design for eXcellence (DfX) methodology emphasises decentralisation of power by keeping power and responsibilities locally and within the business team, led by local business members. Local business members are supported through direct and close contact with a global team of DfX specialists which provide hands-on coaching across the company and regularly review training needs, DfX content, implementation approaches and the results. One of the key process characteristics of the DfX team are its vertical and horizontal communication lines through hierarchy levels and across business boundaries which stimulate the creation and maintenance of momentum of DfX initiatives and the drive to stimulate more cost effective value adding improvement initiatives within the organisation (Philips Procurement Design for eXcellence Strategy & Capability Center, 2014, 2015).

The DfX methodology has been introduced into the organisation through a corporate programme that would span the entire organisation. Starting in late 2012, the organisation set an ambitious cost reduction target to ensure its profitability in the short and longer run. Achieving this goal was deemed impossible by working in the organisation's traditional functional pillar way of working. A new approach was required to cater for working towards reaching the target: a cross-functional collaboration methodology. DfX was chosen as that methodology. It complemented the already established Value Engineering methodology. After its first pilots within a few business units within the organisation, the programme's methodology was further customised to the organisation's needs and corporate language. Its relentless implementation across the organisation accelerated performance since its launch in 2012, and the DfX methodology has included all products, services, regions and markets ever since (Philips Procurement Design for eXcellence Strategy & Capability Center, 2014, 2015).

The programme's main driver on content level is leveraging the different functional perspectives, which when integrated through the involvement of different functions in product development activities, are deemed to result in innovation which better fit the market needs and preferences while being cost effective for the own organisation. Moreover, the organisation can increase the overall business efficiency and reach sustainable cost advantages by leveraging these perspectives over the entire supply and value chain from suppliers to customers (Philips Procurement Design for eXcellence Strategy & Capability Center, 2014, 2015).

On a content level, the DfX programme within the organisation takes a holistic End-to-End view from suppliers to customer, while combining a range of perspectives to create a holistic view on currently available products, services, and solutions, and those still in the development pipeline into the DfX process. The programme creates a strong need for involving a range of different functions in a cross-functional team, a team which besides effective collaboration, is required to make cross-functional collaborative decisions. This cross-functional perspective on decisions is orchestrated by combining the perspectives of cost consciousness, customer-value, quality, sustainability, manufacturability and assembly, the value chain, and risk management, among others.

4.4.2 DfX compared to other Improvement Programmes

DfX is not the only improvement programme that is running within the organisation. Within its NPD scope and its programme governance from the Procurement function, four other programmes are taken into account: I2M Excellence, End-to-End Transformation, Negotiation Factory, and Supplier Development. Each programme has an own Project Management Office (PMO) for its programme governance and capability building activities.

DfX differentiates itself from other programmes within the organisation by its time gaged methodology, its fact based information sharing, mutual-challenging idea generation, and collective scenario building. The nearest programme in the NPD scope is the 'Lean in I2M' initiative of the I2M Excellence programme. This initiative focusses on reducing waste in business processes by implementing the lean methodology in business processes. However, this initiative does not take value and costs waste on a product level into account.

Other unarticulated programmes that have run in the past have aimed to reduce organisational complexity in business processes, communication and collaboration. Additionally, the DfX process is supported by senior management commitment for execution and includes several structured tools from the fields of marketing, supply chain management, value engineering, cost engineering, benchmarking, platform creation and management, open innovation, and circular economy. This integration of fields differentiates this approach specifically, as it encourages cross-functional collaboration, cross-functional learning, and cross-functional discussions in a positive and cooperative manner.

Table 6 illustrates a programme comparison overview related to running programmes within global Philips, Procurement and product development. The programme scope is categorised in five elements: 1) internal orientation within the own organisation; 2) external orientation towards partners, suppliers and customers; 3) systems oriented with regard to the design and management of business management and governance systems; 4) processes oriented with regard to the design and management of business execution processes and activities, and 5) content of business activities.

Table 6: Philips Programmes comparison overview

Scope\Programme	DfX	I2M Excellence	End-to-End Transformation	Negotiation Factory	Supplier Development
Internal	✓	✓	✓	✓	
External	✓			✓	✓
Systems		✓	✓		
Processes		✓	✓	✓	✓
Content	✓				

A more elaboration of these programmes is included in Appendix 9.

4.4.3 DfX applied in a Convention Process

The DfX methodology was introduced within the organisation through a convention process setup, led by the Procurement function as a Procurement tool to reduce costs in NPD. Gradually, the programme gained broad acceptance across other functions through its cross-functional process setup that requires all NPD functions to be present in cross-functional workshops. Due to its positive financial impact on the Total Cost of Ownership (TCO) and Bill of Materials (BoM) cost levels, it has gained support among the General Management of the business units it has been applied in. Over time, the governance and ownership of the DfX programme could transform to other functions or structures following the needs of the business units for its application.

In its current setup, DfX is executed within the organisation in an eight-week convention setting. This setup involves key stakeholders from the main functions; Marketing, Development, Procurement, and Operations in a cross-functional team, and fosters collaborative behaviour by actively training, tracking and supporting functions and management in engaging in business performance improving cross-functional collaboration and decision-making. As one of the business partners in new product development, the Procurement organisation within the firm took the initiative and responsibility of piloting and managing the execution of the DfX programme and the tracking process of its total cost of ownership (TCO) financial results within the entire firm.

Figure 16: DfX Convention Process

Preparation Phase

The DfX process, as illustrated in *Figure 16*, consists of four main phases. It starts off with the preparation phase, continues into the idea generation phase, which is followed by a commitment moment, and finally ending with the implementation of committed plans in order to deliver financial measurable results. The preparation phase is characterised by the gathering process of necessary resources of functional experts, decision-makers, management, tools, and support in facilitation and the scoped content. During the preparation, the involved business partner from a particular function and a small core team of other functions define the scope of the DfX convention. Depending on the needs, known and yet unknown improvement opportunities from the business unit and the available resources, the scope of the DfX project might range from a single component till a complete product portfolio. During the preparation phase, the DfX convention leader and the involved key functional stakeholders define a planning with three key milestone moments; a Kick-off Meeting start moment, a Mid-Term Meeting evaluation moment, and a Convention Meeting moment during which all the fact validated cost and value improvement ideas are presented to the management team to receive their commitment and resources for the actual implementation of the improvement plans.

Idea Generation

During the DfX convention phases, several value and cost analysis tools are made available. The power of these tools lays in the designed-in necessity of creating a cross-functional team for the generation of value and cost improvement ideas of product, services, and solutions. After the kick-off meeting, the DfX process continues with the involvement of cross-functional participants in idea generation workshops with the aim to add value to products and services and cut additional costs and waste out. This is done through a process of creating fact-based information from all involved functions, challenging of ideas and current practices through constructive questioning and debating, and improved decision-making through direct management sponsorship, support, and involvement.

During the DfX workshops, one or more value or cost analysis tools are applied in a cross-functional setting. The cross-functional nature of this setup which combines different points of view and interests is likely to lead to conflict. The DfX toolbox included several so-called work streams; Design, Cost/Spend, Marketing, Value Chain, and Quality. By analysing the systems, components, supply chain, and failure rate of products, services and solutions with the guidance of the analysis tools in a cross-functional team, value and cost effectiveness improvement ideas are generated. This idea generation phase is considered to be the divergence phase in which the scope is widened as much as possible to gain insights and ideas that could result in customer value creation or cost reduction of the analysed product(s). Once ideas are generated during workshops, a majority tends to be in an initially premature phase. The most promising generated ideas are selected by the cross-functional team to be further investigated on feasibility, customer value, investment and cost impact. Due to the broad scope of diverging idea generation and the often premature status of suggestions, this phase tends to be less conflict sensitive than the sequential phase of idea investigation and selection. Due to the likelihood of functional interests and personal preferences colliding during idea converging oriented discussions, this phase is expected to more conflict.

Commitment Moment

Following the predefined planning, the most promising, and more mature ideas with their calculated value and cost impact are presented to the management team and other decision-makers for their commitment for and support for actual implementation. The implementation of ideas often requires time, human, and tooling resources, all of which the management team can decide upon approving.

Implementation and result delivery

The implementation of management committed ideas generated throughout the DfX process by participants takes place after the commitment moment and depends on the implementation complexity, potentially taking up to a few months. The progress of the implementation process is tracked per idea, including implementation owner, planning and financial impact.

Throughout these phases, both digital and face-to-face communication and collaboration are leveraged to achieve results following three main pillars. Principles, people, and processes are the three pillars which enable the DfX programme to drive continuous improvement across the organisation, deliver financial results and reinforce transformation. The principles are characterised by multidisciplinary teams, full management support, and a holistic total cost of ownership approach. The people consist of business management, DfX process and tools specialists, and functional area experts. The principles and people are accompanied by the processes of the DfX program, the DfX convention approach, and its idea tracking and implementation process.

The main challenge for the DfX team is the ability to dissolve the programme as soon as possible by integrating the characteristics of the methodology into the company's business system and regular way of working. By integrating the methodology into the regular way of working, the label it now has dissolves and organisational politics towards the initiative are expected to dissolve as well, while maintaining the cross-functional way of working and becoming adapted to the needs and requirements of a business unit.

Change fatigue, a large number of programmes and change initiatives, prioritisation, and lobbying by programme managers within the organisation makes the integration of this way of working challenging. In reality, the combination of organisational strategy with organisational politics raises questions on the ownership and the allocation of financial results of the programme and increases the required lobbying efforts within the organisation to integrate the programme into the organisation's Philips Business System. This challenge requires cross-functional collaboration, commitment from functional experts and management across functional barriers and hierarchical levels. The envisioned end state is a company which is characterised by competitively superior products, services and solutions which are highly valued by the customer, resulting from time efficient and cost effective result driven cross-functional product development teams with decentralised decision making power and facilitated by its top management.

4.5 New Product Development

The main elements of New Product Development (NPD) have been defined to be the NPD actors, discussed in 4.5.1, the Design for eXcellence (DfX) methodology as a tool and process, discussed in 4.5.2, followed by the cross-functional collaboration and decision-making process from a multi-actor perspective, discussed in 4.5.3.

4.5.1 New Product Development Actors

The NPD process involves a large number of stakeholders from different disciplines across several organisational levels. The main functions involved in the NPD process phase of this research have been defined as: Marketing, Development, Procurement, Operations, and the Integral Project Leads. The breakdown of their functional objectives is listed below to illustrate the interests in the NPD process. The specification of the references can be found in Appendix 1.

Marketing

The functional objective of the Marketing function as stated by the marketers includes the following elements:

- Contributing to the maintenance and growth of the business and its market share by generating a suitable portfolio. And by ensuring a profitable growth with healthy margins meeting the targets (B-M4).
- Understanding the customer, in order to ensure that everything is delivered to the customer (A-M5).
- Presenting, streamlining, and executing a global and regional roadmap, committed to through handshake agreements between Marketing and Development (B-M6; B-M7)
- Ensuring a proper and user-experience focused New Product Introduction (NPI) which suits and connects to the wishes of the customer (A-M1).
- Ensuring the product's quality (A-M5)
- Delivering the promised products to the Markets in time (A-M5)

The functional objective of a management team member from the Marketing function includes:

- Ensuring the creation and maintenance of a long term roadmap (A-M8).
- Executing the roadmap elements throughout the Innovation and Development, Technology & Function Creation, and Lifecycle Management phases (A-M8).
- Delivering [the products] to the markets in time (A-M8).
- Delegating budget for Development, setting of clear priorities at product category level (A-M8).

Development

The functional objective of the Development functions as stated by the development and cost engineers includes the following elements:

- Cost engineers have the objective of achieving the highest customer value for the lowest cost by calculating and maintaining Factory Cost Prices (FCPs) throughout the NPD process. And by finding cost down opportunities through Value Engineering and DfX initiatives (A-D3).
- Designing and creating products based on the requirements received from Marketing, by understanding the standards and rules, and testing the product on the requested requirements (B-D4).
- System architects define the interpretation of commercial wishes into technical requirement, perform technical risk management, create and test the system architecture and its testing

procedure. Furthermore, system architects scout for new technologies, prepare their predevelopment and link the predevelopment to the development. Additionally, it occurs that they have the objective of getting all stakeholders on board to get to a compromise. In reality Marketing holds that power when disagreements are reached and a decision needs to be made A-D8).

- Group leads have the objective of managing their resources. By ensuring the right people, with the right skills, and the right competence set of people are present. Moreover, capturing the right domain knowledge within the product category, team coaching and motivation. They also have the objective of balancing the short term interests of the organisation with the interests of the people (A-D6; A-D7; A-D8).
- Senior product researchers have the role of communicating the voice of the customer throughout the NPD process. And in that process help Marketing with the definition of the proposition. This is followed by translating the identified customer needs into system requirements of the technical design through research with the customer. Along with creating and executing the project's validation and verification plans (A-D7).

The functional objective of a management team member from the Development function includes;

- Managing the programme of projects and products, including resource management (A-D5).
- Aligning the different NPD processes, their timing, fundaments, and relations.
- Improving NPD tools and processes (B-D2)
- Streamlining and integrating quality aspects within the business through standardisation and improvements in quality from Development to compliance to the customer (B-D2).
- Reviewing key deliverables (A-D5)
- Mentoring junior staff (A-D6; A-D7)

Procurement

The functional objective of the Procurement function as stated by the procurement engineers includes the following elements:

- Finding ways to minimise costs on materials, components, and products in the product portfolio (A-P5; B-P2).
- Supporting product development projects in reaching the best costs in raw material and design by being the main contact for all procurement activities and executing all procurement activities (A-P5; B-P2).
- Leading Design for eXcellence (DfX) initiatives to reach the cost savings goals together with the project team (A-P5; B-P2).

The functional objective of a management team member from the Procurement function includes;

- Supporting the procurement engineers in leading DfX initiatives to reach the cost savings goals together with the project team (A-P1).

Operations

The functional objective of the Operations function, as stated by the operations experts includes the following elements:

- Ensuring that products can be produced at the right price and at a good quality (B-O3).

- Enabling industrialisation of new products, including design transfer and manufacturing process validation (A-O1).
- Improving the maturity level of suppliers to comply to company directives and rules and regulations (A-O1).

Integral Project Leads

The functional objective of the Integral Project Leads as stated by the project leads includes the following elements:

- Reaching the project's time, quality, and cost requirements, in that order (A-IPL1; A-IPL5).
- Delivering on promises, quality, timing, budget, and covering all aspects from defining market requirements, programme management, development and manufacturing activities. Including the first year of product sales (B-IPL2; B-IPL3).
- Managing the stakeholders and input from the different functions involved in the project; the product roadmaps from Marketing, technology roadmaps from Development, Design development, Procurement, and Quality (A-IPL1; B-IPL2; B-IPL3).

Conclusion

- All functions focus on certain elements of the entire New Product Development (NPD) process and outcome.
- All functions share a common goal in delivering a product that meets the needs and requirements of the customer at the right time, quality and costs.
- The group leads are in charge of resource management of their function's people and competence, as well as coaching and motivational activities.
- The management team members are mainly involved in strategic, longer term activities, programme management, mentoring, initiating and supporting improvement initiatives, and reviewing project deliverables at project milestones.
- No differences were found between both case studies in the key focus areas per function, suggesting aligned objectives, roles and responsibilities with the NPD functions of the organisation (*Table 7*).

Table 7: Key NPD Focus Areas per Function of Case Study A & B

FUNCTION	KEY FOCUS AREA
MARKETING	Product portfolio, customer requirements, quality aspects, and time-to-market
DEVELOPMENT	Cost price, translation of commercial requirements to technical specifications
PROCUREMENT	Factory Cost Price (FCP), supporting other functions, leading DfX initiatives
OPERATIONS	Production at right price and with good quality, industrialisation
INTEGRAL PROJECT LEADS	Project time, product quality, product cost, stakeholder management, product and technology roadmap alignment

4.5.2 Design for eXcellence as a Tool and Process

The Design for eXcellence (DfX) methodology, elaborated in section 4.4 on page 60, integrates several perspectives related to product development, maintenance, re-use, and disposal. Its application within the organisation is expanding through training and coaching of development teams, management teams and executives in the process, mind-set, tools, and implications of DfX within the organisation. As described in literature, the methodology can be divided into four main categories; 1) the Technical Core; 2) Education & Training; 3) Managerial Considerations, and 4) Communication & Teamwork. Within the organisation, the methodology is presented as an approach with three pillars: 1) Principles; 2) People, and 3) Processes (Philips Procurement Design for eXcellence Strategy & Capability Center, 2014).

Principles: multidisciplinary teams, full management support and a holistic Total Cost of Ownership (TOC) approach regarding the DfX improvement initiatives. The TOC approach is characterised by decisions that are made based on cost calculations over the entire product lifecycle, including production, use, and its disposal.
People: the involvement of business management, DfX specialist roles in the process, content and stakeholder management, and function-area experts in the different perspectives of the DfX methodology.
Processes: the overall DfX programme, executed in a DfX convention approach, and with tracking and implementation of the committed improvement initiatives.

The three DfX pillars defined within the organisation combine the four main categories stated in literature, while lacking the emphasis on the methodology's technical core, and education and training aspects. However, the application of DfX within the organisation does suit the four categories of DfX. These categories will be elaborated briefly below. The views of the interviewed functional experts on DfX as a tool by are presented in Appendix 10: Views on DfX as a Tool for Collaborative Decision-making in New Product Development.

Technical Core

The technical core of the DfX methodology is defined by a DfX toolbox of 33 analysis tools, segmented into five different work streams: 1) Design; 2) Cost/Spend; 3) Value Chain; 4) Marketing, and 5) Quality. Each work stream contains tools within its analysis scope that enable NPD teams to analyse their products, portfolio, supply chain, differentiators, and quality levels with data from different functional disciplines. As means, the tools enable data-driven decision-making and leverage the multidisciplinary input of the team.

Education & Training

Education and training is conducted through classroom trainings in the DfX methodology, process, and tools. Additionally, project support is provided by a central team of DfX coaches to leaders and project members working on improvement initiatives following the DfX method. The DfX coaches are knowledgeable in the DfX methodology, tools and the DfX process within the organisation, and expand the capabilities in the methodology through training and coaching.

Managerial Considerations

The managerial considerations of the DfX approach within the organisation include all the aspects related to the management of the business units which can be impacted by executing DfX initiatives. They operationalise through commitment of the business unit and product category management teams. These teams act as sponsors and supporters of DfX in their business and allocate the resources required for the execution of DfX initiatives. Moreover, the DfX process includes management teams by inviting them to the project milestone decision-making meetings for their input, review, and approval of presented business cases.

Communication & Teamwork

Communication and teamwork operationalises through the DfX execution set-up within the organisation. DfX is executed in tool-driven collaboration and decision-making workshops that include all functions involved in the product's or project's elements looked into with a certain DfX tool. This cross-functional set-up encourages face-to-face communication and teamwork during the workshop, is deemed to eliminate communication barriers, and creates a stage for substantive conflict on the project's content.

4.5.3 NPD Process: Multi-Actor Collaboration, Decision-Making and Conflict

The NPD process is characterised by multi-actor collaboration and decision-making, functional interfaces between different functions and a number of other elements; information uncertainty regarding market needs and requirements and technological feasibility when dealing with novel technology. These elements of the process are prone to lead to disagreements between the involved actors, and therefore can result in conflict.

Research findings on the NPD collaboration process have been gained through talks with the main five stakeholder groups in the NPD process of the two conducted case studies. The findings in both study cases are elaborated below for each of the five functions; Marketing, Development, Procurement, Operations, and the Integral Project Leads.

The Marketing Perspective

Case A: The collaboration and decision-making process in NPD has been described by marketers from the Consumer Lifestyle business as a single project process that requires a lot of time and dedication. The NPD process involves a diversity of functions, with different communication styles and is impacted by resource constraints in people and budget. When dealing with complex products, a fixed experienced team with the right knowledge is required to execute a product development project successfully (A-M1; A-M5). Knowledge relates strongly to the individual group member level in Hackman's (1987) framework of group performance in dynamic collaboration processes. In this level, it is stated along skills and abilities among other elements as an influential factor for group performance.

The higher management layer of this function describes the process as the backbone of the organisation, while emphasising its weakness and strength of always being focussed on only one project at a time. The process simply does not allow for synergies across projects to occur due to the difficulties in managing architecture platforms and splitting a business case. The focus on the execution of one proposition is considered the strength of the process as all the pieces of the puzzle are brought together in this process (A-M8).

Case B: The description of the collaboration and decision-making process by marketers from the Lighting business contains strong similarities. They describe the process as the translation process of customer requirements to product specifications and characteristics, and communication about it to the project team in a cross-functional set-up (B-M4; B-M6; B-M7). In this case, collaboration process elements are emphasised and these elements relate to the collaboration process elements of Hackman's (1987) framework. Hackman mentions the interactive process, shared rules, and norms and structures as the elements of a collaboration process that influence group performance in dynamic collaboration processes.

Within the Lighting business, the NPD process is defined by the product launch calendar, consisting of marketing trends, requirements and market input, and by the portfolio proposition, covering proposition analysis, definition, and a gap analysis. These two elements influence the development calendar and the annual budget spent on new product development projects (B-M4).

On a high level, the process consists of roadmap alignment with key customers and the programming of projects. The execution starts by filling the Customer Requirement Specifications (CRS) document by the product manager, followed by the business case presentation to the management team. After its approval, the project starts and the decision sheet is filled in for further project execution (B-M4; B-M6; B-M7).

A remarkable statement that is emphasised is that Marketing/Product Management is not always perceived as a part of the team as the function has an ambiguous role as project customer and project participant regarding market insights. Despite this ambiguous role, the functions of product development project teams within the Lighting business are perceived by its marketers to be more integrated due to its generally technical-educated marketers (B-M4; B-M6).

The Development Perspective

Case A: The developers from Development within the Consumer Lifestyle business characterise the process of collaboration and decision-making in NPD as a dynamic, exciting but unclear and Marketing-driven process. Role ambiguity is experienced towards Marketing following its strong tendency to act as project owner and customer while being a project team member. This strong feeling questions the role and decision power of the Integral Project Lead (IPL) within the project team.

Misunderstandings that occur are often relatable to differences in mental models between marketers and engineers. Such situations tend to arise when requests from Marketing are answered by Development with different and unexpected results. Discussions throughout the process tend to relate mostly to the Factory Cost Price (FCP) in relation to customer and design specifications, and the execution of the agreed upon technical architecture.

Despite the generally open and honest atmosphere, involvement of non-commercial functions in key discussions is limited due to difficulties in alignment of decisions, and a large and complex network of stakeholders with a say, likely to cause delays. Overall, the required effort and time for technical changes requested by Marketing is often underestimated.

Case B: Development engineers from the Lighting business emphasise that extensive communication between functions in the beginning of the process and clear guidelines until the Project Plan Commitment milestone improved performance of collaboration and decision-making in NPD. As previous experience has shown that issue-related discussions later in the process endanger project timing, the general mind-set is that it is better to have something than nothing rather than a too detailed but too late design. It is expressed as the momentum of 'Design for good enough' for the customer. It requires good collaboration between Marketing, Research, the system architect and the design engineer to define the product or concept scope and direction for the product and its components.

Collaboration is helped a lot by the very good atmosphere without hiding of information but rather a large amount of personal empowerment to take ownership of own roles and responsibilities. Development engineers state that some project teams are almost like groups of friends.

The Procurement Perspective

Case A: Procurement engineers from the Consumer Lifestyle business characterise collaboration and decision-making in NPD as a process with a physical distance between Marketing and the other functions. Moreover, a lack of transparency in the market and product knowledge of Marketing is perceived. The transparency of commercial decisions is stated to be increasing by challenging Marketing on its commercial input into the process. The overall NPD process is constrained by milestones and its timeline, challenging time consuming opportunities of including supplier expertise that could improve product quality and reduce costs.

Role ambiguity of Marketing is perceived regarding its demands and its simultaneous membership of the project team, a perception shared among other the functions. Furthermore, Marketing tends to set an unrealistic factory cost price, which is derived from a top-down pricing and cost price approach. The NPD process is further defined by the use of communication skills for the purpose of collaboration and the integration of functional goals among the different actors.

Case B: The procurement engineers from the Lighting business describe the process of collaboration and decision-making to be focussed on reaching the optimal cost level in reaching the cost business targets. The challenge is to maximise margin before price erosion and price wars occur. It requires optimisation or minimisation of the time to marketing for new product introductions and an optimised quality level.

The Operations Perspective

Case A: The Operations experts from the Consumer Lifestyle business characterise collaboration and decision-making in NPD as challenging, with a large amount of engagement and ownership among team members. Sometimes, the process is impossible due to unrealistic target setting in pre-set launch dates.

Identified risks that are raised throughout the process are often ignored, although their outcome tends to be received as a surprise by the management team. It seems to be simply not accepted to raise risks. When the actual impact of risks occurs, they are deemed impossible and they are questioned by the management team, while the risks were clear in the project team.

Escalations are preferably not chosen due to their extra workload, an approach which usually results in late management involvement when issues arise. Based on business priorities, a reactive approach is chosen over a preventive one when issues arise. Issues tend to be solved rather than prevented. The deployment of the lean methodology is hoped to improve this management attitude, as well as to stimulate the initiation of cross-business learning and improvement initiatives by senior management.

Other characteristics of the process are the challenging, and sometimes impossible collaboration process due to impossible target setting. For example, when launch dates are decided upon before the project definition, and without technical and supplier plans being defined.

The good thing is that there is a 99% drive, ownership and engagement on team and individual level, which is extreme. However, the fear of solving the issues instead of preventing issues not outspoken and the management team seems not interested in issue prevention.

Case B: In the Lighting business, Operations experts remark that the process follows the Integrated Product Process (IPP) and is executed by mature project team members. Its performance in quality of input, component related documentation and planning depends on the maturity of the project members. In general, not much discussion arises during the process and the main discussions relate to investments and lead time, as most quality targets are defined before the start of the project.

The Integral Project Lead Perspective

Case A: Integral Project Leads from the Consumer Lifestyle business characterise NPD collaboration and decision-making as a complex process that is defined by the Project Brief, involves a generally large team and requires full dedication from team members. In reality, in-depth contributions of team members are hindered due to their multiple roles or their involvement in multiple simultaneous projects.

Marketing is often challenged on its input in order to improve projects integrally, but a high turnover in its representatives tends to destabilise NPD projects. Cross-project and cross-site learnings are limited as

surprises arise during product launches, suggested to be largely due to limited focus of project members on the project.

Despite decisions being delayed due to meeting cancellations, management team supported decision-making freedom of the project team tends to be limited. This is argued to be related to limited trust in and experience of the project teams. In some cases, procedures are not known or unclear to project members, causing unnecessary delays.

The essence of these approaches is defined in the three focus areas of direction, structure, and external relationships. These areas include situation monitoring, problem diagnosis, solution implementation, providing clarity, supportiveness and motivation to the team.

Case B: Within the Lighting business, Integral Project Leads define collaboration and decision-making in NPD as a Marketing or technology-driven process. Its main elements are: ideation, the definition of the value proposition, and the elements that are Critical to Quality. Complexity is added as a lot of questions are left unanswered, while a complex stakeholder field involves itself into the process. The initial phase of the process is deemed the most important, defined by the continuous process of discussions with the Markets and customers to gain an understanding of the required product portfolio.

Experienced teams tend to make the difference in such situations. The relatively frequent change of product managers/marketers impacts the process and often results in situations in which they have to be told what a good idea is by the rest of the project team. Moreover, it often occurs that Marketing makes too many promises to customers which have not been communicated to the rest of the project team. The business case is used by Marketing to sell the project, while handshake agreements with Development on the actual feasibility of project execution are limited. In such cases, little room is left for negotiation although the defined timeline in the business more is more efficient and highly theoretical rather than realistic in practice. However, giving Development freedom is thought to be leading to longer lead times as the development engineers have the tendency to keep on working on their activities.

Collaboration Elements in Collaborative New Product Development

Analysis of the collaboration elements in the collaborative NPD context reveals a number of findings:

- On a personal level, LaFasto & Larson's (2001) defined four qualities that contribute to teamwork: openness, supportiveness, action orientation, and positive personal style. In this study, all four qualities were identified in the expressions of the interview sample and in the workshop observations. The personal quality of openness has been found to be more limited between Marketing and Development than between other functions. The expressed level of openness between the NPD functions was higher in case B than in case A. The qualities of supportiveness, action orientation and personal style were also found to be more positive in case B compared to case A. These findings suggest that the NPD actors in case B have more resemblance among each other compared to the actors in case A. It could be a result of the conditions and organisational configuration within the organisational entity, which could have affected the hiring policies and the attraction of employees.
- LaFasto & Larson's (2001) four characteristics of relationships; mutual understanding, constructive, productive, and self-corrective, have been found to a higher extent in case B compared to case A. Although mutual understanding was present in both cases, the expressions in case A showed lower levels of constructive, productive, and self-corrective actions in the relationship between NPD team members. In case B, the observed and articulated relationships during the interviews showed high levels of the four characteristics. Based on the findings, it can be conclude that case B relies on better relationships during the collaboration process.

- On an individual level, the findings relate strongly to the individual group member level in Hackman's (1987) framework of group performance in dynamic collaboration processes. In this level, it is stated along skills and abilities among other elements as an influential factor for group performance. These findings are mostly found in case A. In case B, collaboration process elements are emphasised, which relate to the collaboration process elements of Hackman's framework. Hackman mentions the interactive process, shared rules, and norms and structures as the elements of a collaboration process that influence group performance in dynamic collaboration processes.
- With regard to collaboration outcome, both individual and group elements are found that relate to Hackman's framework. On an individual level, the amount of influence by NPD actors is moderate to high, depending on the person's role and personality. The influence is mainly related to the person's input in both the functional role and team sessions.
- Affective related elements of satisfaction, mood, and motivation on an individual level, as well as group cohesion on a group level, were sensed to be higher in case B compared to case A. This is derived from the attitudes and wording used by the interviewed functional experts regarding the project, the actions of the involved NPD functions, and fellow team members.
- The role of the integral project lead in face-to-face team collaboration in both case A and B is supportive to the process. This support is operationalised by monitoring and redefining the team's goals and objectives. Furthermore, the role includes the monitoring of and anticipation on activities, tasks and procedures that lead to accomplishing the goals, in line with the role activities that were defined by Sarin and McDermott (2003) as cited in (Knoll & Lukosch, 2014).

4.6 Conclusion: A multi-actor perspective on NPD collaboration

This chapter elaborated on the organisation configuration, the objectives of the NPD functions, and an explanation of the applied DfX methodology within the organisation. Furthermore, it elaborated on the NPD collaboration process from the perspective of the five most involved functions: Marketing, Development, Procurement, Operations, and the Integral Project Leads.

This chapter answers the following question:

SQ 1: Which characteristics define the collaboration process between marketing, development, procurement and operations in new product development?

Characteristics of the collaboration process in new product development:

- Collaboration in NPD is a dynamic Marketing-driven process which is defined by the translation process of customer requirements to product specifications in a complex stakeholder field (Case A&B).
- Collaboration is perceived as challenging, with a generally large amount of engagement and ownership by participants on team and individual levels, or as difficult to impossible due to unrealistic target settings (Case A&B).
- The initial NPD phase of continuous discussions with most stakeholders is deemed the most important. Differences in functions, interests, and mental models increasing the likelihood of misunderstanding, problems, and conflict make clear guidelines, early extensive communication, and an open and honest atmosphere between functions key aspects to collaboration. The Design for eXcellence methodology is one of the initiatives that addresses these aspects in NPD (Case A&B).

- Role ambiguity of the Marketing function as customer and project team member causes decreases clarity and increases tensions. Moreover, a relatively high personnel turnover rate seems to be a characteristic within the organisation (Case A&B).
- A physical distance between Marketing and other functions and limited transparency of commercial decisions towards other functions seem to distract collaboration from the content to communication and process related issues (Case A). Limited distance between functions and higher levels of decision transparency stimulate discussions about the content of the project (Case B).
- The performance in quality of input, content and planning depends on the maturity of the project members. Lower maturity seems to be characterised by risk avoidance and problem solving instead of prevention (Case A&B).

The institutionalised aspects of the organisational configuration have been found to show differences between the two case studies in the two different businesses. Despite the fact that both entities used the same process and project management approach to new product development, differences were identified in the level of clarity and maturity of organisational processes, the level of maturity of the product category, the level of granted freedom in decision-making to project teams, and the institutionalised interactions with the management team. Furthermore, prescribed processes, milestones, milestone deliverables, roles and responsibilities, and experienced project team members with a technical educational background were found in case study B, whilst research findings mark them being limited or lacking in case study A. The last main difference between the case studies was found in the subjects and timing of discussions, taking place before or around the Project Start milestone in one case study while arising later in the process in the other case study. Insight in the project performance and relations among functional actors should reveal the impact of these identified organisational differences.

Findings related to the functional objectives of the functional project team members have identified both a focus on specific process phases by each of the functions, as well as a shared common goal in delivering products that meet customer needs and requirements at the right time, quality and costs. Management team members have been found to be involved in activities related to strategy, programme management, mentoring, improvement initiatives initiation and support, and project milestone deliverable reviews.

The application of the DfX methodology has been found to resemble all the elements of the methodology that have been defined in previous studies. The approach provides the means to NPD teams to leverage cross-functional perspectives to achieve higher NPD performance in product design and costs, an efficient and effective supply chain, competitive advantages in customer value, and required quality levels.

The five main NPD functions describe the collaboration process in NPD projects mainly as challenging in meeting the targets, time-pressured, complex in the number of involved stakeholder, focussed on the Factory Cost Price (FCP). Escalations to the management team tend to be limited to prevent additional work.

Negative impacts on the NPD process are stated to be the role ambiguity and relatively high turnover rate of marketers, raised risks being ignored, limited experience of project team members, and unclear processes, roles and responsibilities. On the other hand, when processes are clear, the collaboration process tends to focus on the content of the projects to gain transparency and understanding. In that sense, Marketing is often challenged on its input to clarify its underlying reasoning.

5. Conflict in New Product Development

This chapter will address conflict, the types of conflict and their occurrence in the new product development process, and conclude on these elements from a multi-actor perspective to answer the following research questions:

SQ 2: Which types of conflict occur in new product oriented collaborative decision-making in the new product development process?

SQ 3: Where in the new product development process do conflicts occur?

In chapter 2, the definition of conflict by Rahim (2002) was followed. The concept of conflict is defined as an interactive process that is manifested in incompatibility, disagreement, or dissonance within or between social entities like individuals, groups, or organisations.

After the elaboration of the definition of conflict, this section also discusses the location of conflict occurrence in the NPD process. Information on the occurrence provides a better understanding of conflict during the NPD process in relation to time. The occurrence will be discussed from the perspectives of Marketing, Development, Procurement, Operations, and the Integral Project Leads of the two case studies. *Figure 17* illustrates the milestones that will discussed in this section. The illustrated milestones are preceded by the Technology & Function Creation (T&FC) phase, and followed up by the Market Introduction Process (MIP).

Figure 17: Integrated Product Development Milestones

Disagreement, the nature and definition of conflict, carries the risk of subjectivity when asked about. Therefore, a multi-actor approach was taken in identifying the types of conflict, and their occurrence in the NPD process. In the following section 5.1, situations of conflict and the location of conflict occurrence in NPD are elaborated from the perspectives of Marketing, Development, Procurement, Operations, and the Integral Project Leads. The conclusions are presented in section 0.

5.1 Conflict and its Occurrence in Collaborative New Product Development

The Marketing Perspective

The NPD process has been described as challenging.

Conflict in Case A: Marketers from the Consumer Lifestyle business emphasise several challenges of collaboration and decision-making in NPD. The main challenges include tight project timing, differences in points of view and knowledge levels between functional experts, and the overcoming of communication barriers and frustrations between them. Discussions arise when counterparts from other functions challenge the high demands from Marketing through substantive conflict. Which, when kept unsolved, result in time, technical or cost price related issues later in the process.

A weak attitude within the organisation to in-depth investigation and decision-making characterises the challenges of decision iterations throughout the process. This characteristic relates to aversive behaviour towards initiating substantive conflict. The risky and not recommended initiation of the Integrated Product Development (IPD) phase before the completion of the Technology & Function Creation (T&FC) predevelopment phase is another tendency which is highly likely to result in problems. Seemingly, it suggests a lack of discipline within the organisation, but perhaps there are other causes.

The uncertainties related to the complex businesses and products often result in surprising challenges and time pressures, while deviations in processes between innovation sites and briefing templates do not provide the required levels of clarity and standardised understanding to all involved functions. Deviation in processes can be seen as process conflict or at least a possible cause for process conflict when actors relate to more than one process. Additionally, late involvement of different functions in a project, on the job learning about the processes, and the dual role for Marketing as both a customer and contributor lead to further challenges in collaboration and decision-making. Late involvement can be defined as process conflict, as not all requirements are met when not all functions are involved in the project.

Conflict Occurrence in Case A: Marketing from Consumer Lifestyle indicates that conflict mostly arises at the beginning of projects, on one side related to Technology & Function Creation (T&FC) predevelopment readiness, discussed between the T&FC team, Development and the project team. On the other side, conflict relates to the translation of customer benefits to technical solutions at the Value Proposition Definition (VPD) milestone and the proposed solutions by Development to requests of Marketing at the Architecture Agreement (AA) milestone. The VPD milestone is strongly related to Marketing as a key milestone for defining the proposition. At the AA milestone, the actual technical solution is agreed upon. Communication to the countries start at this moment. Other conflict arises at or before the Project Plan Commitment (PPC) milestone. Pre-PPC, a lot of pre-alignment meetings on finance and quality require motivation and collaboration efforts from the whole team.

Substantive and process conflict regarding misalignment on ways of working and disagreement on the NPD process tends to arise on a higher organisational level between the key stakeholders from Development and Marketing; the Innovation Lead (Development) and the Commercial Marketing Director (Marketing). At and after PPC, conflict may arise between Operations and the project team on design related issues that arise during industrialisation operations.

Other tendencies for substantive and process conflict arise between the Integral Project Lead (IPL) and Marketing, due to role ambiguity of Marketing in NPD projects, between Marketing and Design conflict relates to late delivery of packaging. The Product Research Centre (PRC) challenges the reasoning behind feature choices from a customer perspective through substantive conflict throughout the process. Discussion points include issues like uncertainties of new technologies at young innovation sites with more process flexibility, limited experienced teams, and inflexibility of mature teams as they are not challenged a lot through substantive conflict and therefore tend to deliver sub optimal results. Conflict relates mainly to goal and role misalignment between Marketing, IPL, Design and PRC, a lack of clarity in communication purpose and in roles and responsibilities throughout the process.

Conflict in Case B: The marketers from the Lighting business name priorities in projects defined by management strategy and the risk of project postponement or discontinuation as conflict sensitive elements. Projects are defended by underpinned data related to the predefined launch calendar and timing is a challenge due to resource constraints in Development that challenges the launch calendar. Projects have to be shifted to accommodate them with available resources, while stakeholder need to be convinced to break through the company's very technology-driven push culture. This culture is perceived to be hindering the change within the organisation from a technology push to a market pull approach that suits the market trends and caters for meeting customer needs and requirements more effectively.

People are perceived to be defensive of their work, especially engineers. Marketing requests are sometimes answered with other technological solutions from a Development perspective, leading to endless discussions.

Conflict also arises regarding project leadership. Product managers have a key role and need to convince project leaders to execute projects as they should execute projects, not judge whether if it is the right product. Some KPIs from project team members can push Product Management/Marketing into a certain direction in the alignment of the approximate Customer Requirement Specifications (CRS) of Marketing with the more precise Functional Requirement Specifications (FRS) of Development.

Challenges towards Procurement relate to the initiation of the ordering process when development delays occur due to issues. However, Procurement always waits for the frozen design before initiating orders to suppliers, which increases risks of further delay in the commercial release and potential lost market opportunities due to fast moving competition.

There is a built-in conflict in the NPD process at PPC. The process requirement of having product volume and pricing commitments from the Markets while often the product is in a premature state at PPC and the Markets do not want to overcommit on product volumes. This is solved by making the business case at the best moderate potential and informing the Markets on the proposition to push the products. If the proposition needs to be made more detailed by the engineers to be able to convince the markets, the consequence is project delay.

Long lead time that originate from an insufficient preparation process in scope and stakeholder involvement. Politics play a positive role when milestones are passed without sufficient clarity on the quality of the deliverables, and a negative role when they cause delays, less transparency and no control over process progress. A positive consequence is that is urges the team to challenge each other.

Cross-regional collaboration and decision-making combined with the complexity of the business with a complex stakeholder field leads to high workloads. A state of work overload is caused by ongoing organisational changes, the speed and quality of decision-making depends on the maturity of the people. However, building experience and anticipating customer expectations is time consuming. With lower maturity levels, speed in project programming and execution is lost, and projects are delayed or terminated. It is difficult to overcome such impacts on the programming, as taking shortcuts without endangering the business and raising risks is only feasible with the right experienced people.

With most competitors being more specialised, the challenges of maintaining a diverse portfolio are in setting the right priorities. Good constructive conflicts between engineering and product management in Value Engineering workshops address such challenges through Development's cost focus and Product Management's focus on business risk management. It is the nature of such a workshop. It's even in the name. One marketer emphasised the importance of experience in making trade-offs in business decisions; "Without an experienced product manager, this will be a difficult process. Meeting the business needs might lead to perhaps questionable product decisions in order to not lose face. I see a big risk there. The technical background is historically grown. There are thousands of cost down opportunities. Judging the trade-offs is not so easy" (B-M7).

Data helps to gain the right understanding for component and production decision-making out of the constructive fine-tuning process discussions between Development and Manufacturing. Such discussions are essential to reach the best integral project outcome. It should involve all relevant production sites and there is much more to gain from Value Engineering workshops as projects are interlinked, components are shared, and a lot of commonalities exist between components.

Conflict Occurrence in Case B: Marketers from the Lighting business indicate that conflict arises after the PPC milestone until the Product Freeze (PF) milestone that marks the completion of the design and the start of Procurement and Operations activities in the industrialisation phase. Marketing is involved up

until the PF milestone, followed by the commercial announcement at the Commercial Release (CR) product launch milestone.

Conflict mostly arises between Marketing and the Management Team and is pushed through to other functions when found relevant. The Integral Project Lead is responsible for the input from all disciplines at project milestones that is required to enable the functions to agree upon the passing of the milestone before the management team takes the final decision. Conditional passing of milestones occurs without conflict if an action list for a particular function is defined that does not include involvement of other functions or a huge investment in capital expenses (CAPEX).

Substantive conflict is mostly initiated during a Value Engineering workshop, which tends to be planned at the beginning of a project just before or after the Project Start (PS) milestone. The workshop provides a platform for such discussions and is one of the few occasions where discussions take place. Usually, analysis and discussions arise when the concept design is impacted by negative test results, new insights from customer, competitors and the market, or knowledge gaps that are addressed late. But then it is very late in the project with a high likelihood on impacting quality, specifications or project timing. Situations of uncertainty and delays arise when people leave the organisation during a project, and their replacements go through a learning curve. Impactful technical issues arise when the technical design does not meet the required specifications. Its criticality determines the impact on time. Issues identified during milestones are accepted when they are solved directly.

Conclusion Marketing Perspective

- **From a Marketing perspective, process related conflict tends to occur due to process deviation and uncertainties related to complex products. This whilst dealing with tight project timing and differences in knowledge and perceptions between functions.**
- **Other process conflict relates to management priority changes, the role ambiguity of Marketing in NPD projects, and insufficient preparation of the project scope and the required stakeholder involvement. A lack of clarity in the quality of project deliverables at the milestones tends to result in long lead times.**
- **Substantive conflict during NPD relates to the translation process of Customer Requirement Specifications (CRS) of Marketing to the more precise Functional Requirement Specifications (FRS).**
- **Other substantive conflict relates to the so-called 'built-in conflict' directive that required a handshake agreement on the business case to reached between Marketing and the Markets that request the developed product whilst the product is in an immature state.**
- **The act of convincing stakeholders to change towards a market pull approach rather than a technology push takes time and effort. This issue relates to the technical nature of the organisational culture and is experienced as a substantive conflict.**
- **Furthermore, ongoing organisational changes add to the level of complexity and workload that the organisation needs to handle. This puts pressure on the development teams and increases the likelihood of priority divergence between team members and the likelihood of conflict as a result.**

The Development Perspective

Conflict in Case A: Development engineers from the Consumer Lifestyle business relate the challenges and conflicts in NPD mainly to a too high Factory Cost Price (FCP), instability in the product roadmap, limited underpinning of choices, and indefinite decision-making. Furthermore, substantive conflicts arise from uncertainty about customer requirements for 'first of a kind' products, ad-hoc work and decision-making, and limited understanding between functions regarding the interdependency on activities of counterparts. These conflicts are characterised by process conflict related to communication and substantive conflict related to addressing information uncertainties in priority setting and decision-making.

Limited freedom in decision-making for the project team and project lead, resource constraints, and the fear for making mistakes add to the challenges from a Development perspective. These challenges are most likely to result in delays in project milestone deliverables or the product launch date. A related behavioural challenge is the team morale being impacted heavily by project delays and team instability with leaving project members. These challenges are experienced by project teams as a struggle to recover from.

Conflict Occurrence in Case A: Development engineers from the Consumer Lifestyle business argue that conflict mostly arises at or before the PPC milestone and relate to technical T&FC issues. Some conflict relates to the Development / Design interface regarding design choices that complicate technical solutions. Other conflict tends to arise between Marketing and Design, Development, and the (Market) Country Organisations which request the products for sales purposes. The raising of potential issues often occurs early in the process, which is perceived as too early. It often results in the risks brought to the attention being ignored. However, the raising of and dealing with risks is a choice that needs to be made; either during the development process with potentially moving the launch date, or when the problems actually occur late in the process.

After the project is ended, issues arise regarding extra features and design change requests during the product maintenance or Lifecycle Management (LCM) phase. Conflict during the NPD process relates mainly to strict design requirements versus the Factory Cost Price, tight project timing after T&FC, late delivery of the product roadmap by Marketing, extra requirements by Country Organisations, and technical issues.

Conflict in Case B: The Development engineers from the Lighting business associate most NPD conflict with quality related challenges at the interface between Development and other functions, among which quality versus Development, Operations, and Marketing. Issues relate to either the front end or the back end of the development process. At the front-end, there is limited impact between Marketing and Development, mainly related to trouble in defining the 'voice of the customer'. At the back end it consists of a suboptimal feedback loop from Customer complaints coming in at the call centre or the field quality manager in business-to-business towards Development. Complaints are processed by customer care managers on a Business Market Combination level to address complaints per product type, per market. A recurring issue to the NPD process is articulated to be the often late requirement commitment by Marketing on the value proposition. The quality-oriented examples all relate to substantive conflict on defining the required quality level.

When asked about substantive conflict, Development engineers relate it to the action of challenging proposals of others to make the right trade-off between quality versus efficiency and effectiveness. It requires exploring the possibilities and options of improving product cost and value to come to the best decision, which is a time consuming activity. The relatively generic nature of products in the Lighting business makes most idea generation sessions a repetitive practice. However, that does imply that radical ideas are difficult to implement due to legacy in manufacturing and development, unless an idea is fully

proven. Likewise, the review of business cases, cost bases, volumes, and sales prices by the management team is seen as potentially endangering innovative initiatives. Such initiatives high levels of technological uncertainty and project risks tend not to pass through high levels of management control.

Other challenges are a lack of interest in in-depth technical details by the commercial stakeholder, which results in communication challenges regarding specification details of undiscussed, possibly leading to issues and surprises later in the process. This situation could be perceived as preventing substantive conflict. However, there are limited challenging possibilities towards Marketing due to the limited contact moments. This seem to indicate an institutionalised prevention of substantive conflict, which is further supported by behaviour of marketers, as the underlying arguments of Marketing requests are often lacking in the communication towards Development. Consequently, Development perceives the situation as one with islands within the functions that may prohibit communication and knowledge sharing, and organisational learning.

Another characteristic of the NPD process is the tight project planning, while changes tend to occur late in the process. The quality of the NPD process depends on the level of details put into the process by the functional stakeholders during the milestone process. But despite this dependency, a lot of specification changes arise due to changing insights from the market. These changes then lead to major redesigns and delays, and frustrations due to work becoming obsolescent due to the changes. With regard to prior experiences, Development engineers within Lighting tend to mitigate risks during the NPD process. By looking further into the process, they are able to take potential changes in development activities into account that arise form often occurring change requests from the customer or Marketing. Prioritisation and time buffers are applied to cover cost and timing to achieve more flexibility in the process. A remarkable finding and a cause of a lot of frustration relates to changes in market insights when the product manager changes, although only the marketing individual changed. This issue tends to trouble especially less experienced teams.

Apart from changes to the business priorities, other issues have a technical nature and relate to not complete designs and changing specifications which require time and budget to resolve. New component choices can be risky and change of course might occur if real issues arise. But a real predevelopment platform does not exist for full products. Product platform development is done during the product development phase, which is risky and might result in delays. In general, main decisions are made in the beginning of the project on software and hardware choices, and the building blocks that need pre-development by the system architect. After the Project Start, the system architect is only involved when issues arise.

The cross-functional Value Engineering workshop approach is seen as a substantive conflict vehicle that makes it easier for Development to challenge Marketing/Product Management on product functions, costs and the value of certain requested features. Last, the Commercial Release product launch milestone is not able to pass when the supply chain lack stocks, as the milestone requires stocks to be available.

Conflict Occurrence in Case B: Development engineers from the Lighting business indicate that conflict mostly occurs before PPC, and sometimes after PPC when items are not discussed or specified enough before PPC. Through the Value Engineering approach, substantive conflict between Marketing and Development on specification definition and agreement arises more towards the Project Start milestone. Later in the process, substantive conflict between Development and the project team can arise regarding immature building blocks of the product or its components or underestimated risks. Planning and time related substantive conflict between Development and the Integral Project Lead tend to occur before the Commercial Release (CR) product launch milestone. Conflict tends to impact the project by time through additional work and rework related to technical issues or change requests from Marketing, costs, and disappointment of stakeholders.

Conclusion Development Perspective

- **Conflicts are characterised by process conflict related to communication. Substantive conflict is related to defining and meeting quality levels and the task of addressing information uncertainties in priority setting and decision-making.**
- **Other project conflicts relate to resource constraints, tight planning, late changes to the product, changes in the function of Marketing/Product Management, limited freedom in decision-making for project teams and the project leads.**
- **And last, the fear for making mistakes by Development engineers.**

The Procurement Perspective

Conflict in Case A: Procurement engineers from the Consumer Lifestyle business see the limited sharing of insights, and the discomfort of having others looking into the work of a functional expert, due to a perceived lack of knowledge or lacking underpinning of decisions, as reasons for substantive conflict in NPD collaboration.

Process conflicts relate to uncertainties, and resulting product changes, additional recurring changes to details, and a rush to meet the next project milestone. Sometimes, it is even unclear who the decision-maker is or should be in the complex stakeholder field of a project. At the end, the main challenge is stated to be about addressing and balancing expectations and conflicting interests of different stakeholders.

Conflict Occurrence in Case A: Procurement engineers from the Consumer Lifestyle business indicate that conflict mostly occurs between Marketing and Development, and between Procurement and the project team, at and between the Value Proposition Definition, Architecture Agreement, and Project Plan Commitment milestones. Most conflict occurs between the last two milestones, characterised by the convergence of ideas and decisions towards a commercially and technically proper product and commercially interesting business case.

Conflict relates mainly to limited market facts and figures for proper investment related trade-offs, ill-defined value propositions without unique differentiating customer benefits, not completed T&FC predevelopment. More in-depth issues relate to lacking target alignment in cost reduction versus quality and time-to-market trade-offs, too high Factory Cost Prices, and limited team involvement in supplier selection. Other issues tend to arise regarding product design and packaging before the final production release process. Organisational processes, standards and requirements are often ignored to reach NPD process and commercial product success. This approach is initialised due to the discussion-intensive nature of the regular way of working and a large amount of requirements from the many involved stakeholders.

Conflict in Case B: Within the Lighting business, procurement engineers relate NPD conflict to budget issues, and struggles between functions related to Procurement or Manufacturing. Budget issues comprise the trade-off for business management to either invest in portfolio extension through new product introductions, initiated by Marketing, or in cost reductions in order to meet the annual operating plan, initiated by Procurement.

Commodity Management struggles with the continuous changing supply base, caused by the cost structure of components and products, and by price erosion. Friction and substantive conflict in decision-making between Procurement and Commodity Management arise on price versus quality trade-offs for components when design engineers propose a technical working concept for an electronic design.

Further substantive conflict arises between the Industry Engineers, focussing on the easiest design with the easiest components, and Design engineers, who focus on the easiest production method through Design for Manufacturing (DFMA), standardisation, and line balancing. Most often, extra design time is required to incorporate additional requirements for manufacturing. In most cases, trade-offs are made after discussion, except for cases where the customer interest is at stake. i.e. quality specification not met by supplier, which is then escalated to General Management to get to a solution. The general mind-set within the business is: manage the business the best as we can, while taking into account interests of other functions, and focus on the customer at all times.

Conflict Occurrence in Case B: Procurement engineers from the Lighting business indicate that conflict mostly occurs after the Project Start and before the PPC milestones. The nature of the conflict relates to the open decisions about potential concepts, propositions and technologies at Project Start, whilst conflict before PPC related to process complexity and disagreements when all information and decisions have to converge to one final project outcome.

The Operations Perspective

Conflict in Case A: Operations from the Consumer Lifestyle business view NPD conflict as mostly related to not having clarity in the direction of the solution, and lack of progress and ownership when rules and responsibilities are not clearly defined but left for personal interpretation. Seemingly a combination of substantive and process conflict. Such challenges lead to major mistakes in projects related to unavailability of clear processes and rely on experienced teams. Lesser experienced professionals tend to struggle and suffer the most from such uncertainties. Constructive conflict by challenging each other on content has proven to be very important to prevent ill decision-making.

Tensions between Marketing and technical innovation sites arise with each project, and negatively impact the willingness and drive of innovation sites to stay sharp and challenge unrealistic targets in fear of losing work to other innovation sites. However, challenging targets through substantive conflict does generate motivation to win and tension is great when different perspectives are brought in.

Supplier related activities are the last steps and Operations is not always involved in the project, which carries great risks to their execution. One of the regular issues relates to financing of solutions to issues that arise during the operational execution phase that originate from the investigation and development phase, indicating process conflict. Real decision-making does not take place. Consolidation of all product decisions is done based on clear rules and without discussions but with open actions.

Problems tend to occur mostly with high levels of innovation and the highest level of uncertainty. The real commitment moment of a project is the Project Start milestone, rather than the Architecture Agreement or Project Plan Commitment milestones. Milestones are related to specific functions and have their own dynamics. Risks are ignored when milestones are passed conditionally, partly due to the functions not seeing each other's problems and originating from limited experience in new product development. For example, processes to involve Operations in the project are immature. But resource constraints and the limited experience of people in the importance of involving Operations form bottlenecks in solving this issue.

Conflict Occurrence in Case A: Operations from the Consumer Lifestyle business indicates that conflict arises mostly between the AA and PPC milestones, due to the commitment moment.

Conflict in Case B: In the Lighting business, Operations emphasises conflict in NPD that is related to receiving budget, having a realistic project planning as early as possible, and selecting the right project scope through either a product or end-to-end cost and value focus. All related to substantive conflict.

The NPD process is characterised by challenges in the selling price and cost down opportunities without raising risks or impacting time or quality. And the heavily time consuming process of gathering insights to close knowledge gaps adds to these challenges of NPD. Addressing such challenges requires substantive conflict to clarify the options, the arguments for each option, in order to take the best commercial and technical decision based on the available information. Substantive conflict is said by arise when team members are challenged to test different approaches to find the best way and to gain more insights.

Process conflict is prevented as much as possible by following the predefined NPD procedures, but conflict does arise when they are not followed. The current procedure is perceived as good enough but shortcuts are used because of the relatively low speed of the current procedure. In general, decision-making always occurs based on consensus.

Conflict Occurrence in Case B: From the Lighting business, Operations indicates that conflict arises mostly between the Integral, Industrial and Technical Project Leads at Project Start, Project Plan Commitment, Product Freeze and at the Commercial Release product launch milestone. Substantive conflict occurs at Project Start and PPC, while the Product Freeze milestone is challenging due to the final decision and the Commercial Release. At the latter milestone, pressures related to be ability to sell the products arise, with possible delays in manufacturing. Conflict impacts the project in time through delays, lower quality in manufacturing when temporary and often more expensive solutions are applied in the process instead of solving the root cause of the issue.

The Integral Project Lead Perspective

Conflict in Case A: Integral Project Leads from the Consumer Lifestyle business relate NPD conflict mostly to the complexity of the organisation and its too complex stakeholder field, and the lack of decision-making power in the project team. Experienced teams have proven to have the ability to learn on the job well when they are granted decision-making power.

The involvement of many stakeholders is perceived as risky of delays and decision-making shifting from the project team to a stakeholder. Moreover, process complexity is increased by the strong push of many issues and decisions to key milestones rather than a solution during the process. Projects should be tailored with more flexibility, which requires providing the project team decision-making power. And such decision-making power relies on trust from meeting promises and expectations, which is difficult to achieve due to team instability or lack of focus from resource and budget constraints.

Process conflict is also caused by split responsibilities between budget and proposition between Development and Marketing. A setting which puts pressure from the Innovation Lead on the milestone and timing due to budget constraints, while the more time consuming value proposition optimisation is pressed upon by the Marketing Director. Other experiences are of smooth collaboration and decision-making through weekly meetings, although the limited use of sensitivity analysis-like tools for business case creation tend to leave questions related to the value of features and the Factory Cost Price (FCP) on sales unanswered.

Other challenges within the project team arise related to delays resulting from team instability, especially related to limited continuity of the Marketing representative in projects. Such changes carry the risk of changes of subjective requirements from predecessors. Such instability only adds up to the current workload of too many projects and test, late decision making on product architecture and the pressure to not delay the Project Plan Commitment milestone. Such a delay impacts the budget heavily, and is likely to lead to loss of sales and market value due to the subsequent delay in the product's launch date. These pressures are perceived to result from limited milestone gate keeping management and limited project resource management across projects. Further barriers on process level include budget constraints and approval requests per milestone, people resource allocation based on the initial project plan instead of the

actual situation, technical issues on product level, limitations on product testing and key project decisions, misalignment throughout organisational levels, and an unclear and unrealistic project brief of a NPD project to start the process with. These last mentioned barriers seem to indicate that a lot of problem causing conflict is not outspoken within the project team or shared with the management team, or is not addressed by the organisation.

Conflict in Case B: Integral Project Leads from the Lighting business name the proposition, or to too ambitious targets of programme and product management as conflict in NPD. Especially relating to the complexity of defining the sales price and customer requirement specifications (CRS), and the work overload of development teams due to resource constraints. It is difficult to gain the right CRS from Marketing/Product Management, while clear specifications are needed by Development's architecture engineers. Moreover, requests for global specifications are hard to provide to due to the product's complexity.

Furthermore, it often occurs that marketers do not follow the processes but put the business above them by making promises to customers and selling the product that has yet to be defined and developed. Order are then blocked by quality engineers due to the immature product status of the thing Marketing already promised and sold due to their urge to drive business. Marketing seems to lack process knowledge deployment of the total process, and the risk of early adaptors. A clear case of process conflict, may it be not by accident.

Challenging the ambitious targets through substantive conflict can lead to disagreements and potential damage to relations between the project team and the management team, as often harder and more work is demanded. Such situations are challenged by the project team through substantive conflict with the lower results of previous projects that were conducted under such pressures as supportive argumentation.

Apart from that, the stable relationship between the Integral Project Lead and programme management resolves most challenges and not many other conflicts occur due to the mature and stable nature of the product development team. Moreover, the team has ownership and every issue said to be handled quickly. However, delays do arise from discussions and process conflicts on unclear roles and responsibilities in the team. In one project, such an issue was resolved by the Integral Project Lead by him taking the lead in the initiative to resolve the conflict both with all functions together and with functions separately.

Convincing and on-boarding the management team is another key challenge, personal informal face-to-face contact with them within the organisation seems to resolve business case related conflict as it provides them a timely warning long before the milestone meetings. Limited to no informal contact and communication with the management team like in China are found to result in more misunderstandings, disagreements and potential damage to working relations. Complexity of involving the management team in decision-making relates to its size and equally ranked members. This configuration sets a scene for many discussions and agreements for every project, with the risk of a veto from one of the members.

Other conflicts relate to a not effective Market Introduction Process (MIP) phase of the Idea-to-Market process. Too late delivery of documentation by development occurring often, caused by late development activities that are in turn caused by changing technical requirements due to new insights at a late stage in the development process. Consequences are that the product launch is either delayed or that the customer is not provided with crucial information on how the products should be operated, maintained, or what its precise specifications are.

Conflict Occurrence in Case A & B: Integral Project Leads indicate that conflict occur mostly between Marketing and Development, and between Development (Quality) and Manufacturing, mainly at the verification moments before or at the Project Plan Commitment milestone.

5.2 Conclusion: A Multi-Actor Perspective on Conflict

This chapter answers the following questions:

SQ 2: Which types of conflict occur in new product oriented collaborative decision-making in the new product development process?

SQ 3: Where in the new product development process do conflicts occur?

Types of conflict and their occurrence in new product development:

Case A

- Discussions between functions arise during substantive conflict regarding high demands from Marketing. When kept unsolved, conflicts result in time, technical or cost price related issues later in the process.
- A weak attitude towards in-depth investigation and decision-making within the organisation results in decision iterations throughout the process. This characteristic relates to aversive behaviour towards initiating substantive conflict.
- Deviations in project processes reduce levels of process clarity and understanding and result in process conflict among project team members.
- Late involvement of stakeholders can be defined as process conflict, as not all requirements are met when not all functions are involved in the project.
- Time consuming and costly discussions later in the NPD process seem to originate from little and too much substantive conflict during the Technology & Function Creation (T&FC) predevelopment phase. Resulting in limited certainty on technical feasibility and commercial desirability that arise during decisions later in the process. After the T&FC phase, discussions and conflict arises between Marketing, Development and the rest of the NPD project team.

Case B

- Data driven substantive conflict arises related to the priority setting in project programming and execution with regard to the predefined launch calendar and resource constraints in Development.
- Project delays mostly originate from an insufficient preparation process in scope and stakeholder involvement.
- Differences in mental models and perspectives, and the technology-driven push culture within the organisation lead to substantive conflict between the commercial and technical functions. Project leadership issues arise due to seemingly overlapping roles and responsibilities of the Project Lead and Product Managers (Marketers).
- Predefined procurement process requirements and supplier lead times create conflicting situations which in some cases results in process conflict within project teams.
- Product Management / Marketing deals with the built-in conflict of reaching an agreement on product quantities, price and specifications with the country organisations in the targeted geographic markets.
- Issues arise after the Project Plan Commitment (PPC) milestone until the Product Freeze (PF) milestone. Conditional passing of milestones seems to stimulate their occurrence.
- Substantive conflict is mostly initiated during a Value Engineering workshop just before or after the Project Start (PS) milestone and can arise later in the NPD process. The workshop provides a platform for discussions and substantive conflict and is one of the few occasions where such discussions take place.

Empirical findings on conflict and its occurrence support the notions from prior research that conflict is a natural of the team process. By looking into conflict from both a content and process perspective, specific phenomena have been identified in the arising of conflict. The change towards a market pull approach from a technology push approach that relates to the technical nature of the organisational culture characterises conflict throughout the NPD process. Conflict occurrence has been found to throughout the NPD process with special emphasis on the information and decision convergence phases before key project milestones. With each of the milestones mainly relating to input from a specific function, specific functions tend to encounter conflict at specific phases in the process of which mostly in the first phases of the process. The boundaries of these phases are the Project Start milestone and the Project Plan Commitment milestone. These two milestone form so-called gates in the NPD process and ensure fair and consistent validation of project deliverables that converge towards the full commercial, technical, and operational specifications of a final product.

In this process, process deviations, a lack of clarity in the quality of project severable, and uncertainties that are related to the complexity of the products being developed are emphasised by the key functions of Marketing, Development, Procurement, Operations, and the NPD Integral Project Leads. Moreover, the tight project planning and differences in knowledge and perceptions challenge the collaboration process, which results in both process and substantive conflict. Insufficient preparation and execution of project elements like scope definition and stakeholder involvement have been found to result in late entry of stakeholders into the process, indecisiveness and ongoing discussions due to changes in either the stakeholder field or the commercial or technical specifications.

The parts of the NPD process with the key conflicts are located on the Marketing / Development interface, and the Marketing / Markets interface. At the Marketing / Development interface, conflict arises regarding the translation process of Customer Requirement Specifications (CRS) of Marketing to the more precise Functional Requirement Specifications (FRS). The latter specifications are required for the Development functions to provide an answer to the customer needs and requirements that have been defined in the CRS. And ambiguity or lack of clarity in the CRS causes discussions which hinder project progress.

The substantive conflict on the Marketing / Markets interface relates to the directive that required a handshake agreement on the business case whilst the product is in an immature state. Conflict later in the process arises at the Product Freeze milestone, where the uncertainties about the saleability of the product could arise or long lead times arise due to too late Procurement activities towards suppliers.

Findings suggest that conflict in NPD relates heavily to the open decisions the nature of the process within the organisation. Ill-defined potential concepts, propositions and technologies at the start of the Integrated Product Development (IPD) project, and premature or not complete predevelopment in the preceding Technology & Function Creation (T&FC) phase have been found to increase the workload of the project team. In environments where limited to no uncertainties existed regarding the NPD process and the roles and responsibilities have been found to foster substantive conflict on the project's content. This conflict is aimed at achieving the best answers to issues regarding profitable definition, development, and delivery of customer value at the best possible costs. However, in situations which were characterised by high workload and process conflict related to unclear processes, roles and responsibilities, substantive conflict was found to be limited or more likely to be perceived as personal confrontation than related to the content of the project. Main causes to conflict were found to be sub optimal communication, resource constraints, uncertainties related to the input of other functional counterparts in the process, and uncertainties in priority setting and decision-making by Marketing and the management team. Last but not least, time and task related frustrations towards the Development function have been found to originate from the fear for making mistakes by Development engineers. Other conflict relates to differences in experience and maturity levels of project members, which are likely to result in mistakes.

6. Conflict Management in New Product Development

This chapter will address conflict management approaches in the new product development process, and conclude on these approaches from a multi-actor perspective to answer the following research questions:

SQ 4: How is conflict being managed in new product oriented collaborative decision making in order to safeguard the added value of the new product development process?

6.1 Conflict Management Approaches

This section reflects back on the conflict management approaches that have been identified in theory. In this study, five conflict resolution approaches, illustrated in *Figure 18*, have been selected to reflect upon the empirical findings from a theoretical perspective. The conflict management or resolution approaches have been taken into consideration during the analysis of the empirical conflict management findings and are reflected upon in the following sections of this chapter.

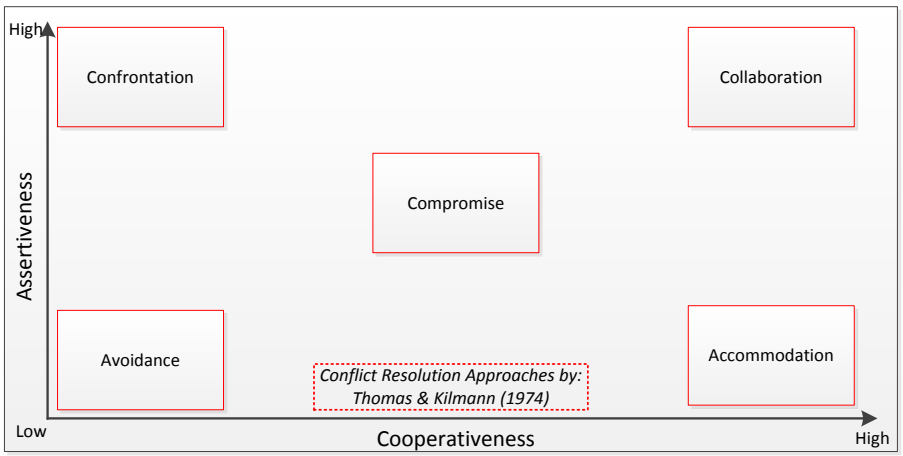

Figure 18: Five Conflict Resolution Approaches.

6.2 Conflict Management in New Product Development

This section addresses the conflict management approaches applied in New Product Development within the two conducted case studies. The research findings are presented following a multi-actor perspective.

The Marketing Perspective

Case A: Marketers from the Consumer Lifestyle business argue that conflict in their business is managed through collaboration and compromise throughout the NPD process and its milestones. Conflict avoidance occurs through conditionally passing milestones when timing and the process are negatively impacted by conflict. Conflict involving the commercial aspects is escalated to the Marketing Director when the project team is unable to resolve it, or when processes are not followed accordingly due to low organisational maturity. Confrontation is applied at such situations towards the responsible Innovation Lead (Development) to come to solution to the issue at hand. The management team is involved in

alignment and communication during team meetings of large projects. Informal contact is used to gain a better understanding and improve relations in order to be able to manage conflict properly and prevent negative effects of conflict from occurring.

Case B: Marketers from the Lighting business state that conflict is managed through collaboration and compromise throughout their process and milestones too. Conflict occurs on delays in the launch calendar, programming or execution, the business case directive regarding the handshake agreement process on volume agreements between Marketing and the Markets, project budget allocation, quality issues, the Procurement ordering moment, and the manufacturing location and capacity.

Conflict with the Markets tends to be resolved by a collaborative dominance from Marketing, through proposals that should fit the needs of the Markets without judging the input on the business case from the Markets.

In conflict resolution, solutions that are proposed early in the process are preferred by the actors. This is possibly because conflicts are then resolved and the actors can refocus on the process, whilst conflicts and decisions tend to stay open in the company, as indicated by several actors when asked about conflict types and their occurrence. However, sometimes agreements cannot be reached within the project team and conflict is escalated to the management team, Development managers, or the Project Management Office. Conflict related to production allocation is reported to the allocation board.

In general, the management team is involved in milestone review meetings of important projects. Smaller and cost down focused projects are decided upon and executed by the project teams themselves through input from Marketing, Quality, Operations, and Development. Sometimes, they are tightly involved, perhaps too much. Their knowledgeability and the indirect communication lines are perceived positively. However, tight involvement is not their job, and can therefore be felt like interference.

The PPC and CR milestones are the more critical, more commitment-driven milestones. With more experience, one gets sharp at Project Start as problems arising at Project Start will most likely lead to problems at later milestones. DfX or Value Engineering workshops reduce the risks for problems later in the process, especially when initiated at the initial phase of a NPD project.

The Development Perspective

Case A: From a Development perspective based on Development engineers from the Consumer Lifestyle business, conflict is managed within the project team to a large extent through collaboration and compromise. This is partly related to the gradually increasing level of decision-making power within the project team over the last years. This approach increases speed of content-related decision-making by reducing the number of stakeholders in decision-making. Conflict tends to occur between the Project Brief until the PPC milestone. However, in situations of high time pressure, issues and conflict tends to be avoided and ignored in order to meet the pre-set launch date. Some potential issues are ignored because they were raised way too early, before the chance of negative effects was clear.

At the beginning of the process after the Project Brief, conflict relates mostly to unclear project briefing, unclear and unmet expectations, and instability in predevelopment activities of 'new to the world' innovations. Later in the process, conflict tends to relate to resource constraints, process immaturity, lack of process knowledge by project members, tooling issues, the factory cost price, capital expenses, quality issues, and delays. Some conflicts are perceived as very educative due to the interesting discussions that arise from them. The quality of discussions relies on the flexibility of people, which is usually a tough one.

Differences in the weight of input of one function over another are perceived as annoying. Quality is one of the functions whose input weighs heavier due to the difficulty in explaining that deviations from the rules and regulations are better, in whatever sense.

Unsolvable conflict within the project team is escalated to the Innovation Lead and Marketing Director which meet regularly with the Integral Project Leads. However, the shared information during these meetings is not always cascaded down to the project team which appreciates being informed on developments related to their project. The higher category management is informed and involved in cases of impactful time and cost issues. Throughout the process, the management team has a big influence on the NPD process at milestones and project related management team innovation meetings.

Different views have been found to exist within the business unit regarding escalation. There is a general belief in the business unit that too few escalations occur. Escalations tend to occur either too early or too late. Some perceive escalation as a positive action to get clarity and a final decision. However, previous escalations have proven to not always being a guaranteed conflict resolution approach. The opposite view is that escalation is not positive to the process and the time and cost efficiency of the process due to the involvement of more actors that need to be informed. This action leads to additional work in the resource constraint process, and adds to the potential risk of individual power struggles and project delays. People holding this view belief that escalations are only to be used when decisions cannot be made fast enough. There is a contradicting general tendency to perceive escalation as negative. This tendency relates to the exposure of potential mistakes through escalation, while people have a 'first time right' mentality that prefers delays to work out issues over issue escalation.

Case B: Development engineers from the Lighting business state that from a Development perspective, conflict is managed through collaboration and compromise. Most conflict relates to the limited clarity between Marketing and Development on product specifications, or the time impact of technical change requests by Marketing. Most issues occur before the PPC and the CR milestones and are solved within the product development team. A large degree of freedom in resolving issues makes it easier and minimises escalations. Management team involvement is generally limited throughout the NPD process, unless a project is strategic or time sensitive. Most issues are escalated from the project team to the system architect of Development and to Marketing, followed by the management team.

The Procurement Perspective

Case A & B: From a Procurement perspective, time or cost price related conflict is managed by the project team and project leader or escalated to either the functional manager or the full management team. Issues related to the business plan or the launch date can arise top-down from the category management to the project team. Usually, conflict creates awareness and ownership to solve the issues within the project team.

The Operations Perspective

Case A: From an Operations perspective, conflict is managed mainly within the project team or is escalated to business group level management when the issue is more severe. Before the PPC milestone, conflict relates to the time, quality and cost triangle being pushed on all sides and is usually resolved within the project team through discussion and decision-making between Marketing, Development and Procurement. After the PPC milestone, conflict is likely to occur related to known issues and likely to impact production, budget, quality or launch timing. At that stage issues endanger strategic decisions and are escalated to business group level management to resolve.

Case B: The Operations perspective from the Lighting business indicates that conflict is managed mainly through collaboration and compromise. Conflict relates to not meeting the planning at the PPC and CR milestones. When escalations are needed, they are put forward to the functional managers, the project manager, or the programme manager. The management team is only involved during the milestones and escalations if they occur.

The Integral Project Lead Perspective

Case A: From a Consumer Lifestyle Integral Project Lead perspective, conflict is managed mainly by the management team and the category lead during information and decision-making meetings. Conflict management is applied to mitigate issues related to delays, resources constraints, and budget overruns. Smaller issues are addressed through collaboration and compromise within the project team.

Case B: Integral Project Leads from the Lighting business indicate that conflict is managed mainly within the project team through collaboration and compromise. The team has ownership of the project, handles issues in the market quickly, and not many conflicts occur. A stable relationship between the Integral Project Lead and Programme Management resolves most challenges. The resource manager organised the configuration of a fixed team over multiple projects for at least one of the NPD teams within the Lighting business, with its core team consisting of industrial engineers, Procurement, and Marketing/Product Management.

Most issues are resolved within the project team, or involve the programme manager if dysfunctional. Management team involvement is project related. Escalations occur mostly before PPC and relate to resource issues, sub optimal processes over multiple projects, the documentation system, communication, priority setting, unclear customer requirement specifications, or manufacturing resource issues.

In some teams, different methods to prevent or resolve conflict are piloted. One of these methods is the Scaled Agile Framework (SAFE), which relies on fixed release trains in the process and heart beats for determining the speed of progress. The implementation of lean in the Idea-to-Market phase creates a more contained development process with lean and agile elements. The integration of Marketing with Development is another approach that reduces the distance. A distinct difference in the initiatives has been noticed. Bottom-up initiatives drive progress, while top down initiatives lead to behavioural change.

6.3 Conclusion: Conflict Management applied in New Product Development

This chapter answers the following question:

SQ 4: How is conflict being managed in new product oriented collaborative decision making in order to safeguard the added value of the new product development process?

Conflict management approaches in new product oriented collaborative decision making:

- Conflict management is applied on different levels within the organisation. It is addressed within a project team at first. Escalation to the project lead, functional management, management team or higher management is chosen for once the substantive conflict is more severe or when conflict relates to the NPD process (Case A&B). From a Procurement perspective, conflict often creates awareness and ownership among project team members to solve issues. Several conflict management approaches have been identified in both cases.
- Collaboration and compromise are the most used approaches to conflict management and resolution throughout the NPD process (Case A&B).
- Conflict avoidance occurs when timing and NPD process are negatively impacted by conflict (Case A).
- Confrontation is applied as a conflict management approach when solutions to conflict are urgently required for further project continuation (Case A).
- In conflict resolution, solutions that are proposed early in the process are preferred by the actors, as conflicts and decisions tend to stay open within the company when conflict is not initiated or not addressed when it occurs (Case B). For example, initiating or addressing conflict in DfX or Value Engineering workshops reduces the risks for problems later in the process, especially when initiated at the initial phase of a NPD project (Case B).
- Stable relationships between stakeholders often provide opportunities for conflict resolution (Case B). Management team involvement is project related and escalations are only chosen in dysfunctional settings (Case A&B).
- Escalation through informal interactions between project team members and management team members provide positive results to conflict management and working relations (Partly in Case A, more in Case B).
- Conflict management is applied through formal and informal escalation to the management team in order to mitigate issues related to delays, resource constraints, and budget overruns. Smaller issues are addressed through collaboration and compromise within the project team (Case A&B). Escalations relate to requirement specifications and technology prior to the PPC milestone (Case A), or to manufacturing and operations after the PPC milestone (Case B).
- However, escalations are not always a guaranteed conflict resolution approach based upon proof from prior experiences within the organisation. General beliefs are both positive and negative. As a positive action to get clarity and a final decision, it is defined as a underutilised approach. Negatively, it is seen as a time, cost, and risk intensive approach during projects by members of the organisation. Escalation also tends to collide with the 'first time right' mentality within Development functions (Case A).
- Accommodation as a conflict management or resolution approach has not been articulated in neither of the case studies. However, this does not mean that the approach is not applicable or not applied in this context. It is likely that accommodation is not articulated due to the relatively low level of assertiveness it is associated with.

The study of conflict management in NPD has revealed a rather straightforward view on and approach to resolving conflict. A majority of the data argues that the misconception about conflict which has been presented in literature applies in this context too. Most cases of substantive conflict, problems and misunderstandings are resolved through collaboration and compromise, while only a minority of the results reflect a positive perception of conflict and a clear articulation of the importance of substantive conflict to collaboration and decision-making in NPD, and overall business performance. Based upon the empirical data from both case studies, this research suggests the addition of the 'Escalation' approach to the model of conflict resolution approaches, as illustrated in *Figure 19*. Based on empirical evidence of both cases across the NPD functions, relatively low levels of assertiveness and cooperativeness have been found in the escalation related situations described by the interviewees of the research sample.

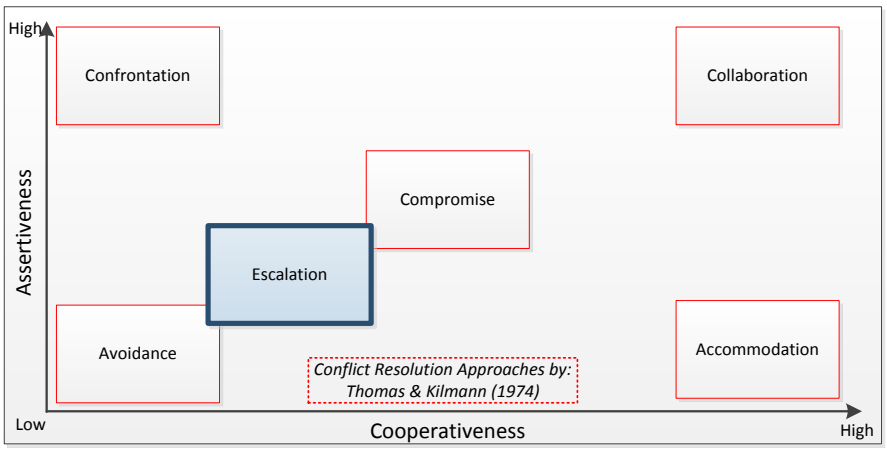

Figure 19: Conflict Management and Resolution Approaches in NPD

Despite these findings, clearly articulated cases of conflict avoidance have been found in cases of process conflict which often occurred at project milestones in one case study. In these cases, conflicts are avoided by ignoring identified and articulated project risks and consequently endangering the projects planning and budget and potentially the product's quality.

Confrontation has been found to be chosen in cases of substantive conflict, and to a lower extent in cases of process conflict, most commonly applied at the Marketing / Development interface were identified and recognised communication barriers exist. Last but not least, the approach of escalation to either the manager within a function or to the management team of the business is often chosen in the studied organisation with the most process conflict and lowest levels of substantive conflict. The reasoning of actions and directions has been found to be very important throughout the organisation. However, it has been clearly articulated in one of the organisations that the actual act of sharing this information is limited and that this is an important improvement aspect that should be improved by the management team of the organisation. Interestingly, high levels of process conflict and substantive conflict are identified in these cases, which might suggest a relation between a lack of information on the reasoning behind decisions and actions on both priorities and strategies of the business, and the occurrence of conflict.

7. Conclusion & Discussion

This chapter concludes on and discusses the research findings in answering the main research question:

'How can conflict be dealt with to sustain a cross-functional collaborative decision-making process towards a committed new product development project plan?'

7.1 Conclusion

This study took an explorative research approach to conflict and conflict management in New Product Development (NPD). Conflict has been argued to be natural phenomenon in NPD and a natural part of the team process. However, misconceptions of conflict being bad give it a negative image. Fortunately, this image is changing gradually through research and own experiences of actors within NPD as both literature and empirical findings have reflected. By looking into conflict from both a content and process perspective, phenomena have been identified in the occurrence of conflict. The research is concluded upon through the ten hypotheses below.

Collaboration characteristics

1) Personal qualities of openness, supportiveness, action orientation and a positive personal style in teamwork influence collaboration and conflict positively. From a process perspective, transparency and openness are key characteristics to collaboration in NPD.
2) Collaborative teamwork is essentially the ability to identify, raise, and resolve issues in ways which integrate different perspectives. The four personal qualities stimulate such teamwork. However, a large physical proximity between team members has been found to affect teamwork negatively.
3) Mutual understanding, constructive, productive and self-corrective characteristics of relationships influence collaboration and conflict positively.
4) Team leadership qualities in situation monitoring, problem diagnosis, solution implementation, providing clarity, supportiveness and motivation to the team influence collaboration and conflict positively.
5) The Design for eXcellence (DfX) methodology enables openness and transparency in cross-functional collaboration. Depending on the planning and execution of the face-to-face DfX workshops, the approach can provide a platform for discussions and the establishment of work relationships among the team members from different functions.
6) Middle management of product development teams influences the collaboration process through proposal review actions at project milestones. In some cases they are informed through informal contact moments with team members, which are likely to improve a project's performance in time and relations.

Conflict and Conflict Management

7) Conflict deals with the misconception of a negative impact. This increases the likelihood of conflict being avoided or ignored.
8) Substantive conflict in collaborative NPD increases the likelihood of good discussions on the substance of NPD projects. Conflict is preferred to arise earlier in the process to minimise or avoid additional discussions from new information and delays due to unforeseen or unchallenged aspects.
9) Conflict is easily escalated to higher management levels when the NPD project team does not have enough decision-power and does not take ownership over its project.

10) The added value of the NPD process can be safeguarded through conflict management in the early stages of the NPD process. The cross-functional DfX workshops provide a potential platform for such interactions. Conflict management awareness during the cross-functional workshops can contribute to safeguarding the added value of the process through moderate substantive conflict.

Additionally, aspects of the organisational configuration have been found to show noticeable differences between the two case studies in the two different businesses. Differences were identified in the level of clarity and maturity of organisational processes, the level of maturity of the product category, the level of granted freedom in decision-making to project teams, and the institutionalised interactions with the management team.

Both entities followed the same process design and project management approach to NPD. A noticeable difference was that early planning of cross-functional workshops in case B had noticeably lower levels of process conflict and higher levels of substantive conflict throughout the NPD process. This indicates that addressing the uncertainties of NPD projects and the NPD process through substantive conflict is likely to increase NPD performance in at least the time dimension. The strong relation between the time and budget dimensions would indicate that budget overruns due to delays are reduced as well, while substantive conflict on the NPD project's content would aim for the best possible and feasible solution by the NPD project team in the scope of the available resources.

The implication of clearly defined processes, milestones, milestone deliverables, roles and responsibilities, and experienced project team members with a technical educational background were found to be positive on the time dimension and relations of NPD actors during the process. Lower levels of the aforementioned elements showed negative effects on the time dimension of the NPD project and increased tensions between the actors.

Findings related to the functional objectives of the functional project team members have identified both a focus on specific process phases by each of the functions, as well as a shared common goal in delivering products that meet customer needs and requirements at the right time, quality and costs. Management team members have been found to be involved in activities related to strategy, programme management, mentoring, improvement initiatives initiation and support, and project milestone deliverable reviews.

The NPD process itself is mainly characterised by the dimensions of Cross-Functional Teams (CFTs), uncertainties that relate to market and customer needs and requirements, technological feasibility, limitations in communication and decision-making, and differences in knowledge, experience and mental model between the actors from the different functions involved in the process.

Conflict has been categorised in two types relevant in NPD: substantive conflict and process conflict. Substantive conflict takes disagreement to the content it related to, while process conflict relates to unclear processes, roles and responsibilities. This differentiation is important as both types have been found in the NPD process.

In the NPD process, the Design for eXcellence (DfX) methodology has been found to be applied in a cross-functional setting, led by the Procurement function. Content-wise, the methodology complied to its description in earlier research. However, it differentiates itself through its process aspect. The DfX convention process with milestone meetings leverages cross-functional perspectives to achieve higher NPD performance in product design and costs, an efficient and effective supply chain, competitive advantages in customer value, and required quality levels.

The five main NPD functions describe the collaboration process in NPD projects mainly as challenging in meeting the targets, time-pressured, complex in the number of involved stakeholder, focussed on the Factory Cost Price (FCP). Escalations to the management team tend to be limited to prevent additional work. Role ambiguity and relatively high turnover rate of marketers and raised risks being ignored are two

remarkable findings that have not been traced to a root cause. Organisational, the limited experience in project teams hinders project performance, an issue which should be addressed.

Conflict has been found to mainly occur on the translation of customer requirement specifications to technical requirement specifications at the interface between Marketing and Development. Process deviations, a lack of clarity in the quality of project severable, and uncertainties that are related to the complexity of the products being developed add up to the causes of conflict between the key functions of Marketing, Development, Procurement, Operations, and the NPD Integral Project Leads. Insufficient preparation and execution of project elements like scope definition and stakeholder involvement have been found to result in late entry of stakeholders into the process, indecisiveness and ongoing discussions due to changes in either the stakeholder field or the commercial or technical specifications.

Findings suggest that conflict in NPD relates heavily to the open decisions the nature of the process within the organisation. The workload of the project team is increased by several problems in the process. The main problems are ill-defined potential concepts, propositions and technologies at the start of the Integrated Product Development (IPD) project. As well as premature or not complete predevelopment in the preceding Technology & Function Creation (T&FC) phase. Overall, tight project planning and high workloads in NPD have been found to affect collaboration, the type of conflict, the way it is dealt with, and the project outcomes. Limitations in knowledge and experience within the project team turn to frustrations. While substantive conflict tends to arise at lower levels due to the extra work it often leads to, while in other cases conflict is ignored for the same reason. A relatively often used approach to conflict has been found to be escalation. Early delays in projects are more likely when conflict is addressed when it arises. If not addressed, conflict tends to arise late in the process with larger consequences in time, budget, and team morale.

Limited to no process conflict has been found to foster substantive conflict on the project's content to achieve the best answers to issues regarding profitable definition, development, and delivery of customer value at the best possible costs. Substantive conflict is found to be less likely under ambiguous processes and time pressures.

Main causes to conflict were found to be sub optimal communication, resource constraints, uncertainties related to the input of other functional counterparts in the process, and uncertainties in priority setting and decision-making by Marketing and the management team. The fear for making mistakes by Development engineers has been found to cause a fair amount of conflict, while left unappreciated by other functions.

Most cases of substantive conflict, problems and misunderstandings are resolved through collaboration and compromise, while only a minority of the results reflect a positive perception of conflict and a clear articulation of the importance of substantive conflict to collaboration and decision-making in NPD, and overall business performance. Despite these findings, clearly articulated cases of conflict avoidance have been found in cases of process conflict which often occurred at project milestones in one case study. In these cases, conflicts are avoided by ignoring identified and articulated project risks and consequently endangering the projects planning and budget and potentially the product's quality. Confrontation has been found to be used for substantive conflict, and barely for process conflict. The Marketing / Development interface hold the most communication barriers and substantive conflicts. The combination of process and substantive conflict has been found to increase the likelihood of conflict escalation to the functional manager or to the management team. Interestingly, high levels of process conflict and substantive conflict are identified in these cases, which might suggest a relation between a lack of information on the reasoning behind decisions and actions on both priorities and strategies of the business, and the occurrence of conflict.

7.2 Discussion

The conducted research has supported prior research findings in the domains of the NPD process, conflict in NPD, and conflict management. Although not all modelled conflict management approaches have been identified empirically, their existence is not questioned.

The academic contribution of this research lays in the domain of conflict management. This research finds escalation to higher management layers as a conflict management approach. This approach involved actors from higher organisational levels, possibly the management team of the business to address issues that could not be resolved within the project team. The implication of this approach is the likelihood of delays if the escalation process is time consuming. Case study B revealed positively perceived frequent informal contact between members of the NPD project team and members of the management team. Among the purposes of this contact is openness in communication between the two groups, sharing of knowledge and experience, and informing about issue and potential risks further the process. This approach has been found to be ideal to address issues in time.

The frequent use of escalation as a conflict management or resolution approach in case A has been found to relate to the limited decision-power within the project team. The NPD team in case B indicated to rarely escalate issues to their managers and management team. They referred to having higher levels of ownership, responsibility, and decision-power within the project team as a reason. Furthermore, an open and friendly atmosphere is thought to stimulate the use of conflict management approaches within the project team and eliminates the need of involving more stakeholders through escalation.

The managerial implications of this research relate to understanding the process. It is recommended for project leaders and managers to address issues in communication. Furthermore, they should address the lack of clarity in the NPD process when such indications arise. Moreover, transparency in the roles, and tasks of functional counterparts could improve the collaborative process and stimulate substantive conflict. Another frequently mentioned suggestion is the need of the Development and Procurement functions among the NPD project team members others to be informed about the reasoning behind commercial and technical priorities and strategic choices. Moreover, all NPD functions would like to receive timely indications of changes in both aspects to be able to anticipate on these changes.

The main implications are that cross-functional workshops early in the process, as observed in one of the case studies, has far reaching implications on relations between NPD actors, and NPD performance in at least the time dimension. Implementing cross-function workshops in the beginning of NPD project will likely stimulate the establishment of trust early in the process and will likely clarify and align most perspectives and interests of the different functions early in the process; two elements that closely relate to the stimulation of collaboration among the project team. Furthermore, the impact on collaboration of such cross-functional settings is likely to create a common ground for substantive conflict among the team members.

Potentially, process conflicts can be addressed early to minimise their impact on the NPD process rather than having to address their implications late in the process at the cost of delays. Cross-functional collaboration and decision-making with substantive conflict has shown that the number of problems after the crucial project plan commitment milestone is limited. Moreover, the early involvement of Manufacturing and Operations in the process is likely to mitigate earlier identified problems and risks that might occur in the execution stages of the NPD process towards the commercial release and product launch milestones of NPD projects. Addressing these issues early in the process will likely save time and money compared to situations where issues are identified and addressed late in the process.

8. Reflection, Research Limitations & Recommendations for future Research

Reflection

This research has explored the domains of collaboration, conflict and conflict management in New Product Development (NPD). An extensive pre-research period within the research hosting organisation opened the easy possibility of contacting a large group of people within the organisation to form the research sample, both for preliminary interviews during the research scope definition phase, as well as during the data collection phase of the research. Literature review proofed to be a never ending activity, as certain knowledge gaps have stimulated the mind to look for answers in literature. The relatively late narrowing down of the research scope, has led to a larger and broader understanding of the functioning of the NPD process and the challenges faced by especially high technology organisations. Due to the scope of this research, valuable information on the domain of NPD has been left out of this document. An underestimated phase of the research was the data analysis phase. Due to the large sample size and the extensive amount of gathered data, the structuring, analysis and interpretation proofed to be far more time consuming than planned and expected. The writing of the research findings proofed to be a personal growth path in which different dimensions come together and the implications of these phenomena are reflected upon on a far more intellectual level than ever expected. This process showed the value of the process besides the outcome of this master thesis research.

Research Limitations & Recommendations for future research

The scope of this research was limited to the face-to-face collaboration process of new product development for electronic products for the consumer or professional market in the context of Western-Europe. This geographical and cultural scope may limit the findings of this research. Future research can focus on collaboration, conflict and conflict management in other geographical regions like Northern, Eastern, and Southern Europe, North-America, South-America, Asia, and Africa. Studies in other parts of the world may result in findings that deviate from the findings in this research. Possible reasons can be based on the way individuals communicate and collaborate with each other, and differing hierarchical influences among other factors. The limitations of this research provide opportunities for future research for both academic and applied research.

The moderating effects of Information and Communication Technology (ICT) in conflict management form one of the topics for future research. With the rapid pace of technological advances in ICT, such technology may have interesting effects on collaboration forms and performance in NPD. Moreover, ICT could make processes more time and cost efficient, depending on the conditions.

Although this research addressed elements in the domains of NPD, conflict and conflict management, this research left a number of topics open for future research:

- The effects of different styles of collaboration on NPD performance and relations between NPD stakeholders.
- The relation between the collaborative elements and conflict resolution approaches from theory.
- The effects of decision-making styles and the implications of the decision-making styles.
- The influence of the number of involved stakeholders on the outcome of the process, following several statements by NPD actors on too large teams and too complex stakeholder fields in NPD.

- The effects and implications of conflict management training on NPD performance and collaborative behaviour
- The effects and implications of granting project teams more decision-power on NPD performance and collaborative behaviour.
- Regarding the level of innovation and the level of uncertainties related to it, research could generate valuable insights on the effects and implications of process flexibility. Especially the effects and implications for 'new to the world' innovation projects on NPD performance and collaborative behaviour. These insights can then be used to improve the NPD process and conflict management.
- The common NPD improvement suggestion of Key Performance Indicators (KPIs). Future research is suggested to study the effects and implications of shared functional requirements and challenges on NPD performance and behaviour.

These research limitations are among the recommendation for further research in this domain. Additional reflections and recommendations below relate to the Design for eXcellence (DfX) methodology.

Reflection on DfX as a context and tool

In both theory and practice, the DfX methodology has been found to combine several perspectives. Sequentially, it brings together people or parties with different expertise and viewpoints. In this study, the methodology was mainly used as a context in which NPD teams took part in cross-functional collaboration and decision-making workshops during NPD projects. Despite this inclusion of the methodology in this study, the methodology has been found to serve as both a tool and a process within the organisation that hosted this research. The DfX programme within the organisation includes several analysis tools that provide NPD teams a format and guidance for data analysis regarding their decision-making. Furthermore, the DfX programme defines a process through which teams can collaborate, analyse relevant data, and make data-driven decision based upon its conclusions.

Experience-based opinions about the DfX tools and process are predominantly positive among the interview sample. Specific tools that brought different functions and insights together to clarify relations between certain influencing factors on a product or supply chain level were perceived as very valuable for collaboration and decision-making. Moreover, the standardised approach to the DfX process of tool-based workshops and review and decision milestones with management involvement was perceived positively as well. A general remark among the interview sample is that the sooner the workshops and DfX process takes place, the better for the collaboration process, decision-making reliability, and project outcome. This is reflected by comments from case A that the DfX process and several DfX workshops should have been held at earlier stages of the NPD process. While in case B it was emphasised that DfX or the shorter Value Engineering process was successfully implemented to start in the initial phase of NPD projects. This approach in case B led to earlier collaboration, data gathering and analysis and earlier conflict management.

Differences in the conditions, implementation, and execution maturity of the DfX process between the two case studies are left unexplained in this study due to its scope. However, future research is recommended to explore DfX, as a whole as both a tool and a process or its separate tool or process elements. Suggestions for future research include the identification of performance influencing factors and their impact on the DfX process, collaboration dynamics between the NPD functions, and the NPD project outcome. Other future research can focus on the operational applicability of DfX as a conflict management vehicle in NPD, and the identification of leading factors in the integration of cross-functional initiatives into the regular way of working. Furthermore, the definition and creation of a proper process design towards integration is suggested as a future research topic. For practitioners, it could be interesting to investigate the effects of conflict management training and its implications to NPD performance, and the explicit mentioning and implementation of teamwork characteristics in each project team. Team leaders can use these methods to gain organisational learnings out of these behaviours.

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10. Appendix

Appendix 1: Interview Overview

This appendix contains an anonymised overview of the interviewees that have provided their knowledge and experience within the research domains.

Case A	Function
A-IPL1	Integral Project Lead, Innovation Project Management
A-P4	Strategic Buyer Finished Goods
A-D3	Industrial Cost Engineer, Innovation
A-IPL5	Integral Project Lead, Innovation Project Management
A-IPL5+	Integral Project Lead, Innovation Project Management
A-P5	Procurement Engineer, Procurement Engineering
A-D5	Group Lead Project Management, Product Development
A-M5	Senior Manager Consumer Marketing
A-D6	Group Lead Architecture & Function Development
A-D7	Product Research Group Lead, Product Research Centre
A-D8	Group Lead Product Development
A-M8	Senior Director Consumer Marketing
A-P1	Procurement Engineering Business Partner
A-M1	Senior Manager Consumer Marketing
A-O1	New Product Introduction Lead, Operations Advanced Manufacturing

Case B	Function
B-D2	Development Quality Leader, Quality Lighting
B-D4	Sr. Electronic Engineer
B-M4	Product & Marketing Management
B-M6	Product Management
B-O3	Industrial Project Leader, Lean Operations Support
B-M7	Product & Marketing Management
B-D9	Global System Architect, R&D
B-P2	Procurement Engineer, Procurement Engineering
B-IPL3	Quality Project Leader, Validation - Development Quality
B-IPL2	Integral Project Manager

Appendix 2: Interview Questions

This appendix presents the interview questions of the preliminary interviews and the data collection interviews as referred to in Chapter 3.8: Interview questions.

Interview Questions Exploratory Interview Round

1. What is your job title?
2. Which of the following function groups do you belong to?
   Marketing | Procurement | Development | Other:..
3. Can you explain the key objective(s) of your job?
4. What are the main recurring or most impactful challenges that you face in your day-to-day work?
5. Can you explain in a few words which elements add complexity to your work?
6. What are your views on the potential of Cross-Functional Collaboration in New Product Development?
7. To what extent do you believe that the complexity in your work relates to cross-functional collaboration?
8. Can you elaborate on the key challenges you face in cross-functional collaboration?
9. During which phase(s) of the New Product Development process do you experience these challenges?
   a. If you experience challenges or bottlenecks in cross-functional collaboration, what do the most frequent issues relate to?
   b. If you experience challenges or bottlenecks in cross-functional collaboration, what do the most impactful issues relate to?
10. Cross-Functional Collaboration involved multiple functions. Can you share your views on how you think other functions perceive the collaborative process? I.e. the challenges they face in collaborating with you among other functions.
11. Which key aspects would you name to be crucial from your own knowledge and experience on how to further improve performance in cross-functional collaboration?

Interview Questions Empirical Research

Function

1. What is your job title?
2. Which of the following function groups do you belong to?
   Marketing | Procurement | Research & Development | Operations | Other:
3. Can you explain the key objective(s) of your job?
4. Which characteristics define the collaboration and decision making process in new product development projects from your knowledge and experience in your current role and previous experiences?
5. Can you share the main recurring or most impactful challenges in collaboration that you face in a New Product Development project?
6. Can you share the main recurring or most impactful challenges in decision making that you face in a New Product Development project?
7. Have you experienced a Design for X convention in your current or previous role?
   a. How you experienced the influence of the Design for X approach on the collaboration and decision making process of NPD?

Conflict

8. Can you share which kinds of conflict you encounter during the collaboration and decision making process of NPD projects?
   a. Between which functions do they occur (most)?
   b. Where in the NPD process do they occur?
   c. How do they impact the outcome of the NPD process?
9. What kind of conflict is usually escalated?
   a. To which milestone or deliverable do they relate?
   b. To whom are they escalated?

Management

10. How would you describe the influence and involvement of senior management in NPD collaboration and decision-making?

Multi-Actor Perspective

11. Cross-Functional Collaboration involved multiple functions. Can you share your views on how you think other functions perceive the collaborative process? I.e. the challenges they face in collaborating with other functions.

Improvement

12. Which key aspects would you name to be crucial from your own knowledge and experience on how to further improve performance in cross-functional collaboration?

13. Do you have a question you would like to ask regarding the NPD process or an issue you would like to see clarified?

Appendix 3: Additional Collaboration Theory

This appendix elaborates the dimensions for good collaboration, as referred to in section 2.2.3: Group Collaboration.

Burkhardt et al. (2009) group good collaboration descriptively along four dimensions; 1) Communication processes; 2) Task-related processes; 3) Coordination processes; and 4) Motivational processes. These dimensions will be elaborated below.

1) Communication Processes

Communication processes help to ensure that a common referential is established within a group of collaborators. Clark and Brennan (1991) as cited in (Burkhardt et al., 2009) argue that establishing common ground is a collaborative process in which co-designers mutually establish what they know in order to proceed with the design activities. This activity of grounding is connected to information sharing through the representation of the environment, the artefact, the dialog and pre-existing shared knowledge. Inter-comprehension and the construction of compatible or shared representations the content's current state is ensured through this activity. The content includes the problem, plans, solutions, design rules and general design knowledge.

The grounding activity was found to ensure good design despite its time-consuming nature in collaboration design studies by D'Astous et al. (2004); Olson and Olson (1992); Stempfle and Badke-Schaub (2002) as cited in (Burkhardt et al., 2009). The latter study argues that skipping the analysis or grounding activity by teams resulted in premature evaluation of design ideas. Furthermore, mutual understanding is allowed through a shared local context, and has been found to be affected in collaboration at distance through communication media Clark and Brennan (1991) as cited in (Burkhardt et al., 2009).

2) Task Processes

Processes that are task related relate to design and evaluation activities of a design problem and solution (Burkhardt et al., 2009). The design activities include elaboration, solution enhancement and alternative solution enhancement, while evaluation activities are characterised by the criteria-based evaluation of solution and alternative solutions. Both design and evaluation activities are supported by content-oriented mechanisms of argumentation and negotiation which reveal the task resolution approach of groups. This is done by sharing and elaborating knowledge on the design artefact, by confronting various perspectives, and by converging towards negotiated solutions (Burkhardt et al., 2009). Pahl et al. (1999) as cited by (Burkhardt et al., 2009) argue that these mechanisms play an important role in the quality of design products. However, Stempfle and Badke-Schaub (2002) as cited in (Burkhardt et al., 2009) argue that the solution search might be limited by a number of factors:

- an early solution choice without alternatives exploration,
- rapid solution evaluation based on a limited number of criteria,
- difficulties in taking all the criteria and inter-dependencies into account, also known as constraint management.

3) Group Management Processes

Identified group management activities in collaboration concern two types of process-oriented coordination mechanisms that ensure the management of task interdependencies of tightly coupled tasks (Herbsleb and Mockus, 2003) as cited in (Burkhardt et al., 2009). These activities are:

- Project management and coordination activities, including task allocation and planning
- Meeting management activities, of for example ordering and postponement of topics in meetings

4) Cooperative Orientation and Motivation

Cooperative orientation and motivation have been found to be important aspects of collaboration in design collaboration process research by Barcellini et al. (2008) as cited in (Burkhardt et al., 2009). These results have been found by considering the role of participants in communication, the management of groups and tasks, and the use of the balance between these two roles as an indicator of collaboration.

Baker (2002) and Dillenbourg (1999) as cited in (Burkhardt et al., 2009) support this further by arguing that the quality of collaboration is linked to the symmetry of interaction, at least in small groups of learners.

Subsequently, the assessment of collaboration quality has been structured in the Spada rating scheme by Spada et al. (2005); Meier et al. (2007); Voyiatzaki et al. (2008) as cited in (Burkhardt et al., 2009). This scheme concerns the following nine qualitatively defined dimensions, covering five aspects of collaboration processes listed in *Table 8*.

Table 8: Collaboration Aspects and Dimensions of the Spada Rating Scheme

COLLABORATION ASPECTS	DIMENSIONS
COMMUNICATION	Sustaining mutual understanding, dialogue management
JOINT INFORMATION PROCESSING	Information pooling, reaching consensus
COORDINATION	Task division, time management, technical coordination
INTERPERSONAL RELATIONSHIP	Reciprocal interaction
MOTIVATION	Individual task orientation

These aspects have been found to be central to the success of collaboration under conditions that are mediated by video communication and complementary expertise in a literature review by Voyiatzaki et al. (2008) as cited in (Burkhardt et al., 2009). A limitation to the Spada rating scheme has been found to be the under specification of collaboration assessment indicators, resulting in subjective assessment without traceability to the original data of quantifiable events (Burkhardt et al., 2009).

Appendix 4: Performance Improvement Suggestions for Team Leaders

This appendix elaborates performance improvement suggestions for team leaders, diversity and cross-functional teams, and collaboration interventions, as referred to in section 2.2.3: Group Collaboration.

Performance, the requirement of results, is broken down into four elements; 1) Objectives, 2) Collaboration style, 3) Management style, and 4) Personal development. these elements relate respectively to the team goal, how to achieve the goal, the management of resources, and personal and professional development. More specifically, LaFasto & Larson (2001) suggest four activities for teams that can improve their performance:

1) Describe the team goal in a tangible and concrete outcome.
2) Describe the mental, physical, and spiritual energies that team members should apply to the goal.
3) Identify energy drains from the goal, especially when it interferes with the goal. I.e. a con-collaborative team member, relationship conflict, and organisational politics.
4) Define what might help the team to refocus on the goal.

Likewise, Parker (2002) suggests to make goals specific, to base them on a defined problem, and to integrate team goals into departmental goals, including interests of senior management sponsorship. For team leaders, the six dimensions of *Table 9* for effectiveness are prescribed (LaFasto & Larson, 2001).

Table 9: Dimensions of Effectiveness and its Elements, derived from (LaFasto & Larson, 2001).

DIMENSIONS OF EFFECTIVENESS	ELEMENTS
FOCUS ON THE GOAL	Emphasis on the difficulty of achieving the goal alone, without team effort.
ENSURE A COLLABORATIVE CLIMATE	Emphasis on goal relevance, individual and team accountability, synchronisation of objectives, open and clear communication, and no politics.
BUILD CONFIDENCE	Involvement of all relevant individuals with responsibility, create and explain a stable mission.
DEMONSTRATE SUFFICIENT TECHNICAL KNOW-HOW	Emphasis on the ability to listen, learn, understand and question things.
SET PRIORITIES	Emphasis on focus, goal related trade-offs and resource utilisation in time, money and energy.
MANAGE PERFORMANCE	Emphasis on direct handling of deviation and challenging underperformance. Use of 3R's of performance management: Require results, review results, and reward results.

Diversity and Cross-Functional Teams

The establishment of effective collaboration and problem solving in a setting characterised by diversity in functions, backgrounds and perspectives relies on diversity management within organisation. Often caused by misconceptions and prejudices, diversity problems tend to result in communication and group process problems (Levi, 2007). Power conflicts and competition are two other main characteristics of diversity. The main focus of diversity programmes has been found to focus on three elements:

1) **Increasing awareness**
   Mainly done through training programmes (Battaglia, 1992) as cited in (Levi, 2007), although such training can backfire because of heightened emotional tension leading to personal attacks (Gardenswartz & Rowe, 1994) as cited in (Levi, 2007). The purpose of awareness training should be the development of informal social contacts and friendships across demographic boundaries. These then develop into relationships that reduce misperceptions, improve understanding of differences, and promote trust (Levi, 2007). Emphasis on similarities, unique contributions, and the development of a team culture bridge the differences among team members (Mannix & Klimoski, 2005) as cited in (Levi, 2007).

2) **Improving skills**
   Stereotypes and distrust often result in miscommunication. People's interpersonal skills are improved by skills-based diversity training programmes which focus on the appreciation of unique contributions of others (Battaglia, 1992) as cited in (Levi, 2007). The development of committed agreements on the team's purpose, roles, norms, and procedures has been found to improve intra-team communication and its diversity relations (Armstrong & Cole, 1995) as cited in (Levi, 2007). Issues in open communication are suggested to be addressed by the team leader through structured communication procedures and encouragement of face-to-face interactions. One of the pitfalls of this approach is the tendency of teams to focus on shared information and commonalities instead of unique contributions of individuals (Mannix & Klimoski, 2005) as cited in (Levi, 2007). Unique individual contributions have been found to arise under the conditions of a climate of open communication, promoting trust and supporting members in sharing their unique contributions.

3) **Improving organisational issues**
   Organisational issues can be addressed through diversity management by breaking down social boundaries between people and equalise power within the team (Nkomo, 1995) as cited in (Levi, 2007). One approach to equalise power and participation among team members is through structured communication, including superordinate goals and strong collective team identities (Van der Vegt & Bunderson, 2005) as cited in (Levi, 2007). Such conditions of team identity increase the willingness of team members to share ideas and pay attention to ideas of others. Another approach is to structure teamwork to require high levels of interdependence that requires coordination and interaction (Harrison et al., 2002) as cited in (Levi, 2007).

Collaboration Intervention

Three stages have been identified in literature on interventions by facilitators of face-to-face collaboration (Westley and Waters, 1988) as cited in (Knoll & Lukosch, 2014). These interventions can be performed to help the group of collaborators in solving the problem at hand in the collaboration context.

1) **Stage 1: to recognize symptoms of a process problem**
   A process that is characterised by behavioural analysis of individual group members through the analysis of contributions, body language or group interaction.
2) **Stage 2: to interpret the syndromes**
   Knowledge on group behaviour and group dynamics theories is required for the facilitator to identify underlying patterns of given syndromes. Listed generic problem syndromes can support the facilitator during the process of pattern identification.
3) **Stage 3: to make an intervention**
   A choice between action and interpretation interventions has to be made by a facilitator that needs to deal with a process problem. Action interventions directly manipulate the process of collaboration through for example a group constellation change when expert knowledge is required, or the prevention of interruptions of individual members. Interpretation intervention can be used by a facilitator to communicate observed patterns to the group in order to increase awareness and to help the group to solve the problem on its own.

Following collaboration process performance monitoring, interventions to those processes can be defined to steer them. These interventions can defined following for example the 'Event-Condition-Action' (ECA) rules of Goh et al. (2001) as cited in (Knoll & Lukosch, 2014). These rules prescribe the actions that can be taken when certain conditions are met during an event. In this context, these three concepts are defined specifically;

- an event is defined as a concept which specifies the situation in which a rule could be used to coordinate possible situation-related interventions.
- A condition is defined as a concept of a logical test that causes the execution of an action if it is satisfied or evaluated as true. The condition can be expressed through logical operations. In interventions, a condition combines the intervention stages of recognition and interpretation of symptoms of a process problem.
- An action is defined as a concept of a change or update in a collaboration process. Action can support it through adaptation through action intervention or by providing individual group members with awareness information through interpretation intervention.

When looking into the context of interventions, Niederman et al. (2008) identified four different levels of context-sensitive interventions *Table 10*.

Table 10: Levels of Context-Sensitive Interventions

Design Level	Guiding individual group members in the choice of appropriate tools, techniques and participants in structuring an effective collaboration process for achieving the intended goal.
Execution Level	Guiding a group step-by-step through the collaboration process and adapting the workflow when needed.
Activity Level	Analysing the activity structure of a collaboration process and providing support to the adaptation of these activities in order to stimulate effective, efficient and rigorous problem solving.
Behaviour Level	Stimulating positive and preventing negative group behaviours through its focus on group behaviour.

The ECA rule can be applied in context-sensitive intervention design for the social loafing theory (Diehl and Stroebe, 1991) as cited in (Knoll & Lukosch, 2014). Social loafing theory concerns the tendency of participants to contribute less effort when their contributions are thought to be not needed for group

success. An effect which increases which the increase of the group size, and can be reduced by the belief of individual evaluation of participants rather than the collective group. This effect in groups can be monitored by the number of contributions or the time between contributions as indicators and the effect can be reduced through a group size reduction (Diehl and Stroebe, 1991) as cited in (Knoll & Lukosch, 2014).

Appendix 5: Design Challenge Model

This appendix offers the design challenge model of (Kolfschoten & Vreede, 2007) with relation to the challenges of collaboration, referred to in Chapter 2.4.2: Conflict Definition and Conflict Types.

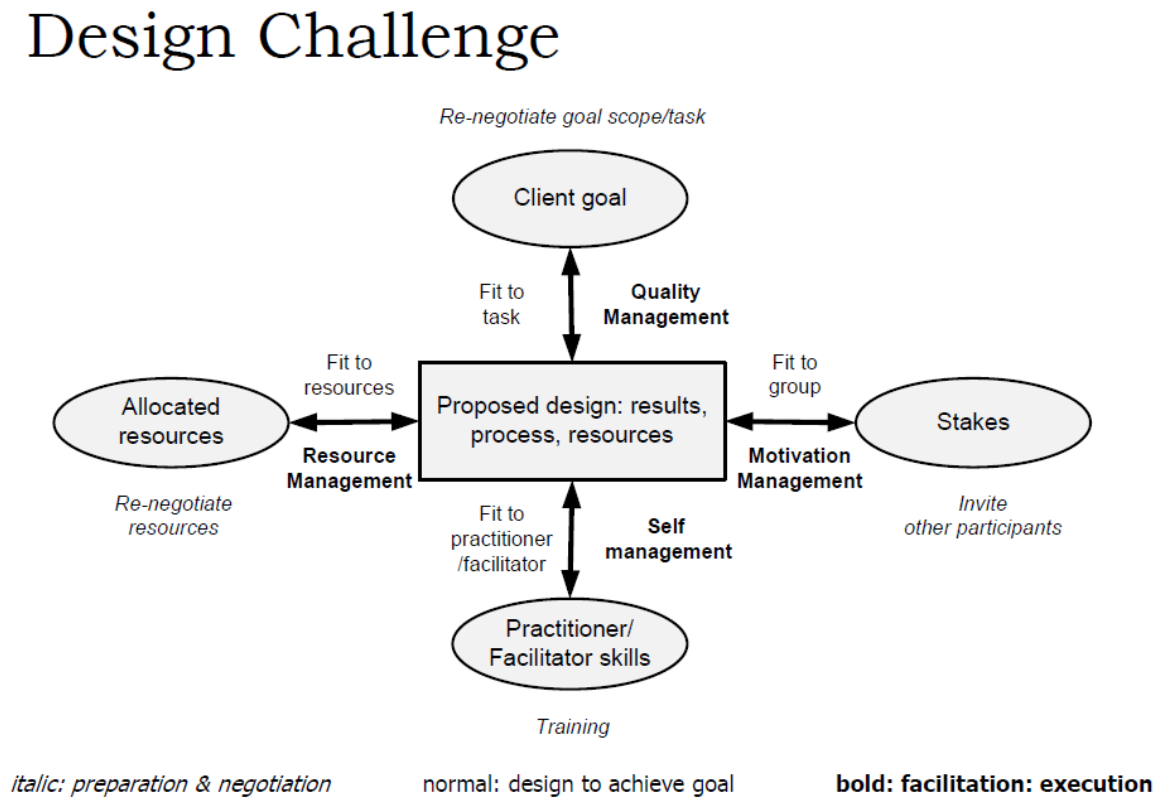

Figure 20: Design Challenge, derived from (Kolfschoten & Vreede, 2007)

Appendix 6: Major Marketing / Manufacturing Interface Conflict Areas

This appendix offers an overview of the major conflict areas at the Marketing / Manufacturing interface referred to in Chapter 2.7.3: Differing Interests of Actors in New Product Development.

Table 11: A typology of conflict areas between Marketing and Manufacturing (Crittenden et al., 1993)

Area of conflict	**Marketing Objective**	**Manufacturing Objective**
Managing diversity		
1) Product line length / breadth	Many and complex models	Few and simple models
2) Product customisation	Customer specifications	'Stock' products
3) Product line changes	Product changes immediately, high risk	Planned, only necessary changes, low risk
Managing conformity		
4) Product scheduling	Constant changes	Inflexible
5) Capacity/facility planning	Accept all orders	Critically evaluate 'fit' of order
Managing dependability		
6) Delivery	Immediate; large inventory	As soon as possible; no inventory
7) Quality control	High standards	Reasonable control

Appendix 7: Workshop Observations

This appendix presents the workshops observations of the participatory observations during DfX and Value Engineering workshops in a cross-functional setting during New Product Development projects, referred to in Chapter 3.9: Workshop observations.

Lighting Value Engineering Workshop Observation 14-4-2015

Second workshop session

- All disciplines present, all viewpoints in the workshop
- Several expertise levels, but levelled by a preceding workshop
- Open discussion

Structure

1) Product Marketing input
   Explaining trends and why product and portfolio decisions are chosen.
   Miniaturization trend within Lighting to make products and design simpler
2) Technical Project Lead
   Explaining the technical
3) Project Lead
   Remark: Perfect Start, Value Engineering, Early Project Start have increased the performance of projects a lot.

Observations

- Pleasant, open, and safe environment facilitated by the host
- The facilitator emphasizes respect for the individual preferences of participants.
- Questions asked among individuals
- Challenging questions asked from Development to Marketing on certain product specifications, in comparison of own and competitor products during a product benchmark session.

■ Day 2:

- **Positive, energetic atmosphere**
- Factory input shared, questions asked by other functions.
- Technical discussions are attended by the commercial product manager but not involved into them.
- In discussion, the electrical engineer asked manufacturing about potential issues in production.
- Positive reactions to miscommunicated information, which was corrected shortly after.
- Engineering related discussions took place with a large portion of agreements between the project lead, development, and procurement. They discussed and prepared several proposals to be presented towards marketing when the product manager re-joins the meeting.
- Additional experts are invited to the workshop to gain new insights.

Conflict types

Substantive

- Development engineers challenging the product manager and system architect on alternative approaches which competitors have applied in the product.
- Development challenging Manufacturing engineers on different ways of component placement in manufacturing
- Global System Architect and product manager compared product specifications

Process

- The structure and process of the workshop was clarified at the start, with the remark that open discussion, remarks are welcome.

Case Description

The workshop was well prepared by all participants. That showed through the presence of relevant data when certain data was requested by a participant during the workshop. The workshop was characterized by discussions between development and marketing, backed by the system architect, which is the technical conscious with the unit. And by discussions between development and manufacturing on the options and alternatives of design and the consequences of choices in manufacturing and vice versa.

The cost price focus of development during their current product design stage challenged the product manager's portfolio product propositions. After challenging some features stated as requirements by marketing, and their answer of no change being possible, a business case was drafted to proof towards marketing that a new technical approach is profitable. One feature that is redundant in this product category but marked as mandatory for all future products could not be removed from the feature list. However, the business case showed possible economies of scale which could dissolve the cost addition of that extra feature.

Changing the product's design now towards a new currently expected to be low volume product, is suggested to make additional investments redundant. Moreover, this new product is a potential future market standard, which will sell in low volumes but at a premium price point.

The involvement and challenging of manufacturing by development led to interesting suggestions for further action that seem to have the potential of lowering product and production costs in the new design. Cost savings are deemed to be possible by choosing more expensive components that would require less handling steps in the production process, and increase the output potential.

With the system architect as the technical conscious present among other functions involved in the product development, marketing, and manufacturing process, the workshop proofed to be a platform to raise suggestions and ideas of any kind that could be perceived as slightly to radically different.

The workshop became powerful by the push from development towards marketing to fully choose a design product that is likely to become the market standard in a few years. Despite the initial investment and low volumes, and current price premium due to its novelty in the market place, choosing to produce that product at high volumes might unlock economies of scale and a certain level of future proof investments. Marketing's worry is an earlier than necessary endangerment of the price premium it can ask, by removing the current common high volume product for the new product.

After the workshop, the participants remarked the fruitfulness of the session, as it brought them the opportunity to raise suggestions related to any aspect of the product, possibly challenging other functions by doing so, gaining insights from other participants, make decisions and agree upon follow up actions.

The workshop was reflected upon positively. No participants were missing. Follow up meetings and actions have been scheduled to address topics that require more insights and data.

Functional interface conflict

- **Marketing versus Development**
- Development Engineer focusing on the cost price for a competitive cost position
- Marketing arguing for including market standards, unique selling points and differentiation, and repair actions.
- Proposes several differentiating features to be included in the product
- Development challenges marketing and the system architect on features that have been found to lack customer value, but are part of a soon to be market standard feature.
  Is it possible to exclude parts of the full feature in which customers are not interested in
  The system architect mediates the discussion between the Technical Project Lead and the product manager.
- "we are not the best in setting standards" – Technical Project Lead – Development
- Development, proposes jokingly about the alternatives. Development argues for several studied alternatives.
- Marketing's response is slightly emotional, related to a potential safety issue introduced by the proposed alternative by development. This is caused by the proposal for a non-standard design solution.
- The technical Project Lead illustrates the proposal on the board, and challenges the system architect on the design feasibility. The system architect is not sure about the it.
- The Project Leader takes initiative to conclude on the discussion between the technical project lead, system architect and the product manager
- Marketing agrees to a consensus agreement only if the system architect ensures the feasibility and safety of the proposed solution. Due to the uncertainty by the system architect, the product manager continues the discussion with the system architect.
- System architect proposes to further investigate as a follow up action.
- Development asks the system architect and product manager to ensure the requirements to either get the mark of the market standard or to follow the market standard.
- Product manager concludes that he does not understand the technical illustration by the technical project lead. **Communication barrier.** The system architect does not follow as well. Too long question.

Participants

- Development: Sr. Electronic Engineer
- Development: Sr. Electronic Engineer
- Development: Quality Project Leader, Validation Engineering
- Development: (Project) Assistant Engineer, Electronics NPI Project
- Development: Product Development Engineer, Electronics Development
- Development: Global System Architect, R&D
- Marketing / Product Management: Product & Marketing Management
- Pprocurement: Procurement Engineer
- Procurement: Procurement Engineer
- Integral Project Manager, Project Office
- Project Manager, Electronics NPI Project

Additional not case-related Observations Value Engineering Workshop Session Consumer Lifestyle 21-23-4-2015

Progress over three days of Value Engineering

Day 1:

The beginning of the Value Engineering workshop felt very formal. After a short personal introduction, the participants showed a reserved attitude towards each other and the workshop. The purpose of the Value Engineering workshop was clear to most of the participants upfront. When asked for their goals and expectations, most candidates stated the identification of opportunities for further product or supply chain optimization that result in overall cost savings*. The common goals and expectations were perceived positively by the participants.

The introduction session was followed by a presentation which included the planning of the workshop over the three days, and a general introduction into the purpose of the workshop and the to-be-applied Value Engineering methodology. During the introduction, the workshop facilitator was challenged by one person on the reason of the Value Engineering session. The person relates the session to previous projects and improvement initiatives that made more sense, as this workshop was planned at a time where most decisions for the project of the workshop participants were already taken. The confrontation was answered by the facilitator through an explanation of the added value of the workshop as a learning exercise for current and future project. The answer was satisfying.

The introductory session was continued with a presentation from the marketing representative explaining the product portfolio that would be analysed during the workshop sessions. During this presentation, the marketing representative was confronted by the supply chain representative on a number of listed product variants for specific countries that added complexity in the supply chain that possibly would not be necessary. The Marketing / Operations interface seemed to be the most likely to experience confrontation as marketing seems unaware of the complexity of the product portfolio in the deployed number of Stock Keeping Units (SKUs). A Stock Keeping Unit is an identification code for a specific product or service. The operations representative explained that a product portfolio overview of just a handful of products, presented by marketing as the entire portfolio, tends to result in a tenfold of localized variants for specific regions, countries, and retailers. It is likely that such variants end up in a so-called long-tale or C-tale; products which are less popular, low volume products. These products are opposed to the high volume selling (A category) products, and the slightly less popular (B category) of products. Through discussions between marketing and operations, the awareness of a high number of SKUs arose. The discussions within the project team concentrate to both commercial requirements and suitable technical solutions. Commercially, the discussion concentrates on meeting the requirements of the different country organizations. From a technical point of view, the discussions concentrate around changes to the product architecture and components in order to identify cost saving opportunities. The cost saving opportunities are focused on in order to be able to deliver a competitive value proposition to the different regions, countries, and retailers.

After the introductory and theoretical parts, the participants were split into two different groups. The participants with a technical background and a technical function were involved in the technical analysis of the product through reverse engineering, also known as a product teardown. During this session, several own and competitor products were disassembled from complete products to the components they are made out of. Doing so, the participants gained insights in the chosen technical solutions to deliver parts of the functionality of each of the products. By gaining insights across a range of products designed and manufactured by different companies, the engineers are enabled to analyze technical solutions and compare them between competing products to learn which solutions work best, and which solutions could be applied in the development of new products. In the scope of this workshop, the findings and learnings are intended for optimizing the margin of the selected product by reducing the costs related to

its production and supply chain. In order to reach such goals, both the technical and commercial characteristics of a product are taken into account. The second group was assigned to analyze the commercial aspects of the product by analyzing the product benefits and visualizing them in a comparison between the existing own products, products of direct competitors, and the proposed value proposition for the newly designed and developed product handled by the project team.

While the technically oriented team had little difficulties in taking apart, and analyzing the components of own products and those of competitors, the commercial oriented team experienced more difficulties in fulfilling their task. It proofed to be hard to clearly define the customer benefits which the analyzed products offer. The lack of clarity in describing benefits instead of technical features led to long discussions among the commercially oriented team members. These discussions arose not directly, as many of the team members understood the terms used, but through confrontations initiated by the author as an observer of and a participant in the workshop. The author was not a part of the project team, nor of the business unit of the team.

It proofed that the chosen definitions were not clear to someone from outside the project team with no affiliation to the business unit, while being familiar with the discussed product and product category. Only after confronting the team members by asking what their understanding is of each of the definitions, a discussion arose among the participants about whether the chosen definitions were clear enough. This discussion addressed each of the listed features or customer benefits and questioned not only the current listing but also whether certain benefits were still missing. This approach of confronting resulted in a clearer definition of the customer benefits of the value proposition comparison and a more complete overview of benefits.

The observation of this cross-functional collaboration session during the workshop showed different levels of substantive conflict. Other types of conflict, like emotional or process conflict, did not occur. The level of conflict differed from a low level, at the time when most participants largely agreed upon the relevance and definitions of the listed items, to a moderate level when the definitions and their relevance were questioned by the participants. The atmosphere of collaboration changed greatly between the beginning and the end of the session. The initial start was characterized by an open but reserved attitude by most participants, and as the conversations went into the content and certain elements had to be clarified by one or more of the participants, the atmosphere became more pro-active. Content challenging discussions were started to address explanations and reasoning of the choices for the new product's value proposition. As an observer and participant during the session, the author concludes that the moments of progress in clearly defining the customer benefits required a moderate level of substantive conflict. With a low level of substantive conflict, and no occurrence of process or emotional conflict, the team was perceived as too reserved in confronting one another.

The observed behavior during the session can be linked to behavior that was mentioned during interviews with members of the same organization which work at other business units. The reserved behavior seems to be caused by a lack of substantive conflict stimuli in the organization's culture.

Day 2:

The second collaboration session of the Value Engineering workshop is characterized by a divergence collaboration setting of generating product, manufacturing and supply chain improvement ideas by the cross-functional project team.

This session started with a brief introduction to the process and the method of idea generation and its documentation. The explained method consisted of analysing the complete product portfolio of the chosen range of products in the workshop and the technical commonalities in product components. All ideas with regard to the addition or removal of product variants on one hand, and the applicability of components across multiple products were listed. The atmosphere and collaborative behavior during this session was very open and constructive. All the participants had the same mindset of achieving the best

possible cost savings by generating improvement ideas. The mindset and atmosphere was more relaxed, and nearly all participants seemed to be stepping out of their functional role in order to reach the desired objectives of the team. This stepping out of their functional role was noticed when participants started stating ideas that were not or not directly related to their own function and did not benefit their own function.

The divergence phase of idea generation was characterized by sharing of improvement ideas related to the product, the components, the supply chain, and open discussions to further steer the idea generation and decide upon the feasibility of ideas. The main interfaces consisted between marketing, and the product research center regarding customer requirements and the effects of certain measures that affect the product. Another main interface in discussions was the development / manufacturing interface. These discussions concentrated on the feasibility of mainly technical suggestions. The atmosphere was energetic with a high level of creativity and enthusiasm. Despite this atmosphere, one of the participants expressed the need for more pressure on taking decisions, actions, and confronting each other on the content of the workshop sessions. This expression could be interpreted as a request for more substantive conflict among the participants to clarify on the content and enable consent decision-making.

This session was closed by a brief summary of the generated ideas by both sub groups. During the closing session, the participants expressed a positive attitude towards the purpose of the workshop sessions and the progress made in analyzing the commercial and technical aspects of their product and product portfolio and the activity of generating improvement ideas from different perspectives through the cross-functional setting of the workshop sessions.

Day 3:

The third day of the Value Engineering workshop aimed at the convergence of all the workshop sessions. The convergence phase emphasizes the act of consolidation, prioritization, and decision-making were possible. Discussions during this convergence-oriented session aimed at verifying the feasibility of proposed improvement ideas and deciding on whether or not to list the generated ideas. This phase requires a critical view on ideas, priorities, and the feasibility of suggestions and is most likely to involve confrontations. These confrontations can have either a substantive or emotional nature.

During this session, the interfaces between functions arose again. The project team members from Marketing and the Product Research Center opposed a number of proposed ideas due to their impact on the perception and user experience of the product by the targeted customer segment. These confrontational discussions were initiated by the project lead in order to clarify the ideas that would be included in the consolidated list of improvement ideas that would be presented to the management team or require further investigation before their feasibility and benefit can be ensured. Discussions on technical and supply chain aspects of the product were less confrontational as they required more investigation and testing in order to proof their feasibility.

Due to limited information being present during the relatively short workshop sessions, a lot of discussions could not be closed with a decision. However, it was concluded that an action point is required. The workshop session was closed by a presentation of all the generated ideas to the whole team and a presentation of examples of other value engineering workshop sessions that could inspire and benefit the team in future projects.

*Cost savings are a common objective for businesses to further improve their financial position by maintaining or even increasing their margins. A lot of technology driven businesses face price erosion due to technological advancements that make the technology and the products it is implemented in cheaper. This urges businesses to continuously monitor the amount of money they spend on purchasing their raw materials, components, products, services, or solutions.

Reflection on teamwork and the Value Engineer workshop by the project team:

In a reflection session following the Value Engineering workshop, the project team members were granted the opportunity to reflect upon their collaboration and decision-making process during the project and the Value Engineering workshop.

The challenges that team members mentioned with regard to the project and the collaboration process were: the difficulty in clarifying the boundaries of the project, communication barriers between team members, and the act of taking action after discussions.

These challenges were related to personal behaviours of team members in situations where a team member would not admit not knowing the answer to an issue, or requires more time to deliver on interdependent actions related to the project. Another aspect was the large physical distance between the marketing function and the other functions.

Another point touched upon was the occasional unrealistic planning with regard to the increase number of tasks added to the project after its start. This challenge started resulting in delay of work and milestones, which has a high likelihood of directly impacting the manufacturing and product launch processes and milestones.

Suggested rules to address these challenges and irritations were more transparency and openness in communication among team members on their knowledge level regarding certain parts of the project, and clearly communicating the actual feasibility of delivering results on agreed due dates and risk of delays. These suggestions were suggested to increase the level of trust between the project team members and allow for tighter cooperation in addressing challenges and unclear subjects. Another suggestion was the introduction of a check-in moment at the start of every meeting. During this moment, all participants are given the room to share their physical and mental attendance during the meeting. This solution is suggested to increase the understanding of the behaviour of fellow team members during the meeting. Another point addressed the management of expectations with regard to the planning and content of meetings. Team members suggested having a clear agenda for every meeting, with every meeting clearly concentrating on brief moments of sharing information instead of long explanations that could be held outside the meeting.

The reflective session provided the project team members to share their thoughts and feelings with regard to their collaboration process. The issues and suggestions that were mentioned relate strongly to process conflict related to expectations and behaviours during collaboration. The challenge for teams like the observed team is the initiation and facilitation of substantive conflict to address both the content they deal with and challenges and obstacles in their way of working.

It leads to the question how pressure to initiate and facilitate substantive conflict can be integrated in the collaboration process of cross-functional product development teams.

Participants

- Procurement Engineer (2x), Consumer Marketing Manager
- Project lead, Quality (2x), Packaging and logistics of packaging, Operations and supply chain
- Electrical Engineer, Industrial Cost Engineer, Mechanical Engineer

Appendix 8: New Product Development Stage-Gate System

The new product development process is a part of an organisational innovation process. Trott (2008) links innovation management with new product development through a conceptual framework that combines Finance and Business Leadership, Marketing, and Research and Technology. The new product development process itself is influenced by a variety of perspectives, including: marketing, economics, production management, research and development, and design and engineering (Trott, 2008).

The innovation process within a firm can be shaped in a number of ways based on one of the three main innovation model types; linear models, simultaneous coupled model, or the interactive model (Trott, 2008). The two linear models are the most familiar ones; Technology Push and Market Pull. Technology Push follows the linear three step process of: research and development, followed by manufacturing and finally marketing, before it ends up at the user. This technology-based approach thrived until approximately the 1970's. From that moment on, studies revealed the presence of a customer need-driven influence on the innovation process (Trott, 2008). The Market Pull model is based on a linear three step process with a different order; it starts with marketing, followed by research and development, and finally manufacturing, before it ends up at the user.

The simultaneous coupling model suggests that innovation results from simultaneous coupling of knowledge within the three domains of research and development, marketing, and manufacturing (Trott, 2008). The interactive model of innovation further develops the concept of simultaneous coupling by combining it with the linear Technology Push and Market Pull models. Without an explicit starting point, the model incorporates an innovation process from idea to commercial product that is influenced by the latest science and technology base, the organisation's capabilities, and needs in society and the marketplace (Trott, 2008).

In the domain of innovation research, Cooper (1990) created the conceptual and operation model of the Stage-Gate System, illustrated in *Figure 21*. The Stage-Gate System is a generic overview of new product development processes, which are characterised by cost increases with every Stage-Gate. The gate to each stage controls the preceding process through project deliverables which are judged based on specific predefined criteria. Each gate forms a decision moment and its outcome is typically a Go/Hold/Kill/Recycle decision (Cooper, 1990). If the Stage-Gate System approach is followed and participants comply to the predefined criteria, the approach ensures a consistent and fair evaluation of all projects that go through it as it eliminates hidden criteria and gut decision (Cooper, 1990).

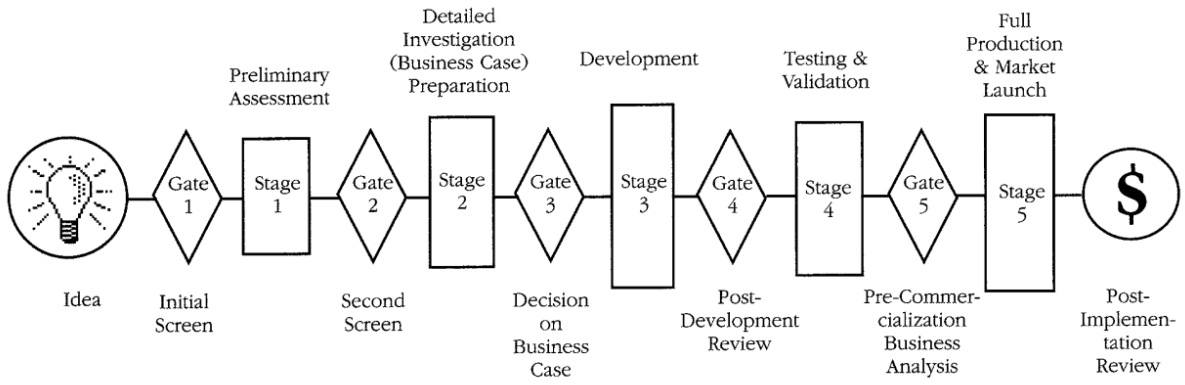

Figure 21: Stage-Gate System for NPD by (Cooper, 1990)

This system is a tool that forms a solution to increasing pressures which are faced by firms who rely heavily on new product development for growth and profitability. These pressures urge these firms to improve their product's market fit while reducing the cycle time of the new product development process.

Appendix 9: Background Information Improvement Programmes

This appendix offers background information on the I2M Excellence and End-to-End Transformation programmes and a comparison of the scope, involved actors, and method of all mentioned programmes referred to in Chapter 4.4.2 DfX compared to other Improvement Programmes.

I2M Excellence Programme

The I2M (Idea-to-Market) Excellence programme is aimed at the organisation's new product development phase. The programme aims to enable and stimulate 'first time right' product development, with delivering the right customer value at the right time and at the right costs as its desired results. The I2M Excellence programme is a part of the End-to-End Transformation programme.

Method

- ✓ Standardisation of processes and methodologies for new product development and launch (NPDL), including Lean I2M and the scaled agile methodology.
- ✓ Deployment of standardised processes and methodologies into the business units and supportive functions.
- ✓ Certification of people involved in the new processes and methodologies
- ✓ Tracking and recognition of created value

End-to-End Transformation

The End2End transformation programme is designated to redesigning the customer value chains of Philips to become faster and more effective in delivering value to its customer. The programme's objective is to transform the current organisational orientation of functional optimisation to a customer oriented optimisation across all functions. This transformation programme redefines sub-optimised and ineffective processes by simplifying the processes and their supporting systems and capabilities to increase the speed and performance of delivering relevant products, services and solutions to identified customer needs. Its five key initiatives are: customer focus, resources, lean end-to-end value chains, simpler and standardised operating model, and a growth and performance culture. The programme bared the following results after one year: 15 running transformations across the organisation, an installed business model and process owner network, and defined high level roadmaps for IT simplification. The programme relies on programme execution, process management capabilities and their framework, and the creation and maintenance of business excellence practices.

Benefits

- ✓ Better quality products and services for customers, delivered faster and tailored to their needs.
- ✓ More effective collaboration for employees through process and IT efficiency.
- ✓ Increased profitability and business growth for shareholders due to a shorter time-to-market, better quality customer service, lower cost of non-quality, lower inventories and lower IT cost.

Method

- ✓ By transforming the End-to-End customer value chains for each Business Market Combination (BMC).
- ✓ By rationalising and improving Philips business processes globally around active business models in the BMCs.
- ✓ By simplifying and improving IT landscape effectiveness globally.
- ✓ By implementing End-to-End Business Excellence knowledge practices and an academy.

The scope, involved actors, and method of each of the programmes are illustrated below.

DfX

- ✓ Scope: New product development and maintenance idea generation to market introduction.
- ✓ Actors: All new product development related functions (Marketing, Development, Procurement, Operations, Quality, Product Research Centre; DfX Support team), customers, and suppliers, and the DfX lead from Procurement
- ✓ Method: 8-10 week DfX convention process

I2M Excellence*

- ✓ Scope: New product development: Innovation strategy and programming to market introduction.
- ✓ Actors: Business Process Owners, Business Process Experts, Programme Managers, I2M Excellence lead, and Business process owners in the Business units and Markets
- ✓ Method: Design and implementation of systems and processes in the Idea-to-Market phase

End-to-End Transformation*

- ✓ Scope: End-to-End Customer Value Chains for Business Market Combinations, business processes and business models, IT landscape, business excellence knowledge practices and academy
- ✓ Actors: Programme managers, general managers, market leaders, business system experts, led by Market Leaders/Business program leaders in the Markets
- ✓ Method: Design and implementation of systems and processes in all business units and markets.

Negotiation Factory

- ✓ Scope: Procurement negotiation processes, negotiation design, communication and content
- ✓ Actors: Supplier account managers and commodity managers; negotiation factory support team; lead business commodity manager
- ✓ Method: Design and support of negotiation sessions of Supplier Account Managers and Commodity Managers with suppliers.

Supplier Development

- ✓ Scope: Production and assembly facilities of select suppliers
- ✓ Actors: Supplier Development Manager, Industrial Engineering Expert, Supplier Development Engineer, Supplier Quality Manger, Supplier Account Manager, Suppliers; Lead business commodity manager or business Procurement leader.
- ✓ Method: 3-month performance improvement projects

Appendix 10: Views on DfX as a Tool for Collaborative Decision-making in New Product Development

This appendix offers the views from the organisation on the Design for eXcellence (DfX) methodology within the organisation as referred to in Chapter 4.5.2: Design for eXcellence as a Tool and Process.

DfX Process and Tool

From a general Marketing perspective, DfX is perceived as a very strict and clear process that touches upon the right elements of NPD projects. Some addressed elements might have otherwise been forgotten or overlooked by the project team. Some perceive it's cross-functional collaborative set-up as an approach that requires more time due to necessary explanations of own expertise, which sometimes leads to frustrations.

The DfX approach is perceived as valuable for its process design of addressing challenges, stimulating substantive conflict between all the required NPD related functions, and data-driven decision-making upfront in the NPD process. Addressed challenges include the range build-up, the factory cost price, and features of the envisioned value proposition.

DfX can be applied as an input vehicle for new projects. However, its many tools might be abundant for the available tools for proposition definition.

Timely start of the DfX approach at the start of the project has been proven to be crucial for its success. Its substantive conflict element of challenging feature related costs and value is perceived as positive, following the more familiar Value Engineering approach.

DfX provides great collaboration with Marketing to discuss propositions and rank the different insights.

Improvement suggestions:

- Procurement / Operations interface: alignment is required between Procurement's volume commitment for cost savings and Operation's availability of operational handling capacity.
- Clarity on budget allocation and problem solving procedures between Development and Manufacturing on the trade-off for solving earlier identified issues. Either rational problem solving can be applied, resulting in a higher FCP, or structural problem solving through capital expenses (CAPEX) can be applied which requires a higher investment.
- Clarity on the choice between short term (FCP / business case decisions) and long term (market) decisions.
- Clarity on benefits of the DfX approach for the functional contribution of stakeholders
- Prescribe a training in the DfX approach for all stakeholders
- Provide resources for executing the DfX process

Requirement management

Requirement management has been implemented in at least one innovation site, which led to mind-set and process alignment of stakeholders, improving efficiency and reducing miscommunication.

Previously, discussions arose when Marketing shared the value proposition they had defined with missing data and valid argumentation but substantive conflict did not occur.

DfX sharpens the product definition with the help of data and valid argumentation through substantive conflict in workshops on how customer value is created and how that value is related to the costs in the end product. It provides transparency in the Marketing insights and enables other functions to challenge the way those insights should be addressed by a product.

DfX changes the previous top-down approach of Marketing to determine the FCP into data-driven information, numbers backed up by data and sufficient transparency to challenge Marketing. The approach provides Marketing the transparency on how all the different (cost) elements relate to each other. That too is a very important benefit of DfX.

The most important and valuable part of DfX is having all important stakeholders in place to come to decisions. The Value Engineering, Value Stream Mapping, and target price tools are not new. DfX supplements is with a 'should costing' tool that can provide insights in what a material, component or product should cost. Although it is a very good tool to challenge the supplier, the should cost prices are not completely realistic.

Experience shows that DfX occupies the project team's time and energy. That's why project teams are a bit hesitative until they see the benefits of the approach. In the IPD environment, time resources are constraining. It leads to mini DfX in 1 or 2 day workshops after the kick-off instead of a full scale DfX, as was applied in the Value Engineering approach preceding DfX.

DfX starts in the T&FC phase, the earlier involvement helps with regard to involving and interactions between functions to bring benefits during design and research, and application of risk management earlier in the process.

Previously, the involvement of procurement was passive. A lot of work started before the official Project Start. Procurement should be one of the key stakeholders at the table when the business makes decisions. DfX enables that.

The main gains of the DfX approach are function overarching elements of a project. Although this approach is perceived positively, it does not zoom in on the trade-offs of certain system elements. The Feature-Value Analysis tool is perceived as an excellent tool and a great method to discuss product elements.

Operations views the DfX approach not to be very different from the NPD process. The consolidation of all the function is new though. The DfX kick-off moment is great as it aligns cross-functionally, and addresses the usual disconnect of Procurement and Operations with Marketing and Development.

Operational excellence

> Towards functional departments, operational excellence is being implemented to get control of the processes on a functional level which the functions carry the responsibility for. But that requires good hand-shakes on the product with procurement for supplier quotes among other activities to receive feedback on the requested product specifications. In practice, while Procurement is requesting feedback on the product specifications at suppliers, new changes occur to the product and its specifications, which makes the process ineffective. It is not only Marketing but also technology or innovation driven. This process goes well in a small team with a Procurement person which requests quotes throughout the process, although it is not effective. But with operational excellence, commercial activities cannot be put outside the project team because the changes or mistakes in the NPD process cannot be taken into account.

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Appendix 11: Glossary & Definitions

Table 12: Abbreviations, derived from (Umaritomo, 2013)

CL	Consumer Lifestyle
CMM	Consumer Marketing Manager
I&D	Innovation and Development
IPD	Integrated Product Development
IPL	Integral Project Leader
IPM	Ideal Product model
IPP	Innovation Planning Process
MI	Marketing Intelligence
MIP	Market Introduction Process
PRC	Product Research Centre
TF&C	Technology & Function Creation
VPH	Value Proposition House

I2M Milestone:

A significant point or event in a project that marks a formal judgment by the Project Management Team on the achievement of a predefined set of deliverables.

I2M Gate:

A significant point or event in a project that marks a formal decision on continuation of the project (Go, Recycle, Hold, Kill) by the Steering team, based on project results and business.

judgment.

I2M Event:

A significant occurrence in the Project, initiated by the Project or the Steering team. An Event is a planned moment in time that marks a significant aspect of the project.

Product:

'Product' is defined as any offering that is developed by the project team, including a physical product, a (product) system, a service or a combination of all of these.
The Steering Team is a subset of the business Portfolio Management Team.

Glossary derived from: (Philips Innovation Logic Team, 2014)