RFQ response process redesign in the high-tech industry for enhanced customer-centricity

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RFQ Response Process Redesign in the High-Tech Industry for Enhanced Customer-Centricity

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“Solve the customers’ problem. Give them possibilities to increase profitability, security and quality in their operations. Help them introduce new and better technology.”

(Gustav Dalén, Nobel Prize Winner)

Abstract

This study investigates opportunities to enhance customer-centricity in responding to Requests For Quotations (RFQs) made by Original Equipment Manufacturers (OEM) in the high-tech industry. A literature study is performed to establish the outline of a customer-centric RFQ process and identify performance metrics.

The As-Is process at the case study firm is captured and evaluated on customer-centricity in the second phase of the research. Additionally, the quotation processes of four benchmark organizations are evaluated to substantially validate identified business problem and identify opportunities for enhancing customer-centricity.

The redesign that emerged from the findings out of the case study and benchmark study is found to contribute to the overall customer-centricity as it supports the selection of an appropriate response method and enables the organization to align its deliverables with customer needs.

Management summary

Introduction – In the high-tech industry, MTO and ETO organizations are facing fierce competition in responding to RFQs made by OEM organizations. Due to high level of diversity and accelerated changes in the market, organizations are required to take on a customer-centric focus (Seth et al., 2000; Sharma et al., 2008). Central in this paradigm, is to focus on delivering customer value, this is widely addressed in prior literature but not incorporated in the order capture process, i.e. the RFQ response process or quotation process. The quotation process of large, highly customized and thereby complex products is found to be a troublesome process (Hvam et al., 2006). It is recognized by practice and literature that there is both potential and a lack of attention for the order capture process (Zorzini et al., 2008).

Literature review – To resolve the identified business problem his study aims to enhance customer-centricity in the quotation process for organizations operating in the high-tech industry. First, the outline of a customer-centric process is established through a literature review. The main activities of the quotation process are identified and it is specified how these should be addressed to obtain customer-centricity. Capturing and assessing customer needs is the first phase in the quotation process. After capturing customer needs, a response strategy is to be determined on how to meet these. Next, the recognized attributes of a quotation: costs, leadtime and possible technical contribution have to be fulfilled. The final stage in the process is to appropriately offer these attributes within a satisfying timeframe.

Methods – Different methods are applied in redesigning a quotation process for enhanced customer-centricity. First, an in-depth field-based case study was conducted at the case study firm. Here, the quotation process is captured and its performance in relation to the prior identified customer-centric RFQ process is determined with use of in-depth interviews and multiple-case studies by analyzing company data and an experience survey. Secondly, the business problem is studied with benchmark studies; other firms within a similar context are analyzed with use of semi-structured interviews. These two studies lead to the identification of opportunities to enhance customer-centricity of the quotation process at the case study firm. A redesign is established and validated at the case study firm with use of a questionnaire and open questions.

Findings case study – it appears that the personnel generating the quotation data is not always aware of specific customer needs and expectations. Costing is the main attribute that is valued by the customer and most troublesome to meet. Enhancing customer value can be achieved through technical contribution: by suggesting cost reductions, quality improvements, leadtime reductions or resolving technical issues in the quotation phase.

Findings benchmark study – Benchmark studies also acknowledge the benefits of providing technical contributions in the quotation process to enhance customer value. Also, costs are recognized as the most troublesome attribute of the quotation to satisfy the customer. Benchmark studies have lower issues on providing technical contribution as a significant share of the end product is produced in-house.

Redesign – Therefore, the redesign of the quotation process aims to contribute to capturing and assessing customer needs by quantifying attributes that are most valuable to the customer. Secondly, it supports the strategy determination and communication of the required focus. Also, it aims to enable the organization to meet recognized attributes. Lastly, its objective is to streamline the entire quotation process such that participants can focus on enhancing customer value and increase the quality of the quotation.

In sum, the redesign holds the following aspects:

- The application of a DSS: a formalized matter of capturing and assessing customer needs and expectations. Thereby revealing the required focus of the request.
- Early technical assessment: collaboratively assessing the technical documentation instead of individually.
- Interface: automatically generating an overview that serves as communication between the quotation team and the sales department.
- Activity automation: automating several activities related to the processing of data in the quotation process.

Conclusions – It is found that in order to enhance customer-centricity in the quotation process, organizations should seek to offer increased customer value over its competitors. This can be achieved by increasing the focus on attributes that are most valued by the customer. A DSS contributes to capturing customer needs and making a quantified decision.

Early and collaboratively assessing the technical documentation is found to result in possibilities for costs reduction, early recognition of technical issues and the identification for design improvements.

Lastly, it is found that automated activities and an interface between the quotation team and the sales department increase the reliability of the quotation data and contribute to elaborating on specific aspects that are most valuable to a customer.

Recommendations – As the redesign holds several automations, it is recommended to invest in the development and implementation of these systems. Further, the ability of the purchasing process to adopt the identified focus in the DSS is recommended to be studied; it has to be able to efficiently select potential suppliers that are most appropriate to the recognized focus.

Preface

This Master Thesis is the final deliverable of my study Innovation Management at Eindhoven University of Technology.

I would like to thank my first supervisor dr. Oktay Türetken for his contribution to my Master Thesis project. When I was struggling with my project, our meetings were always inspiring me to continue and resolve the issues. Also, this result would not have been achieved without your positive attitude and expressed confidence.

Since there was more domain knowledge required to redesign the quotation process towards a more customer-centric process, a second assessor was approached from the ITEM group. Hereby I thank dr. Joost Wouters for his specific guidance, suggestions and feedback on my work, this enabled me to hold the required focus throughout the project.

This project could not have been completed without the help of several persons at the case study firm. My thanks go out all members of the quotation team and the sales department, your availability and input during very busy periods were of great contribution. Additionally, I thank the persons that were available to provide me with the required knowledge on benchmark firms. I would like to express my sincere gratitude to my primary supervisor at ABC-SA. Our frequent meetings throughout the project provided me great knowledge and the ability to take on different perspectives on the process.

Lastly, I would like to thank Marly for her support and excellent meals throughout the project. Also I am thankful for her review and helpful suggestions on the research.

Roy Loonen

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1. Introduction

This study investigates the possibilities of increasing customer-centricity throughout the quotation process on high-tech products by redesigning the quotation process at an organization operating in the high-tech industry. The remainder of this chapter holds a detailed description on the identified problem, project scope and project outline.

1.1. Problem Description

Today, the manufacturing industry, the high-tech industry in particular, is more and more characterized by highly complex modules and machines with ever shortening development times. OEMs (Original Equipment Manufacturers) are increasingly requiring turnkey projects and through life solutions from ETO (Engineer-to-Order) and MTO (Make-to-Order) organizations in order to maintain focus on its core processes and enhance competitive advantages (Hicks & McGovern, 2009; Gilley & Rasheed, 2000). Offering the OEM advantages in terms of minimal responsibilities and risks for the outsourced process and, several disadvantages, such as limited influence on the determination of the conditions and little insights on the cost structure. Resulting in a large dependency on the vendor and related commercial, technical and performance risks (van Weele, 2010).

Vendors in this case are either ETO or MTO organizations that negotiate with clients and bid against other companies for each order that is desired to be captured (Kingsman et al., 1996). These companies face fierce competition in which the primary competition parameters are: delivery date of quotation, product leadtime, ability to meet customer needs and intensive price competition (Hvam et al., 2006).

The combination of pressing development times and outsourcing of critical manufacturing and assembling activities of complex products result in the need for an appropriate response to an RFQ (Request For Quotation) to satisfy the customer by the vendor. Therefore there is a continuous search for satisfying a customer in the quotation process. Due to this nature of the process, it is considered as a customer-centric process (Shah et al., 2006). Customer-centricity's basic philosophy is defined by Shah et al. (2006) as to: "Serve customers; all decisions start with the customer and opportunities for advantage".

Market diversity, intensive competition and accelerated advances in technology are argued by Sheth et al. (2000) as needs for firms to adopt a customer-centric focus. In relation with Sharma et al. (2008), who characterize the high-tech industry as an industry with a high pace of technological change, disruptive competition and intensive product adaptions. The necessity to operate customer-centric in this industry is evident.

Understanding customer needs and processing these accordingly to align the deliverables is essential for customer satisfaction (Hunt & Jones, 1998). Moreover, customer satisfaction is considered to be directly linked to firm performance (Sawhney & Piper, 2002). As the quotation process is often the start of a manufacturing order, it is a fundamental process in the supply chain (Veeramani & Joshi, 1997). Consequently, the quotation process can be considered as the start of satisfying customers.

Zorzini et al. (2008), Bramham et al. (2004), Ebben et al. (2005) and others have recognized the vast influence of the quotation process on company performance and the lack of attention to it by both practice and literature. Though they acknowledge the importance of optimizing the quotation process for customized products, Zorzini et al. (2008) and others predominantly focus on determining and offering the best possible product leadtime.

On the other hand, García-Crespo et al. (2011) and Niazi et al. (2005) performed studies on the costing process that is subsequent to the quotation process by reviewing several techniques and systems for the cost estimation process.

Especially in the case of highly complex and customized products as in the high-tech industry, there are more deliverables next to price and delivery date that could satisfy the customer when filled accordingly. Nicholas (2008) states a customer often chooses for the best project plan, project management, qualifications and reputation of the vendor rather than the proposed solution in terms of price and technology. Stressing the necessity for capturing specific customer needs in the quotation process and handling these accordingly instead of solely focusing on delivery time and price in order to make an attractive quotation. Moreover, Hunt and Jones (1998) argue that MTOs are expected to participate in every aspect of an OEM's product; from design to delivery, in order to win business. Consequently, they state that next to offering a satisfying price, it is critical to reveal these capabilities in order capture process. Also Sharma et al. (2008) find that in order to be successful in the high-tech industry, firms need to be more demand driven. Implying that it is key to adopt a "solution selling" strategy that is based on customer demand rather than a supply chain driven strategy in order to enhance competitiveness.

In the focal industry there is often a lack of a true 'marketing function' since products are requested by the customer at the sales department and are made on demand. Therefore capturing customer needs is mainly regarded as a sales concern when a RFQ is made by the customer. After the request is accepted it is forwarded in the organization to personnel who are generating the quotation (data). It follows that order acceptance and bid preparation are functionally separated, resulting in the need for appropriate communication between these functions.

Preparing an attractive and reliable quotation is thereby a multi-stage decision process that involves complex trade-offs and is requiring cross-functional collaboration (Zorzini et al., 2012). Since customer satisfaction can be achieved by aligning the quotation with the customer's demands and expectations, there is a need for a focus on customer needs throughout the entire quotation process.

High levels of complexity in the requested products cause the quotation process to be troublesome (Forza & Salvador, 2002). To process complexity and customization of the requests, there are available techniques and systems to support the quotation process, but the mere application of these techniques or systems will not be sufficient (Hvam et al., 2004).

Although it is recognized by several authors that customer-centric product development for technology projects can be beneficial, there is a lack of attention for the order capture process and incorporating the customer-centric focus. Also, by increasing customer-centricity a firm can develop close and profitable relationships with its customers, an advantage that is hard to copy or displace (Day, 2000). The general assumption in customer-centric product development is that the actual product is designed by the vendor, excluding the quotation process from the flow. Therefore, the following research question is posed:

> *How to enhance customer-centricity in RFQ response processes in the high-tech industry?*

A delineation of the problem scope is described in the following section that is followed by the project outline.

1.2. Problem Scope

A firm's level of customer-centricity is determined by its organizational culture, organizational structure, its processes and its financial metrics (Shah et al., 2006). While controlling for the other aspects, this study specifically addresses the process of responding to a request.

The study specifically addresses MTO organizations operating in the high-tech industry that are facing issues to achieve maximum customer value in their quotations.

Quotations can be requested by a customer in different situations: a straight rebuy, a modified rebuy and a new-task situation (van Weele, 2010). Quoting a straight rebuy is a routine process with accurate outcome as the product is known in the organization and was ordered in the past. A modified rebuy is the purchase of a new product at a known supplier or the purchase of a known product at a new supplier. When a new product is requested at the vendor, a more complex and time consuming process initiates to respond with an accurate quotation that delineates risks, is in line with the customer's expectations and within the time frame set by the customer. Therefore the focus of this study is on processing the requests of new products as these are most complex to align with customer needs.

1.3. Project outline

The remainder of this study is structured in the following matter: in Chapter 2 a literature study on the concept of customer-centricity is made and an outline of a customer-centric quotation process is derived. Chapter 3 defines the business problem and the methods applied to address the problem. The As-Is process of the case study firm and its performance are described in Chapter 4. Chapter 5 holds an elaboration on the performed benchmark studies. The proposed redesign is discussed in Chapter 6 and the methods and results of validating the redesign are described in Chapter 7. Finally, conclusions are drawn and discussed in Chapter 8.

2. Literature Study

To derive what determines a customer-centric quotation process, the concept of customer-centricity is firstly described. The general outline of responding to complex and customized quotations is thereafter depicted.

2.1. Theoretical perspective

In order to be customer-centric, Shah et al. (2006) state that a firm needs to be focused on customer relationship management (CRM) and profitability can be achieved through customer loyalty. They use customer satisfaction as a performance metric of a customer-centric organization amongst share of wallet of customers, customer lifetime value and customer equity. Further, they state: "the essence of the customer-centricity paradigm lies in creating value for customers, and in the process, creating value for the firm". Woodruff (1997) expresses customer value as:

> *Customer value is a customer's preference for and evaluation of those product attributes, attribute performances, and consequences arising from use that facilitate achieving the customer's goal and purposes in use situations.*

The main issue within an organization should not be whether to compete on customer value but rather how to achieve enhanced customer value (Sawnhey & Piper, 2002). In order to act in this matter, Payne and Frow (2005) indicate a company should undertake value assessment on the attributes that a customer is likely to value.

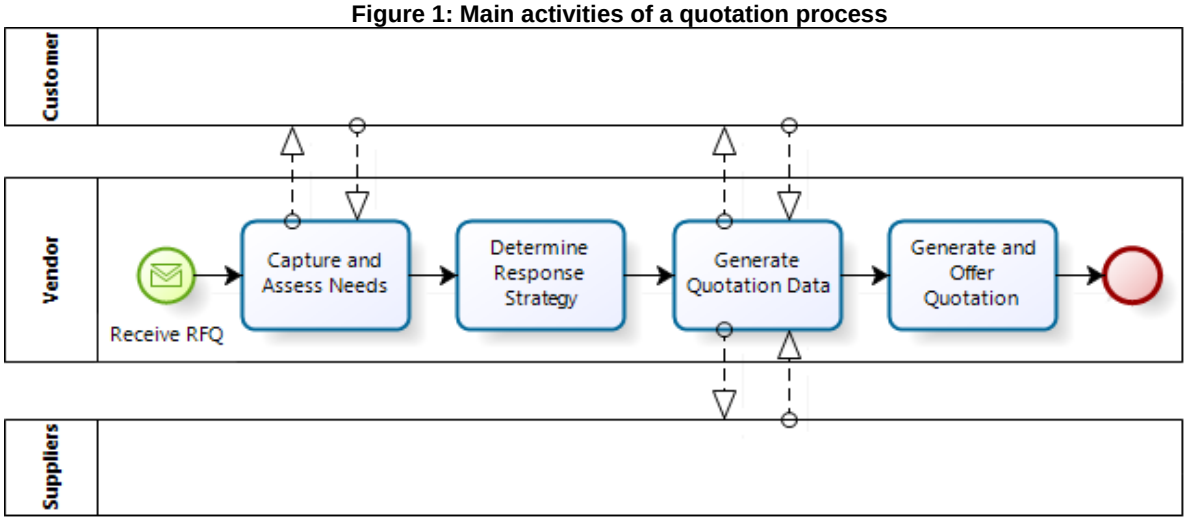
This study is performed in the customer-centricity paradigm and aims to enhance customer value. Therefore, a literature review is made on studies that address specific attributes of the quotation process. These studies are categorized in studies that: aim to identify attributes that are valued by the customer and enable organizations to deliver these.

2.2. Responding to RFQs

Though it is recognized that the quotation process is an underexposed area of research, there are studies available that address specific aspects of the identified business problem. Additionally, performance metrics are identified in the literature study. These metrics are used in the remainder of this study to assess case study firm and benchmark firms.

Multiple studies are combined in order to determine what a customer-centric quotation process is and how it could be enhanced. For a vendor the quotation process initiates when it receives a RFQ (also known as RFP (Request For Proposal), RFB (Request For Bid) and IFB (Invitation For Bid)) and it ends with either the acceptance or rejection by the customer. Figure 1 depicts a high-level process flow of a quotation process that is structured according to the identified major activities in the remainder of this chapter.

Figure 1: Main activities of a quotation process



Capture and Assess Needs

Aligning the quotation process with customer needs and expectations is critical to achieve customer satisfaction (Hunt & Jones, 1998; Hvam et al., 2006). These specific needs have to be captured and assessed in order to meet these.

Through customer interaction, the desired deliverables can be revealed. Bramham et al. (2005) reveal that with increased product customization and involved functions required the complexity of the needs identification process will increase dramatically. Therefore, they propose the application of multiple decision centers in which all required functionalities are involved.

Hicks et al. (2000) divide the customer interaction during the product development into three stages. The first stage is to reveal the technical and non-technical customer requirements and the customer's criteria for assessing competing offers. Hereby identifying customer requirements, commercial factors, the company's ability to compete and the likelihood of success. In case it is decided to respond to the request, a detailed customer needs assessment in terms of: technical features, price, delivery and quality is made in the second stage. The last stage of customer communication takes place after the contract is established.

Errors in interpreting the customer request can lead to decreased customer satisfaction (Forza & Salvador, 2002). Customer needs define how the customer will evaluate the quotation amongst competing organizations. In the most simplified matter this evaluation is based on price and leadtime. However, there are several other aspects that are of influence when responding to requests, such as project plan and management, reputation of the contractor, likelihood of success, fit to contractor resources, technological capability and ease of doing business (Hunt & Jones, 1998; Nicholas 2008; van Weele, 2010).

Though applied on end consumers, Frame (2003) argues that every respond to an RFQ can be regarded as a project; each project is an effort to fulfill needs and stating these needs concise and clear is a challenging task due to the following aspects: needs can be ever changing, solutions can be confused with needs, identified needs can be for the wrong end-user, there might be more than one user who's needs might differ and user needs can be distorted by the "experts".

While capturing customer needs it is also essential to determine what type of product is requested. A strategic product will have a major effect on the price and quality of the end

product, making the customer highly dependent on the supplier. Leverage products, on the other hand, are solely focused on competitive bidding and seek for 'the best' deal for a short term and thereby price and leadtime will be more important (van Weele, 2010).

Identifying customer needs in the high-tech industry is argued to become more formalized and require increased contribution of technical experts by Sharma et al. (2008).

Determine Response Strategy

Captured customer needs are to be processed and an appropriate method of responding to the RFQ is to be determined. An MTO organization has to evaluate whether to offer a quotation and how much effort there has to be placed into generating the quotation; one could spend a lot of effort in generating a competitive bid or quickly estimate the costs that can be used for later negotiation (Kingsman et al., 1996). The determination of a process is loaded with complex cross-functional tradeoffs that increase with product complexity (Zorzini et al., 2008). Additionally, Xiong et al. (2006) express: "by providing the flexibilities to assess different responses and experiment with alternative courses of action, the speed and efficiency for making an informed response to customer enquiry can be significantly improved".

In the DSS approach that is suggested by Xiong et al. (2006) the pre-screened bid is evaluated against material and production capacity availability in the second phase. A final decision is made on whether to respond to the request and the due date, price and delivery plan are determined. In order to streamline the translation from the quotation process towards actual customer orders, Xiong et al. (2006) envision their proposed DSS system as a front-end module that is intended to be aligned with production planning and control systems such as conventional MRPII and ERP. Their study seeks to increase the efficiency of responding to RFQs and increase the feasibility of the delivered quotation and thereby contribute to maintaining a better customer relationship, thereby contributing to customer-centricity.

Zorzini et al. (2012) recognize the effect of the level of customization and complexity in the requested product on the methods of processing the information and responding to the request. They propose a model that formalizes the decision making process dependent on the requested type of product in the case of capital goods manufacturers. Their model assesses the relevance of delivery time, the level of technical complexity of the requested product and the level of customization of the product.

Generate Quotation Data

After determining the response strategy that is to be applied to align the quotation with customer needs the data required for the quotation is to be generated in such matter. Sawhney and Piper (2002) suggest that customer satisfaction can be achieved by defect-avoidance, cost-minimization, on-time delivery, and short lead-times.

Product costs is one of the most critical aspects of a quotation: too low price estimation can lead to financial losses. A price which is too high however, can result in the customer selecting a competing firm with a better offer (García-Crespo et al., 2011; Niazi et al., 2005). Different methods for minimizing costs are described in the remainder of this chapter.

A large proportion of the costs in the high-tech industry is determined by suppliers' quotations. Therefore Hicks et al. (2000) advocate a greater contribution for procurement in the quotation process and early product development activities. To ensure suppliers' quotations are aligned Hick et al. (2000) envision collaborative supplier relationships that ensure reliable and accurate costing. ETO organizations often recognize the benefits of these relationships above the most

frequent applied lowest price order strategy. Though the latter strategy is often justified, it results in organizations being engaged in a continual vendor assessment that is wasteful, time consuming and expensive. A closer assessment of components and applying another strategy with critical components can eventually result in a lower cost price (Hicks et al., 2000).

On the other hand Calosso et al. (2003) perform their study on the assumption that MTO organizations are estimating item costs and leadtimes that are to be delivered by its vendors. They argue that including suppliers' quotations in the quotation process results in an explosion of evaluation processes and the inclusion of multiple enterprises increases the inefficiency throughout the process.

Cost estimation in an RFQ requires knowledge of the manufacturing process as well as the ability to determine its total cost and profit margin. Due to the combination of these tasks, it is common that highly qualified and experienced personnel is performing this task. It follows that estimations done by the experts are based on unwritten rules and previous experiences of the expert, making organizations dependent on the presence of these experts (Kingsman & de Souza, 1997).

Next to offering a satisfying price, product leadtime is also argued to be a key determinant (Zorzini et al., 2008). They state that although delivery lead time is essential, it occurs that other factors such as technical features are of larger importance in some cases.

Hvam et al. performed three studies on the quotation process of a cement plant manufacturer that also had to process highly complex and customized requests. In their 2004 study they implemented a redesign in which they applied a knowledge based system to ensure the information that is generated by the experts is available to all the persons involved. A configuration system was applied in their 2006 study to enable sales personnel to generate budget quotations (quotations with limited information) without using engineering resources. Budget quotations were to be used in dialogue with the customer to derive whether the general outline of the quotation is aligned with customer needs. In case the budget quotation leads to customer satisfaction, the engineers were asked to derive a detailed quotation.

Hunt and Jones (1998) argue that contract manufacturers (i.e. vendors) are expected to participate in every aspect of an OEM's product, from design to delivery in order to satisfy customers and thereby win business. Thereby the aim of the vendor is to make the customer aware that its quotation differs from others. Moreover Perunović and Christoffersen (2012) express that vendor capabilities in participating in an OEM's product development are most critical in winning business. Therefore, revealing these capabilities to the customer in the quotation and the quotation process is essential. This can be done by technical communication with OEM engineers in the quotation process (Hunt & Jones, 1998).

Generate and Offer quotation

Next to the offered product leadtime there is also the due date of the quotation itself. The time in between the RFQ and the requested quote delivery date is classified by the SCC (2012) as quote cycle time. To decrease the quote cycle time, Hvam et al. (2004) acknowledged business process redesign (BPR) was necessary and achieved significant results. Buzby et al. (2002) advocate for the application of lean principles to the quotation process in order to reduce quote cycle time but do not provide any empirical evidence.

With respect to quotation content Hvam et al. (2006) increased the consistency and readability of the quotations. Additionally, they increased the focus on the major issues of the customer in the quotation.

2.3. Conclusion

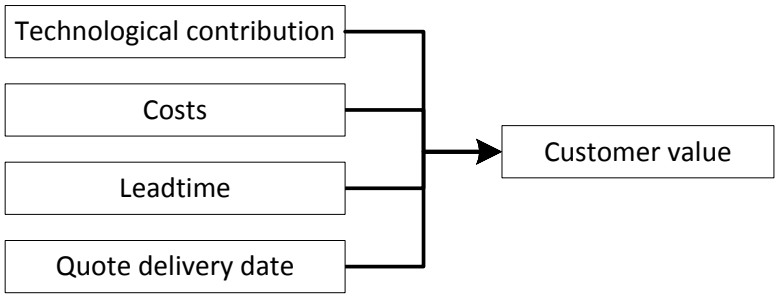
Relating the customer-centric focus to the different attributes of a quotation process, it can be concluded that a vendor is required to:

1. Capture and assess the customer needs during (multiple) customer interaction moments with possible inclusion of technical experts. Also the quantification of attributes that are likely to be valued by the customer is performed in this stage.
2. Determine an appropriate strategy to align the quotation deliverables with the identified attributes that are most valued by the customer.
3. Properly execute this strategy in order to meet the required deliverables. The deliverables identified in the literature study are: costs, leadtime, quote delivery date and technical contribution.
4. Offer the quotation within a satisfying timeframe and offer it in such a matter that it increases customer value over competing firms.

Next to process structure, the organizational structure has to contain customer segment centers, customer relationship managers and a customer segmented sales team (Shah et al., 2006).

An overview on the in literature recognized attributes of the quotation process that are affecting customer satisfaction is to be seen in Figure 2.

Figure 2: Quotation deliverables affecting customer satisfaction



Therefore the vendor should seek to focus on align these attributes best with customer needs in order to enhance its customer-centricity.

3. Research Design

After recognizing the business problem in the previous chapter, the problem is formalized, specific sub-questions are posed and methods on answering these and thereby resolving the business problem are described in the remainder of this chapter.

3.1. Problem Definition

The problem on processing RFQs in the high-tech industry is defined as follows:

> *Responding to RFQs on high-tech products is recognized in practice and prior studies as a complex process that is critical to an organization's performance. Enhanced customer-centricity is found to be beneficial in new product development but there is a lack on specifically incorporating customer-centricity in the quotation process.*

3.2. Research Questions

Changing the quotation process towards a more customer-centric process requires structural changes that can be achieved through business process redesign (BPR). BPR aims to eliminate all activities that do not provide value to the customer and allows great improvements compared to new business processes that are created from scratch (Hvam et al., 2004; Hammer & Champy, 1993). Though applied in another domain and focused on decreasing costs and time to generate quotations, Hvam et al. (2004; 2006) also identified the need to redesign the quotation process of complex requests and achieved satisfying results in terms of throughput time, costs and required resources after redesigning the quotation process. Therefore, the main research question of this study is adjusted to:

> *How to redesign RFQ response processes in the high-tech industry for enhanced customer-centricity?*

This research question is substantiated with sub questions that are derived during orientation interviews and the literature review:

- *Q1. How to measure the quotation process' performance?*
- *Q2. How to capture customer demands and expectations in a matter that all persons involved in the process are aware of these?*
- *Q3. How to provide additional customer value during the quotation process and in the actual quotation?*

3.3. Methods

The objective of this research is to establish a redesign on RFQ response processes that enhances customer-centricity. In order to achieve this objective, a case study is applied. This offers the opportunity to extensively study the phenomenon in a real-life context (Blumberg et al., 2011).

After capturing the As-Is process at a case study firm, its performance is measured with use of interviews and multiple-case studies based on interviews and secondary data.

Through semi-structured interviews, multiple-case studies are performed on four other firms. These studies are referred to as the benchmark studies as these bring the performance of the case study firm into perspective and offer opportunities to enhance customer-centricity.

Finally, the findings of the case study analysis and the benchmark study are compared with literature and a redesign is generated. The redesign is thereafter validated at the case study

firm; the entire process towards the redesign is related to the BPM lifecycle (Dumas et al., 2013) and depicted in Figure 3.

3.3.1. Case description

The organization on which the case study is performed is ABC-SA, (due to confidentiality, its name is shielded) an MTO organization that establishes the supply chain and manages the logistics and assemblage of mechatronic systems in the medical, semiconductor, graphic, solar and nano-industry. ABC-SA is a subsidiary of ABC-Group, an umbrella organization with over 800 employees and a turnover of over 115 million Euros. The development, a large part of the production and assemblage of an end-product can ideally be performed within ABC-Group. Design, production and assembling are performed by separate subsidiaries.

ABC-SA is offering its products directly towards OEM organizations and achieves its business by responding through RFQs made by OEMs. Additionally, management at ABC-SA indicated there is potential in aligning its quotation process with customer needs. Therefore, ABC-SA is considered as an appropriate case study firm.

3.3.2. Operationalization

As mentioned before, the study consists of several stages where different methods are applied. This section addresses the stages and elaborates on the participants and validates the selected methods.

Case Study:

As-Is process: the process landscape and abstract process model are captured with use of in-depth interviews with two process owners. A detailed process model (BPMN) is derived with use of in-depth interviews with all process participants (14).

Performance: measuring performance is done with semi-structured interviews on process participants (14) to gain a detailed understanding and the process' participants viewpoints (Blumberg et al., 2011). To enhance objectivity in the analysis, past processed RFQs are analyzed as a secondary data source (Dumas et al., 2013). Additionally, a detailed multiple-case study is performed on 11 processed RFQs. These cases are selected with great care (Appendix D) and used to assess whether several input parameters can predict similar results or contrasting results for predictive reasons (Yin, 2013). After gathering available archive data on the processed cases, an experience survey is held on two project engineers to capture specific issues of the cases (Blumberg et al., 2011).

Benchmark studies:

The benchmark studies serve as multiple-case studies to assess findings of literature study and case study at ABC-SA. Therefore, it is imperative to carefully select cases for an optimal comparison (Yin, 2013). As the study is specifically aimed at MTO organizations that respond to RFQs of OEMs in the high-tech industry, the selected organizations are also operating within this context. Four semi-structured interviews on sales managers and account managers are held to measure the benchmark organizations' performance and allow for follow-up questions to elaborate on specific aspects (Blumberg et al., 2011). The interviewees are currently working for ABC-Group and therefore able to bring the performance into perspective.

These are the organizations selected for the benchmark studies:

- *ABC-SM*: Part-supplier for specific sheet-metal compounds, frames and assemblies.

- *BM1*: Global operating provider of industrial and professional electronics. Developing, producing and assembling printed circuit boards.
- *BM2:* Sheet-metal and assembly supplier in the field of weighing, cooling/heating, positioning and design of frames and covering.
- *BM3*: Provider of systems and modules in customer specific manufacturing.

Table 1 displays the arguments for selecting benchmark firms. Firms are selected based on differences of product size, level of customization and size of the organization. While selecting benchmark firms, it is controlled for product size and complexity as advocated by Zorzini et al. (2012). In addition, the ratio of costs made in-house gives an indication on the complexity of the process as increased suppliers' quotations increase the complexity of the process (Calosso et al., 2003; Novak & Eppinger, 2001).

Though there is no knowledge available on BM3, it is included in the benchmark study as it is perceived as best practice and market leader. The information on BM3 is gathered from an account manager and business line manager who gained their knowledge on the quotation process of BM3 by working for another subsidiary of BM3-Group and through customer interactions.

Table 1: Arguments for selecting benchmark firms

	BM1	ABC-SM	BM2	BM3
Offering business directly towards similar OEMs	x	x	X	x
Active in similar industries	x	x	X	x
Average product size is	similar	smaller	Similar	similar
Average level of customization is	lower/ similar	lower	lower/ similar	similar
Size organization	larger	smaller	Similar	larger
Perceived as best practice				x
Market leader				x
Offering specific prototype products		x		x

Validation of redesign:

The results of the case study reveal where mismatches between the current As-Is process and the provoked customer-centric RFQ process are. Thereby revealing the objectives of the redesign to address these mismatches.

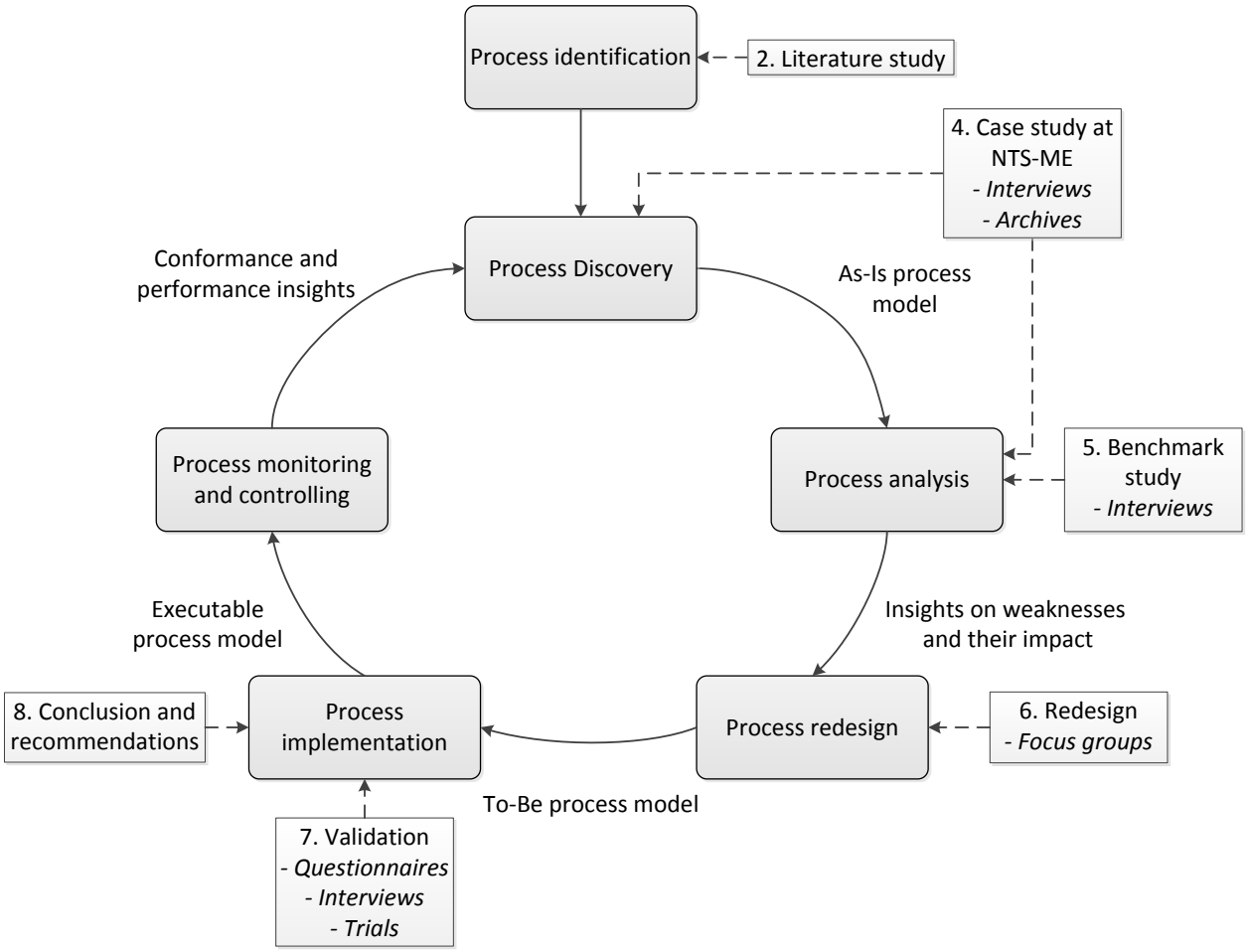
Different concepts are evaluated with use of literature, benchmark study findings and BPM best practices (Reijers & Mansar, 2004). As management support is a critical success factor in BPM implementation (Parkes, 2002), early concepts are presented to management to verify support on the redesign.

Selected concepts are presented and discussed in a focus group meeting with the process owners and 6 end users to increase the end users ownership, another success factor in BPM implementation (Parkes, 2002). Focus group meetings are considered as a cost and time-effective approach to obtain different views on a topic (Blumberg et al., 2011).

To validate the redesign, several methods are applied to ensure validity in the measurement. After presenting the redesign to 8 stakeholders: the calculator (C), the cost engineer (CE), the project engineer (PE), two project buyers (PB) and three business line managers (BM). They are

asked to fill a 5-point Likert scale questionnaire to specifically measure the concepts on expected performance (Blumberg et al., 2011).

Figure 3: BPM life cycle (Dumas et al., 2013) and related chapters



4. Case Study

Quotations are mainly requested by OEMs at account managers and business line managers of ABC-Group (Appendix A). As ABC-SA does not produce any parts itself but purchases all components at other ABC-Group subsidiaries and external suppliers, its product costs and leadtime are mainly determined by the sum of supplier quotations. These suppliers are most often MTO organizations.

The overall strategy is to purchase the majority of the items within the ABC-Group and limit the added value of external suppliers.

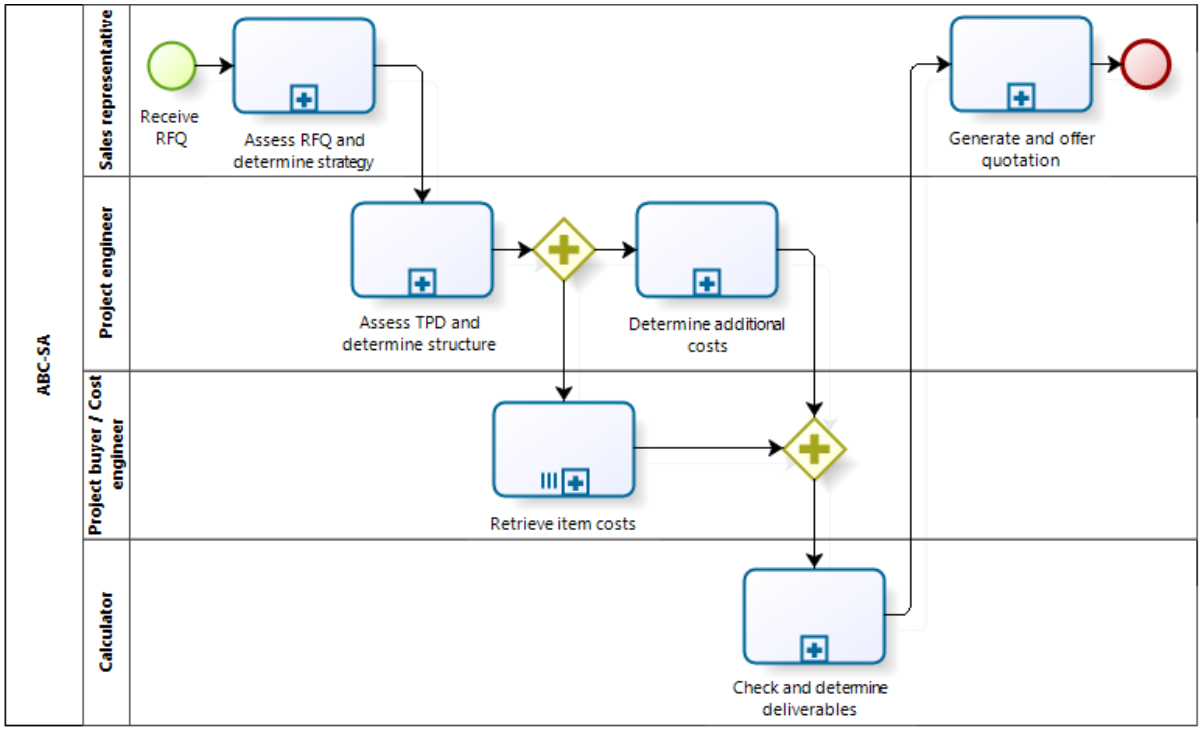
4.1. As-Is Process

In order to capture the As-Is process and its performance, first the abstract process model is derived by in-depth interviews with the new products introduction manager and the calculator (who is managing the quotation process).

To derive a detailed understanding, 14 process participants are interviewed with the protocols denoted in Appendix C-1 (Appendix B depicts all interviews held at the case study firm). One calculator, one cost engineer, three project buyers, three project engineers, four account managers and three business line managers were interviewed. Thereby all persons of the (former) quotation team and the entire sales department is involved in the analysis to ensure validity. In parallel to the interviews, the case study firm's archive data on past processed RFQs is analyzed to obtain objective knowledge.

After the account manager or business line manager (from here on referred to as sales representative) of ABC-Group receives the RFQ, it is forwarded to the quotation team at ABC-SA that generates the data for the quotation. When the required data is gathered, the quotation is offered by the sales representative to the customer (Figure 4).

Figure 4: High level quotation process flow As-Is ABC-SA



Capture and Assess Customer Needs

Most frequently an RFQ for a new system is made through an email by the customer towards the sales representative of ABC-Group. The sales representative checks whether all required information is available and possibly contacts the customer for additional information.

It is checked by the calculator with possible inclusion of the project engineer whether the request is aligned with ABC-SA, other ABC-Group subsidiaries or external suppliers.

Retrieving the required information is sometimes done by visiting the customer. Visiting the customer is done nearly at all times when it concerns a new customer to capture customer needs and expectations. It can be decided to include the project engineer in this visit to resolve technical ambiguities and issues, and retrieve standardized technical norms.

For about half of the requests, the calculator captures relevant information for the RFQ in a RFQ feedback form that is filled after meeting with the sales representative. Additionally, the calculator registers the RFQ in a registration scheme that is used to track the RFQ's progress.

Determine Response Strategy

For high potential requests it can be decided by the sales representative to include the management team to derive a project plan and/or hold a kick-off meeting with the quotation team to communicate specific customer demands, expectations and the strategy that is to be applied.

In case the request is better aligned with another organization it is outsourced to this organization by ABC-SA.

System requests that are to be processed by ABC-SA are estimated on the required order management costs and quote delivery date based on the size and complexity of the request. This is performed by the calculator, captured in the RFQ feedback form and forwarded to the sales representative.

In case the calculator recognizes a lack of resources to timely provide a full quotation, it is communicated to the sales representative. After verifying it with the customer, it can be decided to offer a budget quotation; solely determining the costs of the items that are likely to be the most costly items of the requested end product to get an indication on whether these costs are satisfying and it is worthwhile to invest in generating a full detailed quotation.

Generate Quotation Data

First, the project engineer checks the TPD (Technical Product Documentation) on completeness and possible technology related risks. If the TPD is incomplete or unclear, the customer is contacted to retrieve the information. Critical items are recognized and items are specified by the project engineer as custom made, standardized items, non-stock items or sub-assemblies in the next step. The specification is done in the KPM (KostPrijs Monitor) that serves as a central document in the quotation process.

For about one out of ten RFQs, it is asked by the sales representative to include 'value engineering': the project and/or cost engineer thoroughly analyses the technical documentation and checks whether cost reductions or design improvements can be applied to provide additional value in the offer. In general, it is applied on new customers, products that are still in development or products with high potential.

After items are specified, the project buyer starts sending out requests for quotations towards suppliers. These suppliers are preferred to be other ABC-Group subsidiaries but most frequent are external suppliers (±65%). The aim is to request cost drivers – 20% of the parts that account for 80% of the costs – at multiple suppliers to benchmark suppliers' quotations and retrieve the best item costs. If timely recognized, the cost engineer applies Activity Based Costing (ABC) in a costing tool to derive a cost estimation.

The project buyer enters all selected quotations in the KPM, resulting in the BOM costs for the customer request. Except when the supplier's quotation delivery date is about to exceed the delivery date set by the customer. In this case, the cost engineer estimates the costs of the item and uses the estimation to complete the BOM costs in the KPM.

Complementary to the BOM costs, the project engineer estimates the assembling costs. Lastly, one-off engineering costs that are to be made while implementing the product are estimated, referred to as non-recurrent engineering (NRE) costs.

With all data filled in the KPM, the calculator checks the data and adjusts the data when necessary in collaboration with the project engineer or project buyer. Then, he determines the total leadtime of the end product by summing the item with the longest leadtime, queuing time and assembly time. Additionally, the calculator determines the total costs of the end item per batch that is requested by the customer and notifies the sales representative.

Generate and Offer Quotation

Quotation data included in the KPM is checked by the sales representative. The thoroughness of this analysis is dependent on potential profit, request size, request type, customer, available time and technical knowledge of the sales representative. Therefore this activity varies from approximately one hour up to a day. The quotation team is consulted and requested to resolve distinctive values that are found in the quotation data.

Generating the actual quotation initiates when the data is deemed complete and appropriate. The sales representative formulates the conditions and deliverables that are to be included in the quotation. Costs can be adjusted during the generation of the quotation, based on the expertise of the sales representative. Finally, the quotation is offered to the customer that either makes a finite choice or gives the opportunity to adjust the offer.

The detailed BPMN of the As-Is quotation process on new system requests is to be seen in Appendix C-2. Additionally, an overview on the information artifacts and related usage ratios are depicted in Appendix C-3.

4.2. Performance

Performance is determined with use of interviews (Appendix C-1), archive data on processed requests and a multiple-case study that combines the two methods (Appendix D). This section aims to identify and scrutinize differences with the model derived in the literature study. Thereby revealing ABC-SA's performance on customer-centricity.

All 98 RFQs on systems that were processed in 2013 were used as a sample for the data analysis since the current process is similar to the process used in 2013. The requests handled before 2013 went to another process and were not tracked accordingly. Offered quotations and the quote registration scheme were used as a source for the data analysis. Interviews with the sales representatives (Appendix C-1) were applied to capture missing knowledge and ensure the data was accurate.

Eleven requests are analyzed in detail; it is checked what activities are performed and what the outcome of the quotation is. KPMs, offered quotations, e-mails, the quote registration scheme, RFQ feedback forms, TPD questionnaires and ERP data are used as source for the case analysis. In addition, the requests are discussed with the project engineers who processed the request. Since the current project engineer of the quotation team is a different engineer than last year and the process is similar, both are interviewed to increase validity. The arguments for selecting the cases, the interview protocol and measurements for other attributes are described in Appendix D-1 to D-3; the results of the case studies are depicted in Table 2.

Capture and Assess Customer Needs

Frequently the RFQ sent by the customer contains sufficient information to offer a quotation. However, to enhance the alignment with customer needs, the quotation team members perceive that they sometimes do not receive adequate information to do so.

Kick-off meetings are only applied for requests of high importance to communicate: the customer's situation, type of product and required focus of the quotation. Benefits of these meetings are recognized but the usage ratio is considered too low by various persons involved in the quotation process.

Customer needs are captured in the by Sharma et al. (2008) foreseen formalized matter by the calculator in the RFQ feedback form. This however, is not performed for all system requests and not used for communication within the quotation team.

One issue addressed by the quotation team on the needs identification process, is the sales representative verifying whether the customer would value design improvements. As expressed by the following case:

> *"We did put some effort in suggesting design improvements, the customer eventually made its decision based on the original design as it wanted to maintain its current design in the future, making our suggestions irrelevant". (Project engineer)*

Determine Response Strategy

Though Kingsman et al. (1996), Xiong et al. (2006) and others provoke not responding to an RFQ as a valid strategy, it is not recognized within ABC-SA; the general strategy is to respond to all RFQs. There is a dispute on how to achieve overall high levels of customer value; respond to all requests or increase focus on specific requests and offer high quality quotations.

As the current strategy is to respond to all requests, these are all forwarded to the quotation team. This sometimes occurs before potential profitability, product type, requested delivery time and relative chances of achieving the order are known. Causing the quotation team to be unable to make an appropriate planning, set an appropriate focus and making decisions on a gut feeling rather than a substantiated matter. For important requests the required strategy is determined in a kick-off meeting as mentioned in the previous section.

The general perception of the quotation team members is that the same costing method is demanded for every request; retrieving all item costs by requesting quotations at multiple suppliers and eventually retrieving end item costs that are low and highly accurate.

> *"Deriving accurate costs for all the requested system requires a lot of time and resources while costs might not make that much of a difference to a customer in certain cases, as the customer might value other aspects such as quality". (Calculator)*

Case 10 justifies the application of other costing methods as costs were in a satisfying range while the majority of the costs were estimated and not retrieved by supplier quotations.

In addition, the strategy to only offer cost drivers and verify the customer whether these costs are appropriate could be beneficial for certain requests. This ensures the quotation team to relatively early recognize a mismatch with customer expectations and possible inability to meet customer expectations.

Generate Quotation Data

The initial activity of generating the quotation data is to check the technical documentation and retrieve possible missing information. Case 6 depicts the criticality of appropriately clarifying technical issues and risks in the request; it was one of the most costly RFQs processed in 2013 and eventually the quotation was never offered as there were still a vast amount of issues in the TPD. Moreover, case 5 illustrates that unknown norms and an obsolete TPD dramatically increases quote cycle time. Technical issues are to be communicated to the customer in an early stage and resolved before sending these towards the suppliers as queuing time on customer feedback and supplier quotations are main determinants of the quote cycle time and meeting the quote delivery date.

Overall, it is found that costs inappropriate costs are the main mismatch with customer expectations and are resulting in the customer selecting competitors or maintaining production in-house. Detailed analysis revealed that the cause for inappropriate costing is not uniform but mainly relies in the purchasing process that is subsequent to the quotation process.

Insufficient cost driver assessment and focus on these items throughout the entire process is argued by sales representatives and members of the quotation team as a root cause of excessive costs. Case 5 illustrates that overall costs were 25% above the customer's target and not all cost drivers were requested at multiple suppliers. Additionally, late identification of cost drivers inhibits the cost engineer to make a timely estimation:

> *"Most of the cost estimations are requested when supplier's quotations already arrived, the cost engineer cannot make an estimation at this time anymore due to time constraints". (Calculator)*

Another issue that increases overall costs is the costing structure; instead of purchasing a total sub-assembly at a supplier, the custom made items could be purchased at a supplier and the standardized items at another supplier and perform the assembling activity in-house to increase added value and reduce overall costs.

Next to excessive item costs, Case 7 also reveals that excessive item leadtimes can result in customer dissatisfaction as the end product's leadtime is not appropriate. Most often, a specific leadtime is not requested by ABC-SA when sending out an RFQ to a supplier.

While retrieving the quotation data and processing data in the KPM, several resources require different information fields. This causes the spreadsheet document to hold a lot of tabs and columns that can be relocated by all persons involved, resulting in an unstructured and cluttered document as a project buyer indicated:

> *"I cannot work efficient while processing data in the KPM as I have to search for fields that are distributed amongst information I do not need. Therefore, I am spending approximately a quarter of my time on processing and checking data".*

Moreover, the unstructured and complex matter of processing data can result in erroneous item costs and consecutive end item costs (Case 5).

This is issue also recognized by the calculator, as he indicates to be spending around 40% of his time on retrieving the required data, checking data and correcting data. Thereby inhibiting him to focus on activities that do provide value for the customer.

Offering value engineering i.e. technical contributions is argued to positively enhance customer value by all involved in the quotation process. This is in line with Hunt and Jones (1998) and Perunović and Christoffersen (2012) as they express that capabilities of contributing to the customer's product development are essential in enhancing customer value. Technical expertise can also lower issue on excessive costs by suggesting cost reductions. Other opportunities are: quality improvements and resolving issues included in the TPD.

> *"One should always look for opportunities to increase quality and decrease costs to differ from competing firms". (Account manager)*

In general, the case studies reveal that offering technical contributions in the quotation process and the quotation enhances customer value. Specific effort was put in to suggesting design improvements and cost reductions in Case 5. Though the quotation is still pending, the customer made follow up requests and indicated they were satisfied with the offered improvements. The same holds for case 10; design improvements were suggested and the customer made a larger request. In case 8 the customer asked for assessing its design and offering possibilities to improve it. Eventually the sales representative added an additional margin over the product and the order was not achieved due to excessive costs.

Most interviewees share the opinion that the frequency of suggesting design improvements is too low. Available time is the main cause of not offering technical contributions, partially caused by the earlier mentioned inappropriate selection of requests to spend technical resources on.

Direct communication between the customer's project engineer and ABC-SA's engineer throughout the quotation process is essential in order to appropriately resolve technical issues and verify whether design improvements are valued and possible.

Customer visits with the inclusion of the project engineer are made for 5 out of 11 requests in the case analysis. Hereby increasing the technical contribution and ease of communication (Hunt & Jones, 1998). New customers were visited at all times and technical contributions were discussed during meetings. For known customers there is a lower perceived need for visiting the customer as often the customer's project engineer is known and direct contact is often possible. Overall, it can be concluded that customer visits are more beneficial when performed in an early phase (Case 1, 5, 6, 8, 10).

Generate and Offer Quotation

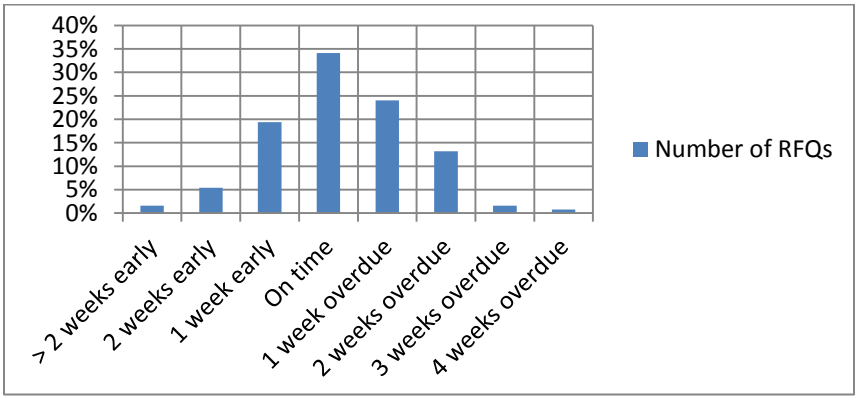
The final check on the data performed by the sales representative is highly dependent on several aspects such as the importance of the request and available time as indicated:

> *"I check the potential profit of the request and determine whether additional analysis is required as I have limited time to do so". (Account manager)*

> *"I have experienced too many flaws in past KPMs and therefore I am distrustful on its reliability and I am spending several hours on analyzing its content". (Account manager)*

Figure 5 depicts the delivery date performance in terms of number of requests sorted on the difference between the confirmed delivery date and the actual delivery date. Quotations finished over 4 weeks after the initial confirmed delivery date are all related to changes in design by the customer and not included in this analysis. When excluding these outliers the ratio of late quotations is 40%, 34% are on time and 26% are finished early.

Figure 5: Quotation data delivery performance



Though a large ratio of the quotations are not offered in time, it often does not directly lead to decreased customer value if it maintains within acceptable margins and is communicated properly. This is confirmed by the ratio of cases that were offered too late (Cases 4, 6, 8)

> *"The customer waits until it receives all offers from the addressed vendors, decreasing quote cycle time will not have an effect on most of the quotations". (various persons)*

Except when the customer specifically requests the quotation to be delivered within a few days; a so-called 'fast-track' request. Cases 9 and 10 were both fast-track requests and offered on time but not achieved on price basis and withdrawn product demand.

Frequent factors that are causing the confirmed quote delivery date to be exceeded are: changes in the design by the customer, late identification of technical issues, low TPD quality and queueing time on suppliers' quotations. These factors are also causing the average quote cycle time of 5,2 weeks to have a relative large standard deviation of 3,4 weeks.

When offering the quotation to the customer, it can be chosen to offer derived design improvements directly and transparent in the quotation or somewhat shielded; indicating there are possibilities for reduction in costs or increased quality but not revealing the actual changes:

> *"The improvements were directly and transparently offered to the customer, the customer did not accept our offer yet but adopted our improvements in its design". (project engineer on Case 5)*

There is a large difference in the content and structure of the offered quotations: highly detailed with the inclusion of a project plan, design improvements, specific assumptions that were made and other aspects or solely including costing and general conditions. Though highly dependent on the size and complexity of the request, the level of detail in the quotation tends to be related to customer satisfaction and order achievement (Case 2, 3, 4).

Table 2: Detailed case analysis

		Achieved				Pending	Not achieved					
Case		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Comment on status						Initial costs 25% above demand	Quotation delivery time	Costs and leadtime	Costs	Series costs	Product demand is gone	Strategic decision
Product type		Redesign	Existing	Existing	Existing	Redesign	Existing	Existing	Existing	New	Existing	New
Motivation request		Outsource decision	Outsource decision	Outsource decision	Benchmark	Benchmark	Benchmark	Outsource decision	Outsource decision	Unknown	Outsource decision	Benchmark
Request value		1	5	4	4	5	4	3	3	2	4	2
Product complexity		3	5	3	2	2	2,5	2,5	3	1	1	1
TPD Quality		5	4	3	4	2	2	4	3	3	2,5	1
PE customer visit		Early	n	n	n	Early	Very late	n	Late	n	Middle	n
Communication		5	4	2	2,5	1	1	2,5	3	4	5	5
Technical contribution		-	2	0	0	4	0	0	4	0	3	0
Quote cycle time		3	3	2	3		5	3	2	1	1	2
Delivery date		Unknown desired delivery date	Unknown desired delivery date	On time	Late	Changes in design	Extremely late	Unknown desired delivery date	Late	On time	On time	Unknown desired delivery date
Order management costs		4	5	4	3	5	5	1	3	1	1	1
Quotation content	**Costing details**	1	5	4	5	3		1	3	2	2	2
	Technical remarks	1	2	1	2	5		0	4	1	1	2
	Project plan	0	2	5	3	1		0	0	0	1	0
	Sum	2	9	10	10	9		1	7	3	4	4

4.3. Conclusion

Firstly, the organizational structure of the quotation process is not entirely customer-centric. Though business lines at ABC-Group are focused on specific customer segments, the quotation team at ABC-SA is centralized and generating all quotation data. The creation of new system quotations was recently found to be subordinate to other activities performed by the project buyer and project engineer. Thereby it was decided to establish a centralized quotation team and performance was found to be increased.

Identifying customer needs is done by the sales representative with possible inclusion of the project engineer, which is found to be beneficial. Despite the calculator captures these needs in a formalized matter, it is not used for internal communication. Insufficient kick-off meetings result in an overall low perceived awareness of customer needs and strategy to address these.

The determined strategy is not always found to be appropriate as most requests are direct accurately calculated with use of supplier's quotations while some might be satisfied with only estimations on cost drivers. Offering a detailed quotation after the initial offer lead to customer satisfaction is proven to be a valid strategy that increases the quality of the final quotation (Hvam et al., 2006; Kingsman et al., 1996).

While aligning the quotation data with customer needs, costs are most troublesome. This is mainly allocated in the purchasing process and related focus of this process, also found by Hicks et al. (2000), who advocated the higher contribution of procurement during the quotation phase. In addition, Hunt and Jones (1998) argue that the essence of competent purchasing resources increases when the functionality and supply of the logistics becomes more complex.

The potentials of offering technical contribution to reduce costs, increase quality and resolve technical issues are acknowledged. However, it is also recognized that these contributions are offered too infrequent.

Case analysis also revealed that focusing to increase customer value on one specific aspect of the quotation is not beneficial when another attribute is outside an acceptable range.

Further, the large load of information is processed in an unwieldy matter that inhibits the focus on creating customer value.

Meeting the confirmed quote delivery date is not largely affecting customer satisfaction as long as it is communicated accordingly towards the customer and maintains within an acceptable timeframe. In general, higher levels of detail in the quotation result in higher levels of customer satisfaction.

Overall, the quotation process and subsequent purchasing process require a better focus and flexible structure. The data processing during the quotation process is required to be more structural.

5. Benchmark studies

Four organizations are analyzed in order to validate the business problem, determine their level of customer-centricity and identify opportunities for enhancing customer-centricity. Semi structured interviews that allow for follow-up questions and thereby increased understanding are used, depicted in Appendix F.

5.1. Results

Results of the benchmark studies are combined and presented per main activity of the quotation process.

Capture and Assess Customer Needs

Capturing and assessing customer needs is at all benchmark firms performed by the sales representative. The by Sharma et al. (2008) provoked contribution of technical experts, i.e. project engineers in the needs identification process is not recognized by ABC-SM as its sales manager expresses:

> *"We are cautious with including project engineers to customer visits as they might give away design improvements in their enthusiasm".*

Also at BM2 the project engineer rarely visits the customer (Table 3). At BM1 however, the project engineer is included as early as possible to assess whether there are opportunities to provide additional customer value, described in the remainder of this chapter.

At ABC-SM the RFQ goes through several checks and evaluations before it is taken into consideration. In case it is recognized that leadtime is likely to be infeasible or the product cannot be manufactured in the requested matter, the customer is timely notified.

All benchmark firms apply a kick-off meeting to communicate customer demands and expectations when it is deemed necessary by the sales representative. These needs are not captured in a formalized matter as argued by Sharma et al. (2008).

Table 3: Benchmarked capture and assess customer needs

	BM1	ABC-SM	BM2	BM3
Inclusion of project engineers in customer needs identification process	As high as possible	Very low	Low	Unknown
Formalization in capturing customer needs	No	No	No	
Communicating customer demands	Kick-off	Kick-off	Kick-off	

Determine Response Strategy

Though it occurs rarely, in case risks are too high or potential profit is too low, it can be decided to not offer a quotation when an RFQ is made at ABC-SM. At the other firms, all requests are taken into consideration and a response is made to all RFQs made by the customer.

Strategy is determined by either the account manager or the business line manager at all firms included in the benchmark study. Both BM2 and BM1 use a kick-off meeting with the stakeholders to determine what the focus of the request should be.

Therefore, the provoked formalization in the assessment of incoming RFQs and the determination of a response method by Bramham et al. (2005), Zorzini et al. (2008) and others is not acknowledged.

Most frequently, the focus of the quotation process is on costs as it is assumed that quality and leadtime are within a satisfying range (BM2).

Generate Quotation Data

Costs at ABC-SM and BM3 are mainly determined in-house, at BM2, sheet metal components are produced in-house. This decreases the overall number of suppliers involved and thereby the inefficiency of the negotiation process (Calosso et al., 2003). Additionally, relative low complex finishing activities are estimated at ABC-SM rather than requesting quotations for these.

An RFQ that requires a fast respond, i.e. fast-track request, is processed differently than regular requests at ABC-SM and BM3. The fast-track process at ABC-SM involves similar activities as a regular request at ABC-SM but all activities are performed by the account manager rather than specialized resources. Resulting in shorter quote cycle times and increased costs. This is valid as the customer values meeting confirmed quote delivery date and product leadtime above appropriate pricing.

BM3 applies a different approach than ABC-SM while responding on fast-track requests. At BM3 there is the opportunity to include more cost engineers who will rapidly estimate the costs of all critical components. Hereby providing the costs for the requested product within one to two weeks. Risks in this case are higher since there is no commitment made by any suppliers. Differences in these processes are denoted in Table 4 (resources derived from SCC (2012)).

Table 4: Stakeholder analysis

	ABC-SA	ABC-SM		BM1	BM2	BM3	
		Series	Proto			Regular	Fast-track
CRM	AM*	AM	AM	AM*	AM*	AM	AM
Strategy determination	AM*/C/MT	AM/CE	AM	AM*/BM*	AM*/PE*	U	U
Pricing	CE	CE	AM	AM*	CE	CE	CE
Procurement	PB	PB	AM	PB*	PB*	PB	-
Product Information Management	C	CE/AM	AM	PE/SS*	PE*	U	U
Product and configuration validation	PE	PE	-	PE*	PE*	PE	-

*Resource focused on customer segment, AM: Account manager, BM: Business line manager, C: Calculator, CE: Cost engineer, PB: Project buyer, PE: Project engineer, MT: Management team, SS: Sales support, U: Unknown, -: Activity not performed.

Visiting the customer with the engineer to discuss potential areas for improvement is not practiced by ABC-SM and BM2 due to the above mentioned issue. At BM1 however, the account manager expresses it as follows:

> *"The risk of the customer adopting our technical knowledge without rewarding the business is always present. To me it is an indication the customer values our knowledge and capabilities. In case it occurs multiple occasions at one customer, there*

is an issue that needs to be resolved. In general I trust the customer and I think it enhances the relationship".

This perspective is aligned with the by Shah et al. (2006), who advocated organizational culture were employees are willing to share knowledge with their customer's counterparts.

Offering cost reductions is mainly done by suggesting alternative parts for items provided by suppliers that have beneficial contracts with BM1. These suggestions were often proactively made by project buyers as they requested sales representatives whether alternative parts are likely to be valued by the customer. More detailed design improvements could be offered during the sales pitch.

Though the engineer rarely visits the customer during the quotation process at ABC-SM and BM2, alternative materials and production methods on sheet metal components to increase product quality or decrease costs are offered as frequent as possible. Expressed by a sales manager of ABC-SM:

"If we do not recognize and offer these opportunities, a competitor might recognize these and win the order".

BM2 aims to recognize technical issues in an early quick scan performed by the project engineer. Resulting in early questions towards the customer. The frequency of offering design improvements and thereby enhancing customer value is found to be too infrequently offered by BM2 due to the general attitude of "customer specifications are leading".

During fast-track process at ABC-SM there is no focus on offering design improvements as quote cycle time and leadtime are the main determinants in achieving the order.

Table 5: Benchmark generate quotation data

	BM1	ABC-SM	BM2	BM3
Costs in-house	Similar to high, (more in-house assembling activities)	Very high (60%)	Similar to high, (in-house sheet metal components)	Very high, (in-house machinery)
Quote cycle time	Low complexity: 1 week High complexity: max 5 weeks	Fast-track: 3 days` Regular: 2 weeks	Low complexity: 2 weeks High complexity: max 6 weeks	Fast-track: 1 to 2 weeks Regular: unknown
Technical contribution	Slightly higher, mainly on suggesting alternative parts	Higher, mainly on suggesting alternative materials and production methods	Higher, mainly alternative materials/ production methods on sheet metal parts	Higher

Generate and Offer Quotation

ABC-SM meets the confirmed quote delivery date on 80% of the cases and half of the belated quotes are communicated early towards the customer. Though the limited purchasing activities in the process of ABC-SM, it is one of the main causes exceeding the confirmed delivery date.

Design improvements are often not transparently offered in the quotation; the organizations indicate costs can be reduced or quality can be increased but do not reveal how this could be achieved.

BM1 offers transparency by specifically mentioning the items recognized as cost drivers in its quotations and verifying the customer whether the derived costs for these items are appropriate.

Overall performance

Table 6 depicts the most occurring causes of not achieving orders at benchmarked firms. As can be seen, it is troublesome to offer satisfying costs to the customer. Additionally, ABC-SM also indicated personal preferences (customer's goodwill) caused in not achieved business, this was not acknowledged by BM2.

Table 6: Causes of not achieving orders at benchmarked firms

	BM1	ABC-SM	BM2	BM3
Costs	Unknown	60%	Main cause	Unknown
Goodwill		20%	0%	
Quotation delivery time		10%		
Leadtime		10%		

5.2. Conclusion

Most resources involved in the quotation processes of benchmarked organizations are organized in a customer-centric matter: they are focused on a customer segment and perform quotation activities as ancillary activities (Table 4). Except from ABC-SM that has an insufficient size to operate in this matter.

At all firms, the resources generating the quotation data are different than the ones offering the quotation, hence the application of kick-off meetings in order to make all aware of specific customer needs, expectations and strategy to meet these.

While generating the quotation data, the potentials of suggesting changes in design and alternative parts to achieve cost reductions, quality improvements and resolved technical issues are recognized by all firms.

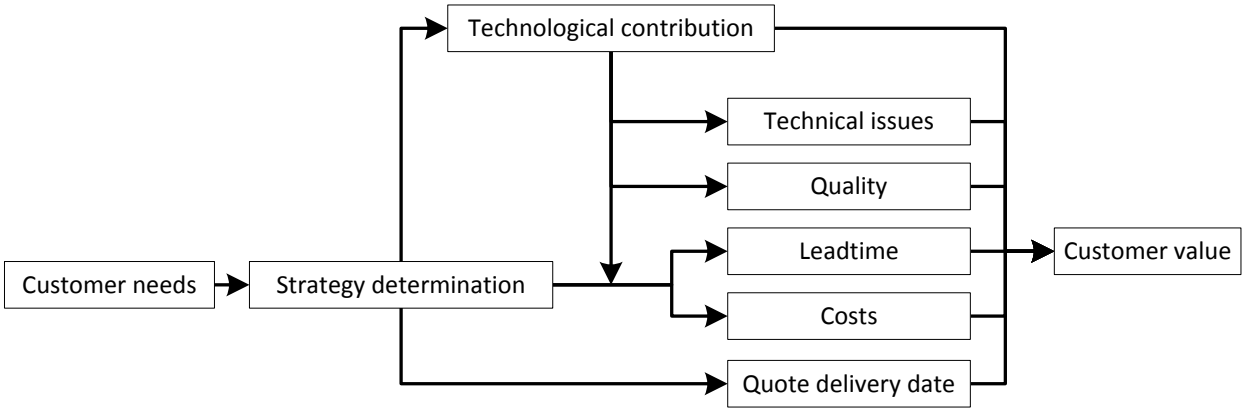
6. Redesign

First, the outline and main objectives of the redesign are described with use of the literature study, case study and benchmark studies. Concepts are evaluated in the next section that is followed by a detailed description on each of the changes.

6.1. Objectives

As stressed by Payne and Frow (2005), a vendor should firstly assess whether the offered value proposition, e.g. the quotation, is likely to result in superior customer value. Thereby quantifying the relative importance the customer places on attributes. For the quotation process these attributes are: costs, leadtime, technical contribution and requested delivery date, denoted in Figure 6. Note that quality and resolving of technical issues can only be offered by technical contribution: increased quality and resolved technical issues cannot be offered without providing technical contribution.

Figure 6: Quotation (process) parameters affecting customer-centricity



With selecting an appropriate strategy, the focus of the quotation process can be aligned with the aim to meet these attributes.

Enabling an overall understanding and focus on meeting customer needs does not directly lead to a customer-centric process, as Shah et al. (2006) express: “the ability to optimally match the product with the customer’s requirements is one of the key challenges in establishing a customer-centric process”. This is recognized by all firms in the study as frequently they are aware of its customer’s needs but are not able to meet these.

Offering appropriate costs is a main determinant of customer value in the quotation and the process towards it and is found to be an overall acknowledged issue. Three benchmarked firms produce certain cost-drivers in-house and thereby have the ability and flexibility on the cost determination process. High levels of sourcing on complex products at ABC-SA’s side increases the overall complexity of the process (Novak & Eppinger, 2001) and thereby the difficulty of determining appropriate deliverables.

Leadtime is argued by Zorzini et al. (2008) and others to be essential, results of the case study and benchmark study narrow this deliverable down to an infrequent mismatch with customer requirements. Therefore reducing leadtime is not considered as one of the objectives of the redesign.

Quote delivery date is found to be an attribute that generally is not considered as critical by the customer as long as it maintains within an acceptable timeframe. Two benchmark firms have

separate fast-track processes in order to timely respond to RFQs of which the main criteria are quote cycle time and product leadtime.

Providing technical contribution to the customer's design could satisfy the customer by resolving technical issues included the TPD, decreasing costs, decreasing leadtime and increasing quality. Additionally, contributing to the customer's product development itself could enhance the relationship with the customer.

Benchmarked organizations perceive lower issues in providing technical contributions as relevant items are made in-house and specific technological knowledge is directly available. This specific production knowledge lies at other ABC-Group subsidiaries or external suppliers for ABC-SA. Therefore design improvements are either to be made before requesting a quotation at a supplier or requesting the supplier itself to suggest design improvements.

In order to streamline the entire process and increase ease of communication it is found that visiting the customer with the project engineer is beneficial. To reap the maximum benefits out of customer visits it is essential to plan the visit as early as possible in the quotation process.

Additionally, high levels of complexity result in high volumes of information that have to be processed throughout the process and thereby increased chances on risks, errors and delays (Forza & Salvador, 2002). This is recognized by ABC-SA and found to inhibit the customer-centric focus. Moreover, the centralized quotation team at ABC-SA enables participants to focus on the generation of quotation but is not contributing to overall awareness of customer needs.

Therefore, the objective of the redesign is to firstly quantify the attributes that are (likely) to be valued by the customer, determine an appropriate response method to meet these, ensure all involved are aware of these and enable the organization's possibilities to meet these (Figure 6). An additional objective of the redesign is to obviate the required effort in data processing and increase the reliability of its outcome to enhance focus on value adding activities.

Though actual implementation was not feasible during this study, the critical success factors in BPM implementation addressed by Parkes (2002) are taken into account in order to successfully implement the redesign in the future. Management commitment is ensured as the aim of the redesign is aligned with the organization's strategy: "provide consult and attractive alternatives that result in the reduction of leadtimes, increased flexibility and the reduction of costs". Additionally, concepts and related benefits are shared in an early stage and biweekly meetings with the new products manager during the study. Through the continuous involvement of the quotation team in which the concepts are discussed and adjusted the end user ownership is ensured. Further the motivation of the redesign was to align the entire process with customer needs and demands and not the BPR itself, another critical success factor (Parkes, 2002).

6.2. Concept Evaluation

Conceptual changes in the process are derived with use of addressed methods in literature, applied methods in benchmarked firms and BPM best practices (Reijers & Mansar, 2004; Dumas et al., 2013). Table 7 denotes the changes to the quotation process and the literature and/or benchmark organizations that (partially) apply the derived constructs.

BPM best practices were evaluated on applicability (Appendix G). When found applicable, it is checked whether the best practice could be incorporated in one of the changes that are discussed below. This elaborated in Table 22, Appendix G.

Table 7: Support for changes

Change	Descriptions	Literature	Benchmark organizations
Early Technical Assessment	Early and collaboratively assessing product details	Bramham et al. (2005)	BM2 ABC-SM
DSS	Formalized capturing and quantification of customer needs. Quantify strategy determination process.	Xiong et al. (2006) Zorzini et al. (2008)	
Interface	Automatic generation of required information between two functionalities.	Sawhney and Piper (2002) Hvam et al. (2006) Sharma et al. (2008)	
Activity automation	Automating activities and restructuring information.	Dumas et al. (2013) Reijers & Mansar (2004)	BM2 BM1

Best practices that are applicable and not addressed by any of the proposed changes or already applied in the As-Is process, are discussed with management:

Integration: integrating the quotation process with suppliers, i.e. other ABC-Group subsidiaries, is aimed to result in more specific production knowledge and thereby abilities for better costing and technical expertise. The potentials are acknowledged by management but it has to be aligned with top management and therefore is considered infeasible within this research.

Case manager: including customer service resources as case managers for specific customers or markets could result in a better understanding of customer needs and increased transparency. This is argued to be mainly applicable for modified rebuys as customer service employees processed prior designs on these requests, thus, outside the scope of this study.

Extra resources: the aim is to increase possibilities in-house cost determination instead of retrieving these from suppliers. As cost engineering resources are currently a constraint to act in this matter, there is an open vacancy. This heuristic is applicable but its effect is expected to diminish with the implementation of other changes.

Trusted party: requesting a supplier to suggest design improvements and deliver reliable item costs that do not require an assessment. Higher levels of technical contribution and lower need for engineering resources are potentials of this heuristic. Such method is considered inapplicable by management due to the increased dependence on a supplier. With respect to other ABC-Group subsidiaries it holds the same limitations as the prior mentioned integration heuristic.

Activity Automation: automating activities could result in essential reductions on the time spent on processing data and increase the reliability of its outcome. Therefore, it could decrease quote cycle time and enable the participants to focus on value-adding activities. Its potential is recognized by the quotation team, sales department and management. Possibilities to automate certain activities in the redesign will be further analyzed and included in this study.

Exception: excluding ‘fast-track’ requests from the regular flow could result in better alignment with customer needs for such requests by decreased quote cycle time. This is also performed by two benchmarked firms. Both methods are currently deemed inappropriate at ABC-SA as one is applicable to low complex products and requires a high level of technical knowledge of the sales representative. The other requires ample cost engineering resources. Due to the low ratio of

fast-track requests at ABC-SA and the limited possibilities within this study it is decided to exclude this heuristic from the redesign.

Table 8: Expected effects of redesign on quotation process attributes

Attribute of quotation process		Early Technical Assessment	DSS	Interface
Capture and assess customer needs			Standardized matter of capturing customer needs Quantify attributes valued by customer	
Determine response strategy			Select appropriate focus Identify risks in the strategy determination	
Enable organization to offer appropriate:	**Costs**	Early identify cost-drivers Determine most beneficial costing structure Timely and reliably identify critical items		Increase reliability
	Support in resolving technical issues	Early identify technical issues		
	Technical contribution	Timely recognize opportunities		
Generate and offer quotation				Increase level of detail

Activity automation is left out of the overview as it does not directly influence one of the parameters. Rather it enables the quotation process's participants to focus on customer value-adding activities.

Concepts are further developed and nonfunctional representations of the additional information systems are derived and presented in a focus group meeting with the quotation team. Elaborating on the objectives of the redesign and representations of the concepts incites a focused discussion on how the concepts can be improved in order to enhance customer-centricity.

6.3. Early Technical Assessment

Instead of performing the technical assessment as an individual task of the project engineer, it is proposed to perform this activity with the inclusion of the project buyer and possibly the cost engineer. It is also argued by Bramham et al. (2005) to perform the initial check and classification of the request details by multiple resources. Additionally, at BM2 there is also collaboration between the project engineer and project buyer in an early phase.

As there are no production costs made in-house and there is a high number of suppliers involved in the quotation process of ABC-SA, the quotation process is complex and inflexible compared to the benchmarked firms (Novak & Eppinger, 2001). Stressing the need to early identify technical issues and enable the project buyer to maintain an appropriate focus.

Objective

The objective of the early technical assessment is to:

- Early identify technical issues.
- Lower overall costs.
    - Early identify cost drivers.
    - Derive the most beneficial costing structure.
- Timely and reliably recognize critical items.
- Identify risks in the process.
- Increase the overall understanding of the product.

By timely identifying cost drivers and critical items, it enables the quotation team to focus on these items: the project buyer can request multiple suppliers for these items and the cost engineer is able to timely estimate the costs.

In addition, early identifying technical issues enhances early recognition for design improvements and an increased timeframe to resolve technical issues. The potential need to visit the customer is therefore also early recognized and maximum benefits can be gained.

Since deriving the most beneficial costing structure requires not only technical know-how but also knowledge on capabilities of specific suppliers and commercial understanding, collaboratively determining the costing structure is expected to be more beneficial.

Lastly, by collaboratively assessing the technical documentation it is expected to enhance overall understanding of the product and reduce the contact moments and rework.

Design

The As-Is process is to be seen in Figure 18, Appendix C, the To-Be process in Figure 24, Appendix J. To elaborate upon the main differences, an overview in timing, stakeholders and deliverables between the As-Is and To-Be process is depicted in Table 9.

Table 9: Delta analysis technical assessment

	As-Is		To-Be
	Resource	Timing	
Specify items	PE	Relative early	PE/PB/(CE)
Adjust specification of items	PB	Throughout the process	-
Recognize critical items	PE	Relative early	PE/PB/(CE)
Recognize cost drivers	PE/PB	Throughout the process	PE/PB/(CE)
Rate TPD quality		Not performed	PE/PB/(CE)
Identify technical issues	PE	Throughout the process	PE/PB/(CE)

The outcome of the early technical assessment is to be captured in the KPM; item specification, indication of critical items and cost driver recognition are captured in the list of subsequent items. TPD quality and completeness are rated in the DSS that is described in the following paragraph.

Implementation

Essential in the application of an assessment with multiple resources is an appropriate planning of the meeting. Since the project engineer, project buyer and possible the cost engineer have to

be available at the same time when an RFQ arrives, it is proposed to fix a number of timeslots per week with the quotation team that can be used when necessary. An additional advantage of these fixed timeslots, is the potential usability to hold a kick-off meeting.

6.4. Application of a DSS

Though not performed at any firms in the benchmark study, several authors provoke the use of a quantified decision making process in responding to an RFQ (Xiong et al., 2006; Zorzini et al., 2008).

Selecting an appropriate strategy requires capturing customer needs and the appreciation of these needs. At ABC-SA appropriate strategy determination is of increased importance as the remainder of the process is inflexible and highly complex due to the number of suppliers that are involved. Also sharing customer needs and expectations is found to be more troublesome at ABC-SA as the quotation team is organizationally separated from the sales department.

Objective

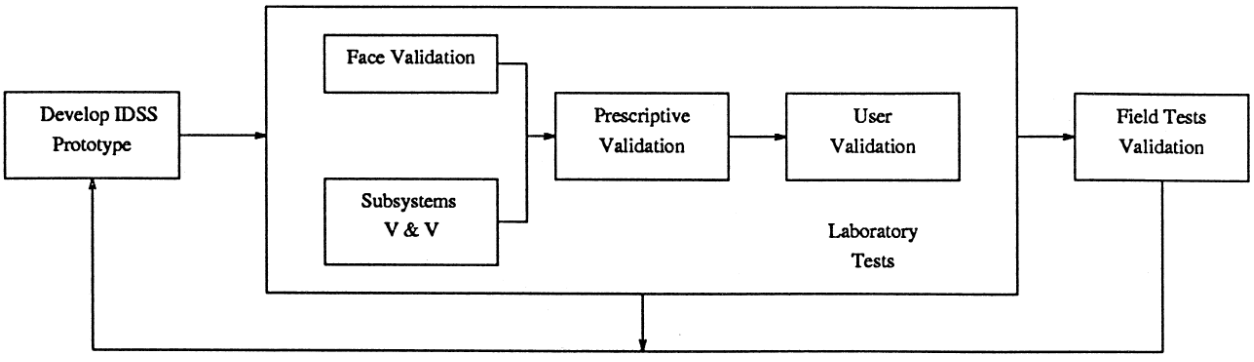
The Decision Support System (DSS) provides support in capturing and quantifying customer needs and in determining the response strategy as it aims to:

- Identify and quantity risks.
- Increase the overall awareness of customer demands.
- Increase the accuracy of the quotation team's workload estimation and quote delivery date.

By capturing relevant customer needs, the different attributes of the RFQ can be quantified and an appropriate focus can be selected.

For the design and validation of the DSS, the method developed by Borenstein (1998) is applied (Figure 7) and prior literature on RFQ assessment is studied.

Figure 7: DSS life cycle with emphasis on validation (Borenstein, 1998)



Design

Literature is studied, secondary data (Appendix D) is analyzed, the current RFQ feedback form is analyzed and the assessment criteria of ABC-SM are evaluated to derive the requirements of the DSS prototype, Table 10 depicts an overview.

Table 10: Relevant RFQ evaluation criteria

	Xiong et al. (2006)	Zorzini et al. (2008)	Veeramani & Joshi (1997)	Hicks et al. (2000)	ABC-SM	Sum
Completeness TPD			X		X	2
Delivery time relevance		X			X	2
Future business	X				X	2
Market circumstances				X		1
Quantity	X			X	X	3
Technical feasibility	X	X	X	X	X	5
Risk					X	1

To reduce the number of information artifacts used in the quotation process and enable certain fields to be automated, the DSS will be added to the KPM. The RFQ feedback form that is currently applied will be excluded from the process.

With use of the identified requirements a conceptual (nonfunctional) DSS was derived and discussed with the quotation team in a focus group meeting. Afterwards, the DSS was adjusted, the final design is to be seen in Appendix H.

Implementation

The resistance to implement the DSS is expected to be limited as it replaces the RFQ feedback form that is used by the calculator. Additionally, the amount of the required input data is below the data that is currently to be filled by the calculator.

6.5. Interface

Sawhney and Piper (2002) focus on organizational separation of order acceptance and bid preparation argue that increased effectiveness of a marketing-operations interface positively influences customer value. In organization theory functional interfaces are found to result in higher levels of effectiveness in communication. In addition, best practices in the SCOR-Model (SCC, 2012) indicate that communication of customer quotes is critical when the functional group responsible for accepting and managing the customer quotation is other than the customer service group.

The case analysis revealed that time and knowledge constraints at the sales department inhibited the thoroughness of the check and level of detail in the quotation. Complementary, the activities that are performed for each request are identical and offer opportunities for automating these activities (Dumas et al., 2013).

Objective

In the As-Is process, several resources are generating overviews and manually retrieving information in the quotation data (KPM) at different stages of the quotation process (represent simplified BPMN models of the As-Is processes, detailed processes are denoted in Appendix C.

Figure 8; Figure 9; Figure 10). This is a troublesome process as the data is scattered throughout the document and is not in a uniform structure.

The interface aims to automatically generate an overview on the quotation data in the KPM. Additionally, the interface enables a continuous check by the quotation team on the data they are generating. In sum, the purpose of the interface is to:

- Increase the overall understanding of the product.
- Reduce time on non-value adding activities.
- Increase reliability of data.

By increasing the overall understanding of the product, it is aimed to increase detailed product knowledge at the sales representative, found to be essential for selling complex products by Sharma et al. (2008). It enables them provide a more detailed quotation that highlights specific attributes that are most valued by the customer. For instance by increased transparency in the quotation such as applied by one of the benchmark firms by specifically mentioning cost drivers in the quotation.

In addition, increased reliability through the continuous check that can be performed by the quotation team is expected to result in more appropriate costs and leadtime. Moreover, the chances on rework are reduced and the quote cycle time will be reduced.

Design

While determining the aspects to be included in the interface, the activities of the project engineer, calculator and sales representatives are more closely analyzed as these resources require specific overviews on the quotation data. represent simplified BPMN models of the As-Is processes, detailed processes are denoted in Appendix C.

Figure 8, Figure 9 and Figure 10 represent simplified BPMN models of the As-Is processes, detailed processes are denoted in Appendix C.

Figure 8: Determine additional costs As-Is

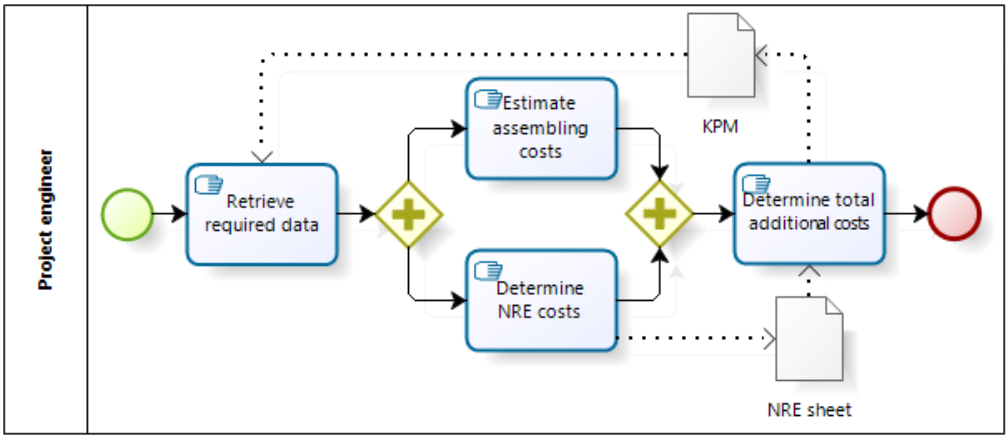


Figure 9: Determine deliverables As-Is

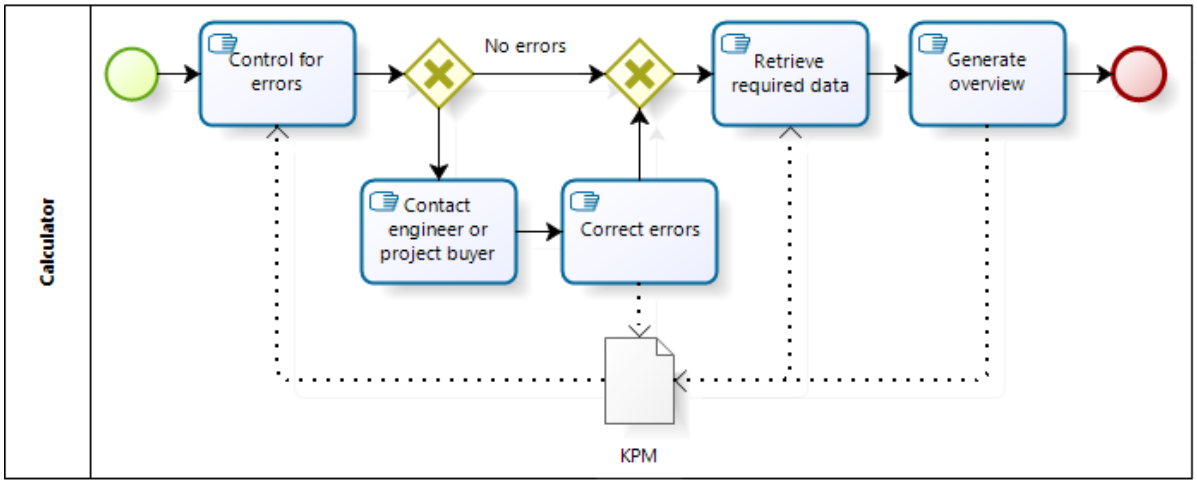
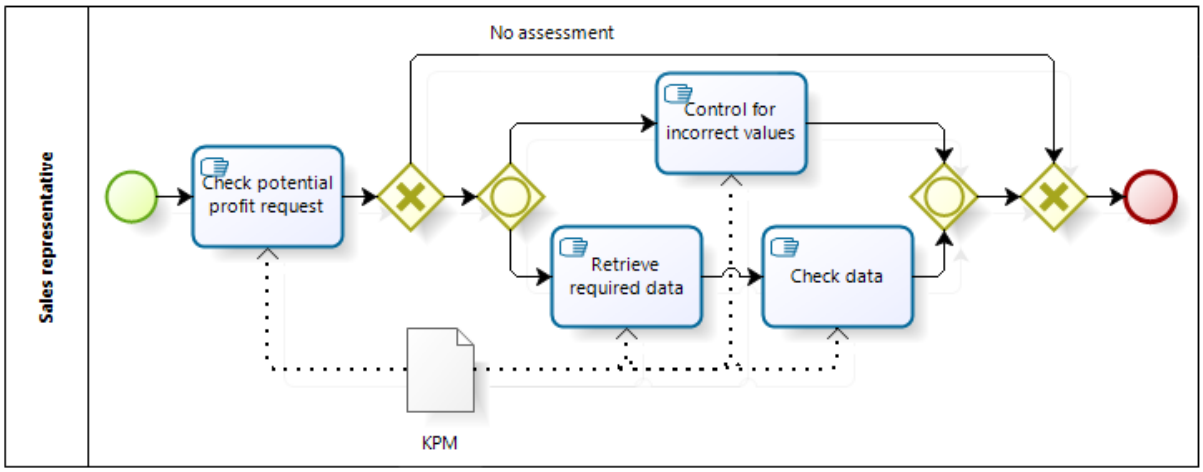
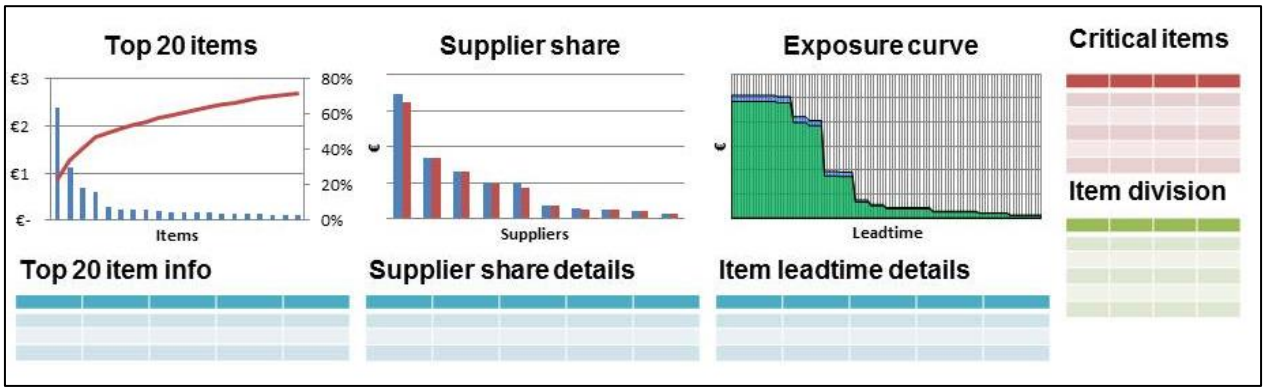


Figure 10: Analyze quotation data As-Is



Since the quotation data is generated in a spreadsheet document (KPM), the interface is an additional sheet that is included in this document. A conceptual version is derived from the requirements and is discussed in a focus group with the quotation team and with the business line managers. Afterwards, the conceptual version is adjusted with use of the given feedback. Resulting in the final design of which the outline is depicted in Figure 11.

Figure 11: Simplified representation of quotation team-sales interface



The top 20 items (cost drivers) are displayed in a Pareto graph with additional information on these items underneath the graph. Costs per supplier are depicted in the center graph with detailed information on the product types and number of items in the table below. An exposure curve reveals how the product leadtime evolves over time and gains insights on possibilities to reduce leadtime. Items are sorted on leadtime underneath the exposure curve along with the suppliers committed to these items. Additionally, there is information on the items classified as 'critical' by the project engineer and project buyer and the division of items with respect to item specification and number of new items is depicted in a table.

The To-Be processes are displayed in Figure 12, Figure 13 and Figure 14. Table 11 depicts the differences between the As-Is and the To-Be process per stakeholder that is affected by the interface.

Figure 12: Determine additional costs To-Be

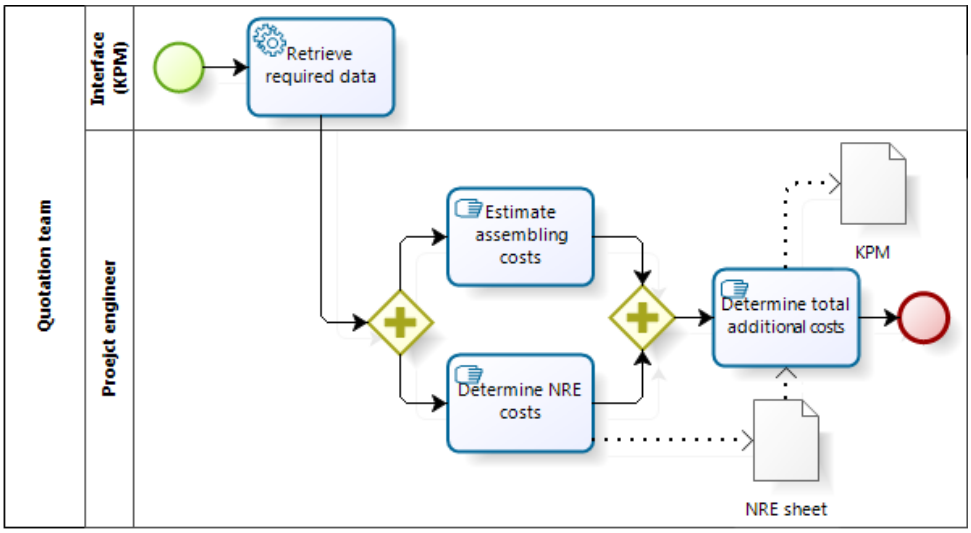


Figure 13: Determine deliverables To-Be

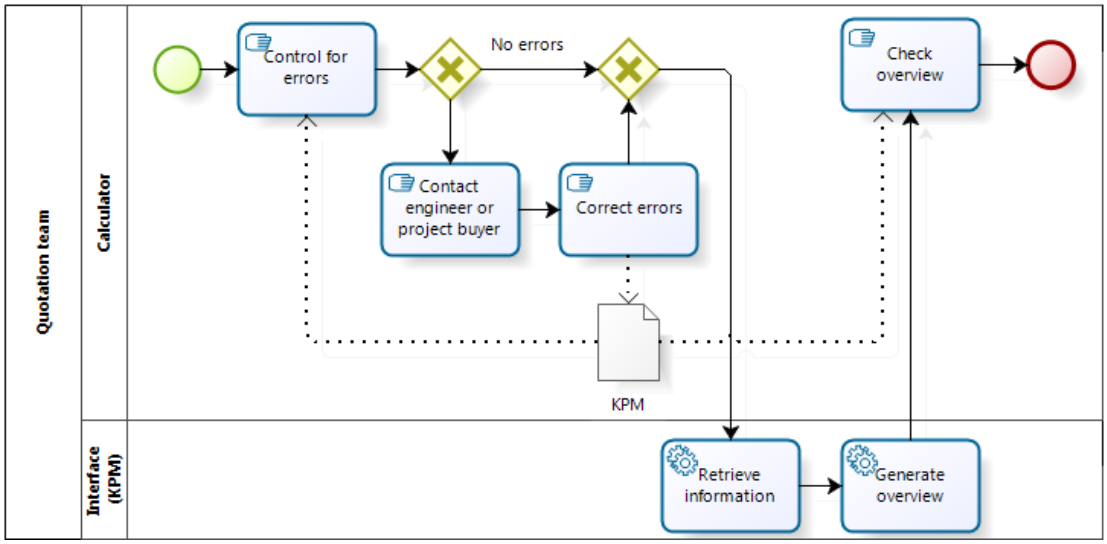
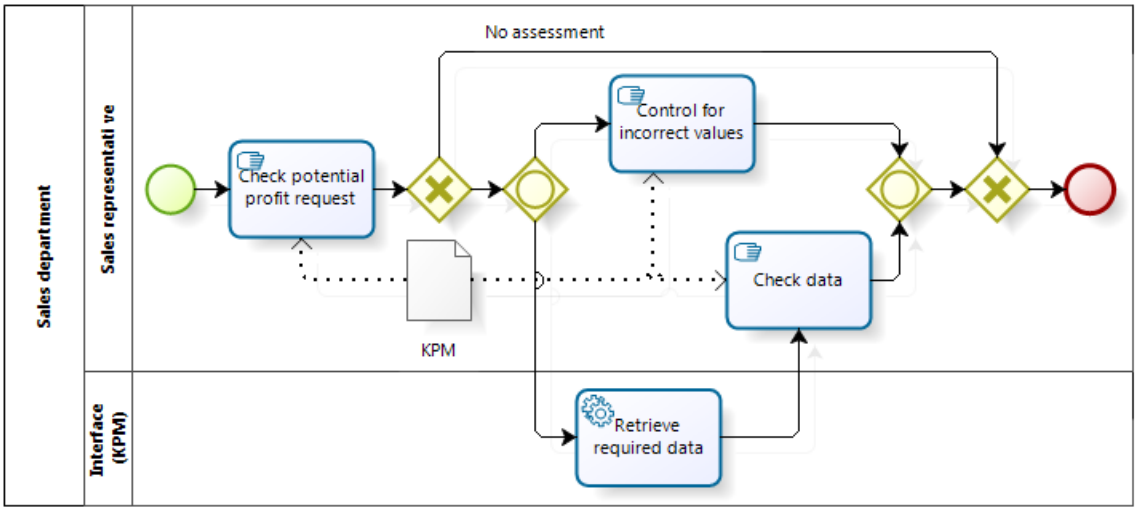


Figure 14: Analyze quotation data To-Be



To reduce the additional effort required to work in this matter, several automation activities are included in the KPM that are discussed in the following section.

Implementation

During the focus group meeting with the quotation team, they acknowledged the need to work in a more structural matter. As they perceived the benefits of the interface and are eager to use it, they indicated they were willing to do so. Automating activities will therefore also contribute to the ease of implementation.

Table 11: Delta analysis interface

Activity	Resource	Elaboration
Retrieve item costs	PE/PB	As the interface serves as a continuous check for the persons filling the data the reliability is aimed to increase and thereby also reduce the need for rework.
Determine the additional costs	PE	While determining the additional costs the, project engineer currently had to manually retrieve data on the division of items, critical items and suppliers. With use of the sales interface the required data is available.
Determine deliverables	C	While checking and controlling the data, the calculator has to analyze the quotation data, the interface will decrease the time to be spent on this task. Further, the calculator manually generates lists on items that require attention, have exceptionally long leadtimes or high costs. A large amount of these deliverables are generated automatically with the interface.
Analyze quotation data	AM/BM	Currently this analysis depends on the available time of the sales representative as it is a time consuming activity. With the interface the required time reduces.

6.6. Activity automation

Automating activities where possible is found to be faster and to increase the predictability of the outcome (Dumas et al., 2013). Benchmarked organizations also apply a more structured matter of processing data in the quotation phase with higher levels of automation.

Objective

For ABC-SA there are several activities performed that are similar for each request and therefore can be automated. The objective of automating activities is to:

- Decrease time on non-value adding activities.
- Increase data reliability.

A disadvantage related to automating activities that is considered by Dumas et al. (2013) is decreased flexibility. The flexibility that is currently embedded in processing data results in unstructured and cluttered data. Further, the activities will not all be fully automated, diminishing the concern on reduced flexibility.

Design

It is aimed to include identified automation possibilities in the KPM as to be seen in the overall To-Be model in Appendix I. To reduce duplicate input fields, several documents that are currently operated separately are combined in one central document where possible. Table 12 depicts the activities and artifacts that are affected by automating several activities. First, the activities that are to be automated are described:

Generate list with unique items: All incoming items are sorted on a BOM structure where items can occur multiple times underneath different sub-assemblies. For large requests, lists are made of unique items with the total quantity over the requested product. With this list, the project buyer can identify the batch size that is required to be purchased for each item.

Check for known items: items are currently checked manually with use of a data export out of the ERP-system on whether these are already applied in prior achieved orders.

Generate RFQs: generating RFQs to selected suppliers is done with a separate RFQ template in the As-Is process.

Assess supplier quotations: the comparison of multiple quotations on a single item is currently done in a separate document.

Predefine potential suppliers: the project buyer currently has to evaluate what suppliers are appropriate for requesting specific parts. By predefining what suppliers are most capable in providing low cost, high quality, short leadtime and thorough technical assessment it simplifies the supplier selection procedure (Qian and Tan, 2008).

Additional aspects: In addition to automating above mentioned steps in the process, it is also aimed to increase chances of identifying errors in the process by: highlighting duplicate items with different units of measurement and highlighting empty input fields.

Table 12: Expected effects of activity automation

	As-Is		To-Be	
	Resource	**Artifact**	**Resource**	**Artifact**
Assess supplier quotations	PB	Quote comparison tool	PB	KPM
Create list with unique items	PB	KPM	Automated	KPM
Check for known items	PE/C	KPM	PE/C (partially automated)	KPM
Identify duplicates	C	KPM	Automated	KPM
List potential suppliers	PB	KPM	Automated	KPM
Generate RFQs	PB	RFQ template	Automated	KPM

Implementation

In order to automate the activities, a more structural matter of processing data is required. This was also the case for the sales interface and acknowledged by the quotation team. As they recognize the benefits, the quotation team is willing to adjust their process. Further, an investment in developing the automation is required.

7. Validation of Redesign

Developing functional versions of the interface, DSS and automation of activities was not possible within the limited timeframe of this study. Therefore, it is not feasible to fully implement the redesign and validate it in the most optimal matter. In addition, Hvam et al. (2004; 2006) required more than three years to reveal significant results of BPR on the quotation process.

Through the development of conceptual representations of the redesign it is possible to properly communicate the redesign to its perceived users, thereby contributing to their ability to evaluate the redesign.

7.1. Early Technical Assessment

Firstly, the results of the questionnaire and statements by the process participants and owners are described.

Questionnaire results

Table 13: Questionnaire results on early technical assessment

	C	CE	PB	PE	BM
I think early TPD assessment will increase the overall outcome of the quotation process.	5,0	4,0	4,5	5,0	5,0
The earlier the TPD is assessed, the better.	5,0	4,0	5,0	5,0	5,0

Statements

Account manager: "By early identifying technical issues and communicating these towards the customer, the customer is aware that its request is taken into serious consideration, thereby it will positively influence our reputation".

Calculator: "The early identification of cost drivers in this assessment can eventually lead to better item prices".

Calculator: "Specifying the items and recognizing the critical items is essential in the remainder of the quotation process, especially when increased levels of automation are applied. It should therefore be done by multiple resources".

Project buyer: "I think collaboratively specifying items will result in a more beneficial costing structure".

Project buyer: "The recognition of critical items does not fully depend on technical knowledge but also requires procurement knowledge, therefore it should be collaboration between the engineer and project buyer".

Business line manager: "An early collaborative assessment will increase the quality of the quotation".

Business line manager: "One knows upfront where to focus on in the quotation process and everybody involved is aligned to the same goal".

Business line manager: "It takes appropriate planning and organization to manage the early assessment, if this is not properly managed it can lead to disillusion".

Project engineer: "An early check by the project engineer and project buyer results in early feedback to the customer who can improve quality and decrease costs".

Project engineer: "It can be time consuming if not applied appropriately".

Results analysis

It can be concluded that all involved recognize the importance and benefits of collaboratively assessing the TPD as early as possible. Overall, it is expected that early collaborative technical assessment offers possibilities to lower overall costs through a more beneficial costing structure, increased focus on critical items and early recognition of cost drivers.

In addition, it is found that reputation of ABC-SA can be enhanced by early communicating the recognized technical issues. Thereby contributing to the level of technical involvement at the customer's side.

Though the benefits are recognized, various persons also acknowledge the criticality of planning the early meeting such that it is timely and efficient.

7.2. Application of a DSS

The validation method of decision support systems by Borenstein (1998) (Figure 7) is applied to validate the DSS:

Face validity: the conceptual DSS was discussed in a focus group meeting with the quotation team and adjusted afterwards to ensure alignment of the retrieved decision variables and the potential users' views.

Subsystems V&V: the DSS is divided into different modules and it is defined what input the different modules require with use of past processed RFQs (Appendix D). Further, it is identified what input variables can be determined automatically from the data that is generated in the early technical assessment that is also included in the KPM document.

Predictive validation: past processed cases of which the results are known are to be used as test cases to compare the results of the DSS with the actual results. As the DSS is not functional yet, this method of validation was not applied in this study.

User validation: a questionnaire on 5-point Likert scale that includes ease of use, perceived usefulness and intention to use (Davis, 1989) is filled out by the quotation team and business line managers to assess whether the DSS can be of use in the actual decision making process and on selecting an appropriate response strategy. In addition to the questionnaire, statements are included that were made after presenting the DSS.

Calculator: "The DSS will facilitate communication towards the sales department and management".

Cost Engineer: "Certain aspects that are included in the DSS are essential for applying the correct focus during the process, I will check these before I perform my activities".

Business line manager: "Risks can be detected in an early phase".

Business line manager: "It increases the understanding of RFQ details and customer needs, and therefore the necessary focus of the quotation team".

Table 14: Questionnaire results on DSS

		C	CE	PB	PE	BM
Ease of use	I think the decision support system is difficult and hard to follow.	2,0	3,0	2,5	4,0	4,3
	Overall, I think it will be difficult to use the decision support system.	2,0	3,0	2,5	2,0	4,3
	I found the rules related to the DSS clear and easy to understand.	5,0	4,0	3,0	5,0	4,3
	Average ease of use:	4,3	3,3	3,3	3,7	4,3
Perceived usefulness	The DSS could help to identify and quantify risks related to a request.	4,0	3,0	4,0	5,0	4,3
	It will be easier to make an appropriate planning with the DSS.	4,0	3,0	3,5	3,0	3,8
	Average perceived usefulness:	4,0	3,0	3,8	4,0	4,2
Intention of use	I will not look at the DSS if an RFQ arrives.	1,0	1,0	2,5	1,0	-
	I intend to use the DSS in the future to analyze incoming requests.	5,0	4,0	4,0	5,0	-
	Average intention of use:	5,0	4,5	3,8	5,0	-

Business line manager: "It is essential to work in standardized and correct method to gain the envisioned results".

Project engineer: "Internal discussions will be initiated in an earlier phase through the application of the DSS".

Field tests validation: testing the DSS on actual cases requires the process to be executed several times. As the DSS is not functional yet, the average quote cycle time is between 4 and 6 weeks and a substantial amount of requests is required for proper validation this step is considered beyond the possibilities of this thesis.

Results analysis

The main objective of the DSS was to quantify attributes that are valued by the customer and contribute to the strategy determination. Both the calculator and business line managers have a high level of perceived usefulness on the application of a DSS and are confident that it contributes to selecting, communicating and maintaining an appropriate focus.

By capturing customer demands and thereby expectations the quotation team members perceive it will contribute to the overall understanding of the request and selecting the appropriate focus while generating the quotation.

Whereas the DSS was also expected to contribute in making a more appropriate planning in order to meet the quote delivery date, it is primarily recognized by the calculator and two business line managers. Other persons involved in validating the DSS did not perceive its usefulness in making an appropriate planning. Since the calculator performs the planning, it is less troublesome that other resources perceive a lower usefulness.

It is found by all except the cost engineer that the DSS contributes to the risk identification process. Specifically, the project engineer and business line managers acknowledge that it will enhance possibilities to identify risks.

Overall, ease of use and intention to use are rated high. With exception of the perceived ease of use by the cost engineer and project buyers. This is not considered as an issue for implementing the DSS as these resources do not provide any direct input in the DSS.

7.3. Interface

Next to requesting the process participants to fill a questionnaire, sales representatives were asked to track distinctive variables while analyzing the quotation data. Data with distinctive values was included in a trial version of the interface, the output was generated and it was checked whether these errors would have been recognized by the quotation team.

Questionnaire results

Table 15: Questionnaire results on interface

		C	CE	PB	PE	BM
Ease of use	I think the procedure for using the sales interface will be complex and difficult to follow.	1,0	2,0	3,0	1,0	1,3
	Overall, I think it will be difficult to use the sales interface.	1,0	2,0	2,5	1,0	1,3
	I found the rules related to the sales interface clear and easy to understand.	4,0	3,0	3,5	4,0	4,3
	Average ease of use:	4,7	3,7	3,3	4,7	4,6
Perceived usefulness	The sales interface would make it easier to analyze the data.	5,0	4,0	4,5	5,0	4,0
	The interface will save me time while processing data.	5,0	3,0	3,5	5,0	4,7
	I think working with the interface will make the process more controllable.	5,0	4,0	4,5	5,0	4,7
	The sales interface will increase the overall understanding of the requested product and thereby reduce the time spent on communication.	5,0	3,0	3,5	3,0	4,7
	It will be able to more easily spot incorrect values with the interface.	5,0	3,0	3,0	5,0	4,7
	Average perceived usefulness:	5,0	3,4	3,8	4,6	4,5
Intention of use	I intend to use the interface in the future to process data.	5,0	3,0	4,0	1,0	4,7

Statements

Cost engineer: "the interface will provide a better overview but I think it also requires more time to work in the required structured matter".

Business line managers: "It will provide a better overview and cross functional understanding of the product".

Business line manager: "With use of the interface, detailed information can be shared with the customer in an early phase and thereby increase the value of the quotation".

Business line manager: "It is essential to fill correct data as otherwise the output will also be incorrect, one should always distrust the data and think by themselves".

Project engineer: "the current version is of little use to me as I can only retrieve some information to determine NRE costs. Therefore we should look into the possibilities of including the determination of NRE costs".

Trial cases

Case A: An account manager found a label of €0,59 that was due to a mismatch in unity included for €5900, causing the total price in the quotation to be 20% higher than the actual price.

Due to the fact that this label was causing 20% of the total costs it was automatically included in the Pareto chart of the top 20 cost items. Therefore, the project buyer indicated that he would have recognized this with use of the interface, reducing the need for rework and risk of sending out a quotation with erroneous data.

Case B: After the conceptual interface was presented to the quotation team members, they asked whether the interface could be applied on a large request that was in process at that moment. The interface was generated and used to ease communication towards the account manager.

The project buyer and calculator indicated to be satisfied with the delivered interface. In addition, this specific customer requires the exposure curve which is included in the interface for its running projects.

Results analysis

Though the benefits of the interface are recognized by all involved, the ease of use and perceived usefulness differs per resource. This can be traced back to the resources' activities: the calculator perceives a higher usefulness and ease of use as the outcome of the interface largely influences his activities (Figure 13). A lower perceived ease of use is recognized by the project buyers as the interface mainly requires their process to be more formalized. Further the activities of the cost engineer are not directly affected by the sales interface and thereby his perceived usefulness is lower. However, he recognizes it will increase the overview on the RFQ that is being processed.

The intended increase in overall understanding of the product was acknowledged by the business line managers. They supported the increase in communication effectiveness and possibilities to increase quotation quality.

Further the expected effect of the interface on increased reliability of the quotation data is confirmed by its main users; the project engineer, calculator and business line managers. Also all participants endorse the increased controllability of the quotation data with use of the interface. Additionally, a trial case confirmed the ease in allocating flaws in the data and thereby increasing the reliability of the data.

Lastly, it is expected to reduce the time spent on the quotation, as it is indicated by its main users that the interface will reduce the time and increase the ease of analyzing data.

7.4. Activity Automation

As establishing a functional version of the automated activities was not possible during the timespan of this research, the recognized activities that are to be automated and the envisioned methods to automate these are proposed to the quotation team. Hereafter, the team members are asked to fill the questionnaire and give their opinions on the concepts.

Questionnaire results

Table 16: Questionnaire results on activity automation

		C	CE	PB	PE
Ease of use	I think the procedure to automate activities will be complex and difficult to follow.	1,0	2,0	3,0	1,0
	Overall, I think it will be difficult to apply the automation.	1,0	2,0	2,5	1,0
	I found the rules related to the automation clear and easy to understand.	4,0	3,0	3,5	4,0
	Average ease of use:	4,7	3,7	3,3	4,7
Perceived usefulness	I believe working with a more automated process will increase the reliability of the data.	5,0	3,0	3,5	4,0
	It will be able to more easily spot incorrect values with higher levels of automation.	5,0	3,0	3,0	4,0
	A more automated process will save me time and increase the quality of my work.	5,0	4,0	4,0	5,0
	Average perceived usefulness:	5,0	3,3	3,5	4,3
Intention of use	I intend to adapt my work in order to use the automated processes in the future.	5,0	3,0	4,0	4,0

Statements

Calculator: "A more automated process can save me time on processing modified rebuys and therefore increase the time I can spend on processing new system RFQs".

Project buyer: "I recognize the benefits of the interface and increased levels of automation but we should be careful in not exaggerating the formalization of the process such that the efficiency decreases".

Results analysis

As with the interface, the results differ per resource: perceived usefulness is higher at the calculator as he spends a large share of his time on processing data. The perceived usefulness of the cost engineer is relatively low as it does not directly affect his activities. Therefore his intention of use is also lower but does not affect the quality of the process.

All involved endorse the time that can be saved by automating several activities. Moreover, the calculator specifically indicated this reduces his effort on modified rebuys and increases his contribution to new system requests.

Another objective of automating activities was to increase overall reliability of the data, this is also confirmed by all involved.

Though there is sufficient intention of use, there are some quotation team members reluctant as they fear the required structural way of working results in a cumbersome process and will work counterproductive. This is not in line with their results of the questionnaire but it gives an indication that the implementation of this part is to be done with great care.

8. Conclusions and Recommendations

In this final chapter an answer is provided to the posed research question: *How to redesign RFQ response processes in the high-tech industry for enhanced customer-centricity?* After answering the sub questions and thereafter the main research question, recommendations are made and the contributions of this research are described. Thereafter its limitations are recognized and potential areas for future research are identified to resolve these limitations.

8.1. Conclusions

Firstly, the first posed sub question is answered:

- *Q1. How to measure the quotation process' performance?*

Order capture rate: though the order capture rate is defined in literature as the ratio between the amount of incoming requests and the amount of achieved orders, it does not represent an accurate indication of the quotation process. More signifying however, is measuring the potential turnover or profit that is related to the RFQs. Thereby associating the order capture rate to customer-centricity measures mentioned by Shah et al. (2006): share of wallet of customers, customer lifetime value and customer equity.

Order management costs: costs related to generating the quotation give an overall understanding of the effectiveness in processing the request. While measuring order management costs it is essential to control for product size, complexity, ease of communication, quality of delivered technical documentation and required deliverables.

Quote cycle time: measuring the quote cycle time is the most convenient measurement as it is the difference between the request date and the quote delivery date. Similar to the order management costs, the quote cycle time is also highly dependent on product size, complexity, ease of communication, quality of delivered technical documentation and required deliverables.

Ratio of meeting quote delivery date: due to the diversity in requests the ratio of meeting the confirmed quote delivery date is a performance measurement that is not fully applicable in the high-tech industry. Though it is important to deliver the quotation within an acceptable timeframe, there is a limited number of requests in which meeting the exact confirmed delivery date is considered essential. In all other cases it is more critical to communicate in cases the confirmed delivery date is likely to be exceeded.

- *Q2. How to capture customer demands and expectations in a matter that all persons involved in the process are aware of these?*

Specifically capturing and sharing customer demands and expectations is of less importance at organizations that are relative small or structured in business lines. In these business lines, resources are focused on one specific customer or market and therefore aware of the overall expectations.

With a centralized quotation team this relies on the communication between sales representatives and the quotation team. Applying a DSS that is embedded in the central quotation document increases the overall awareness of customer demands and expectations.

Additionally, kick-off meetings can be applied to elaborate on specific attributes that are likely to be valued by the customer. Requests where this is most beneficial are identified with the DSS.

Detailed, technical needs, can best be captured by direct communication between the vendor's engineer and the customer's engineer, possibly with a visit.

- *Q3. How to provide additional customer value during the quotation process and in the actual quotation?*

Increased customer value to enhance competitiveness can be achieved by increasing the role of project engineers in the quotation process. Checking the technical documentation on issues, suggesting quality improvements, cost reductions and leadtime reductions are found to be beneficial.

Essential while offering technical contribution in the quotation process is ensuring the other attributes are also within a satisfying frame. Further, suggesting alternations in design is not valued in certain requests, increasing the criticality of appropriate capturing customer needs.

As was the case with capturing customer needs, direct engineering contacts and possible visits are also essential while offering technical contribution.

- *How to redesign RFQ response processes in the high-tech industry for enhanced customer-centricity?*

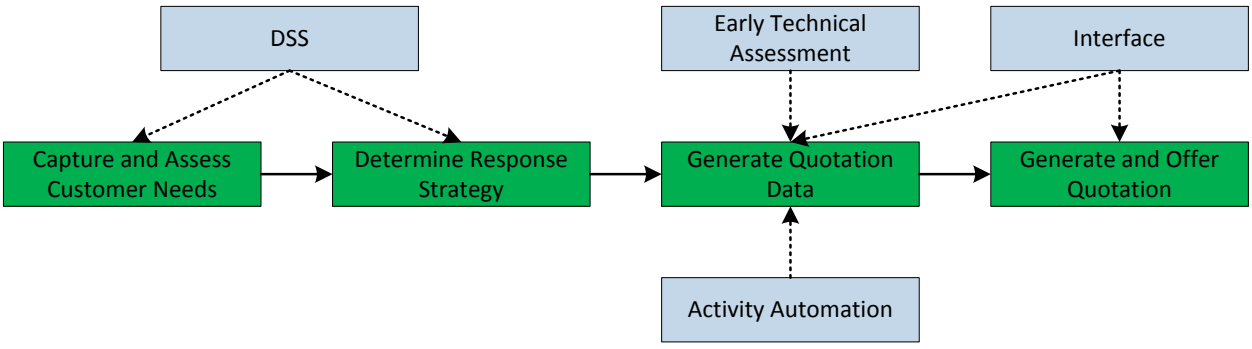
Customer-centricity can be enhanced by increasing focus on most beneficial aspects of the request: costs, technical contribution or quote delivery date. Next to focusing on these attributes, it is also essential to enable the organization to act in this matter. Therefore, the redesign offers opportunities to increase technical contribution, decrease costs and decrease quote cycle time.

Customer needs are quantified and appraised in a DSS and combined with the output of the early technical assessment to determine the strategy and focus of the quotation process.

An early collaborative technical assessment results in an early recognition of cost drivers and a more beneficial costing structure and thereby will contribute to the overall costs. In addition, technical issues and potential areas for design improvements can be recognized and communicated in an early phase towards the customer.

To increase focus on activities that do provide customer value, non-value adding activities are automated. Additionally, quotation data is displayed in an interface that increases effectiveness of communication by increasing the reliability of the data and overall understanding of the requested product. Moreover, the sales interface enables the sales representatives to generate more detailed quotations and thereby increase customer value. Figure 15 depicts all redesign actions (blue) and the effects on the different parts of the quotation process (green).

Figure 15: Effects of redesign



It can be concluded that an early collaborative assessment of the technical documentation and the application of a DSS contributes to selecting an appropriate focus for the quotation process.

Combined with the inclusion of higher levels of automation and a quotation team – sales interface it is found that overall focus on customer value i.e. customer-centricity, throughout the process is enhanced.

8.2. Recommendations

The goal of this research was to redesign a quotation process in the high-tech industry that increased customer-centricity. It is found that an early technical assessment, the application of a DSS, the use of a quotation team – sales interface and increased levels automation are beneficial. Conceptual versions are derived and therefore it is recommended to invest in these conceptual versions and implementation of these.

To gain the maximum benefits out of the purchasing process, it needs to be checked whether the appropriate focus, beneficial costing structure and early recognition of cost drivers and critical items can be applied correctly in the purchasing process. Selecting appropriate initial suppliers requires an understanding of what suppliers' competences are: low costing, fast delivery, high quality or possibly technical contributions.

In order to resolve the cost engineering resource constraint in offering a fast-track quotation process ABC-SA is advised to investigate the inclusion of cost engineers of other ABC-Group subsidiaries who have specific knowledge on the required production methods.

Further, it is recommended to look at opportunities for including the ERP system in the quotation process. Specifically requests that are alike requests achieved in the past, can be processed more reliable and efficient. Moreover, it aligns the quotation process with the new products introduction process and thereby reduces the required workload to make the transition from quotation to order.

8.3. Contributions

This study contributes to the research area of customer-centricity by enhancing customer-centricity in the quotation process of high-tech products.

With respect to creating customer value delivery strategy, the study contributes to recognized benefits of technical contribution (Sharma et al., 2008; Hunt & Jones, 1998) in the customer needs identification process. Further, the formalization of the decision making process through the application of a DSS reveals essential parameters in determining an appropriate response strategy for MTO organizations processing customized and complex requests that were not addressed by Xiong et al. (2006), Zorzini et al. (2008) and Bramham et al. (2005).

While translating customer value strategy into internal processes, it is found that this is troublesome for MTO organizations due to the complexity of the quotation process. As complexity increases with the number of organizations involved in the process, it is a major issue for organizations that are highly dependent on its purchasing activities. This study provides methods to obviate this issue and align the process with specific opportunities for advantage.

In delivering the customer value, this study offers opportunities to enhance customer value in a phase where a customer did not decide upon a potential vendor yet. Thereby contributing to relationship management.

Lastly, this study gains insights on approved quotation process' performance metrics and confounding variables that are affecting these.

8.4. Limitations and Future Research

Future research directions are determined by identifying limitations to the study and recognizing underexposed areas. First, the redesign is specific for the case study organization and therefore holds large limitations with respect to external validity, the extent to which results can be generalized in other contexts (Yin , 2013). Inclusion of benchmark organizations that confirmed similar issues and strategies enhanced the study's external validity.

The validation of the redesign could only be performed at the case organization as it was specifically designed for this organization. Therefore, the validation was limited to 8 persons and a small number of trial cases. Further, field validation, the final step in the DSS life cycle validation by Borenstein (1998) is not performed in this study as the DSS was not functional.

To resolve the issues on validity, further research is to be performed on the implementation of the redesign or extending the research to other organizations. Additionally, the redesigned process is to be executed several times to reveal whether it actually enhances customer-centricity.

Moreover, as the quotation team was also involved in the development of the redesign, they might give a biased view and thereby jeopardize internal validity.

Since providing technical contributions in the quotation process is found to be beneficial it provokes early supplier involvement in the customer's product development process. Therefore specific links between the quotation process and the concept of early supplier involvement is a potential area for future research.

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Abbreviations

AM Account Manager

ATO Assemble To Order

BM Business Line Manager

BOM Bill Of Materials

BPM Business Process Management

BPR Business Process Redesign

C Calculator

CE Cost Engineer

DSS Decision Support System

ETO Engineer To Order

KPM KostPrijs Monitor

MTO Manufacture To Order

NRE Non-Recurring Engineering costs

OEM Original Equipment Manufacturer

PB Project Buyer

PE Project Engineer

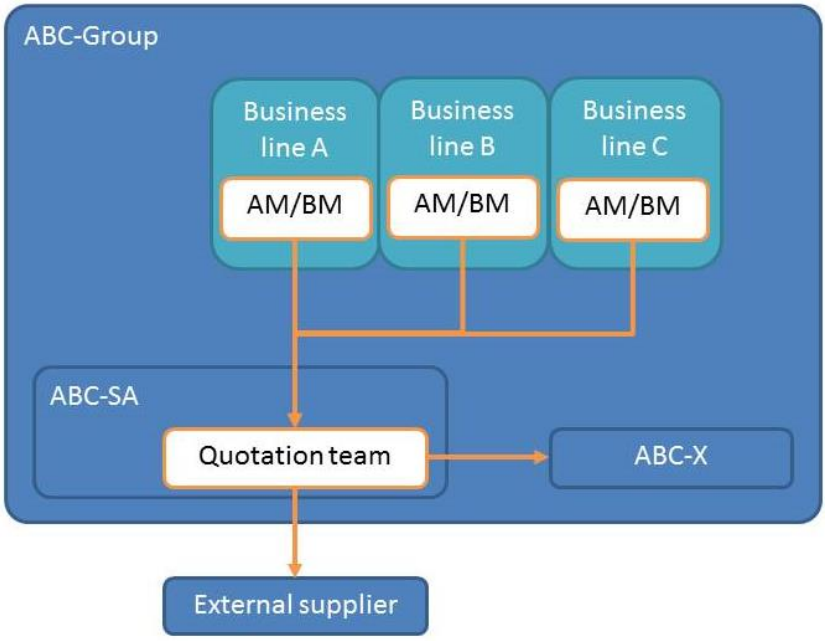
RFQ Request For Quotation

TPD Technical Product Documentation

Appendices

Appendix A: ABC-SA & ABC-Group

Figure 16: Organization ABC-Group



Appendix B: Interviews ABC-SA

Table 17: Overview interviews ABC-SA

	Management			Quotation team								Sales department						
Outline	NPI-M	OD	MD	C	CE	PB_1	PB_2	PB_3	PE_1	PE_2	PE_3	AM_1	AM_2	AM_3	AM_4	BM_1	BM_2	BM_3
Process analysis				x														
Process analysis				x		x			x									
Process analysis																x		
Process analysis					x													
Process analysis				x														
Process analysis												x						
Process analysis													x					
Process analysis																	x	
Process analysis														x				
Process analysis																		x
Process analysis															x			
Process analysis						x		x										
Process analysis										x	x							
Process analysis review/discuss concepts		x	x															
Process analysis review/discuss concepts	x															x	x	x
Focus group	x			x	x	x	x		x									
Validation of redesign				x														
Validation of redesign					x													
Validation of redesign						x	x											
Validation of redesign									x									
Validation of redesign																x	x	x

Management: New Products Introduction manager (NPI-M), Operational Director (OD), Managing Director (MD)
Current quotation team: Calculator (C), cost engineer (CE), project buyer (PB_1, BP_2), project engineer (PE_1)
Prior quotation team members: PB_3, PE_2, PE_3
Sales department: Account Manager (AM_1, AM_2, AM_3), Business Line Manager (BM_1, BM_2, BM_3)

Appendix C: As-Is process at ABC-SA

Appendix C-1: Unstructured interviews

Several interviews were held to capture the As-Is process and retrieve information on potential areas of improvement. Initially the calculator and new products introduction manager were asked to verify the high level process that was available at ABC-SA and indicate the discrepancies with the actual process.

After the high-level process was identified the different resources involved in the process were asked to elaborate on more specific questions to capture the actual As-Is process and retrieve potential areas of improvement.

Calculator

- Is the model representing the actual quotation process and what are misfits?
- What are the main activities of the quotation process?
- What information artifacts are applied to perform these activities?
- How much time is spent on these activities?
- What are areas for improvement for the quotation process?

Cost engineer

- What aspects of a quotation are estimated?
- How is it determined which items should be estimated?
- How do you estimate item costs?
- What information artifacts do you use while estimating the costs?
- What are areas for improvement for the quotation process?

Project buyers

- How is the request communicated towards purchasing?
- How are areas of attention / priorities indicated?
- How are RFQs sent towards suppliers?
- How is it checked whether the item costs are realistic?
- What information artifacts do you use in the purchasing process?
- What are the opportunities for achieving better item costs?
- What are areas for improvement for the quotation process?

Project engineers

- How is the request communicated towards engineering?
- How does communication towards the customer take place when technical issues are identified?
- How are areas of attention / priorities indicated?
- What is your opinion in value engineering in the quotation phase?
- What information artifacts do you use during the quotation process?
- What are areas for improvement for the quotation process?

Sales representatives (business line managers and account managers)

- How do you assess an incoming RFQ?
- How are customer needs forwarded to the quotation team?
- How does reducing quote cycle time affect the chances of achieving an order?
- What methods do you apply in offering the quotation?
- How do you evaluate incoming quotation data?
- What are areas for improvement for the quotation process?

Additionally processed RFQs in 2013 were discussed in an individual meeting with the sales representative who processed the requests in order to ensure the data that is included in the quote registration scheme is matching the actual data. Thereby posing the following questions:

- What is the current state of the request?
- If not achieved, what was the cause of not achieving this request?
- What method was applied in offering the quotation?
- What was the potential turnover of the request?

Appendix C-2: BPMN quotation process ABC-SA

Figure 17: Assess RFQ and determine strategy As-Is

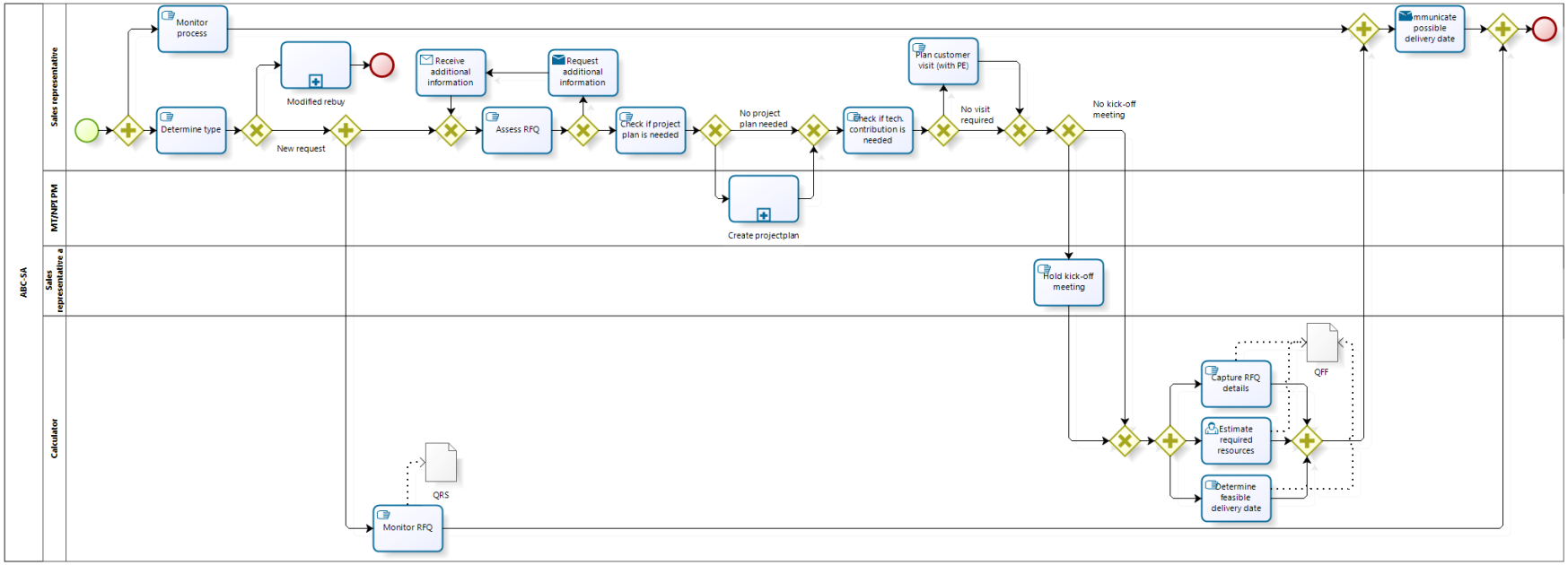


Figure 18: Assess TPD and determine structure As-Is

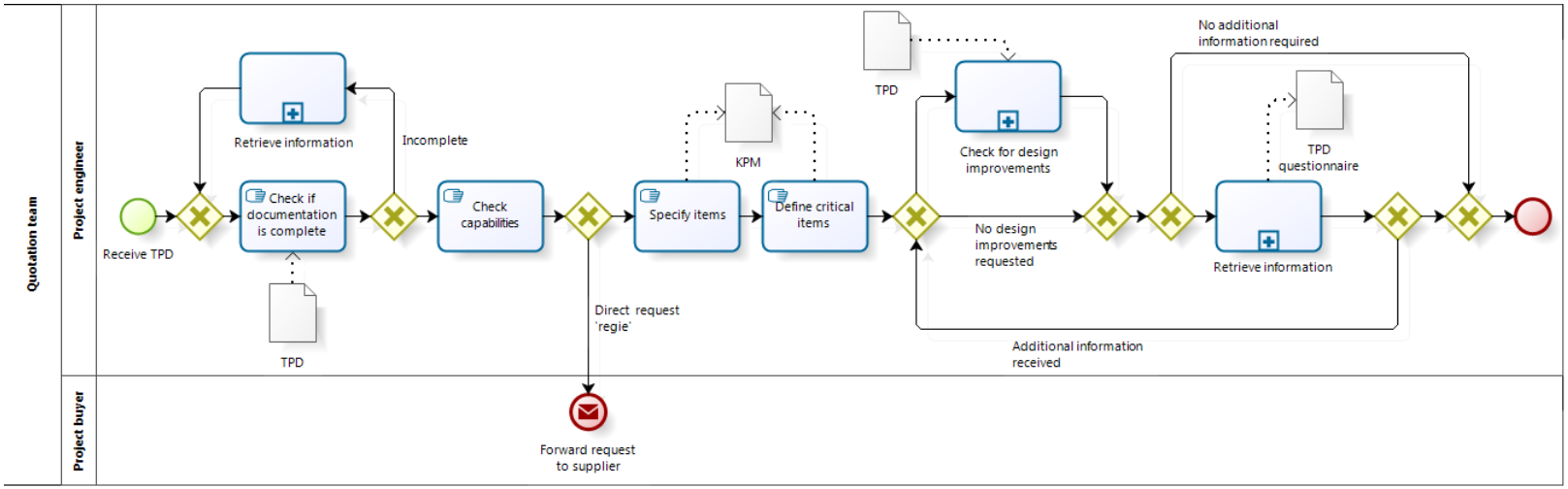


Figure 19: Retrieve item costs As-Is

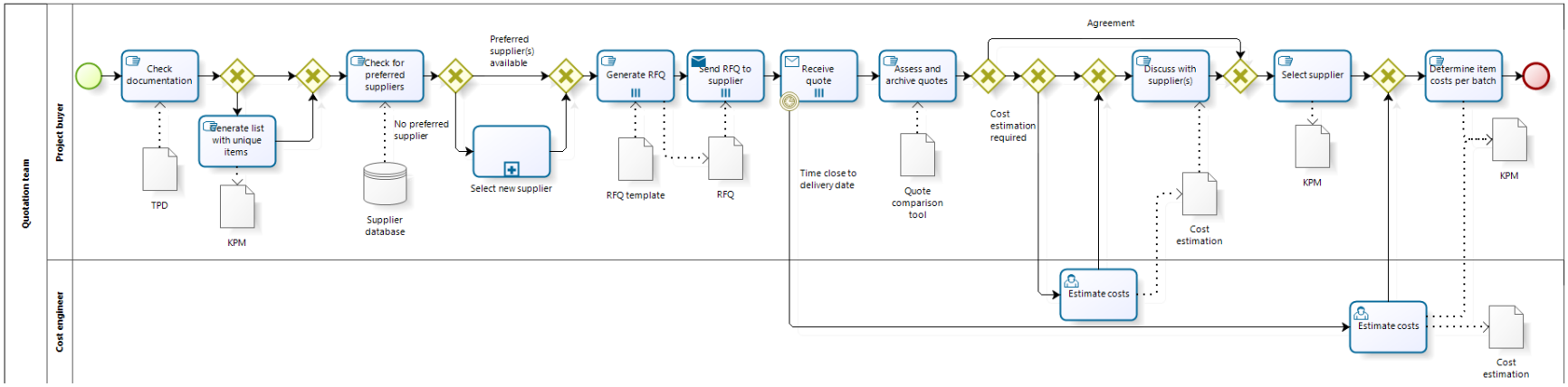
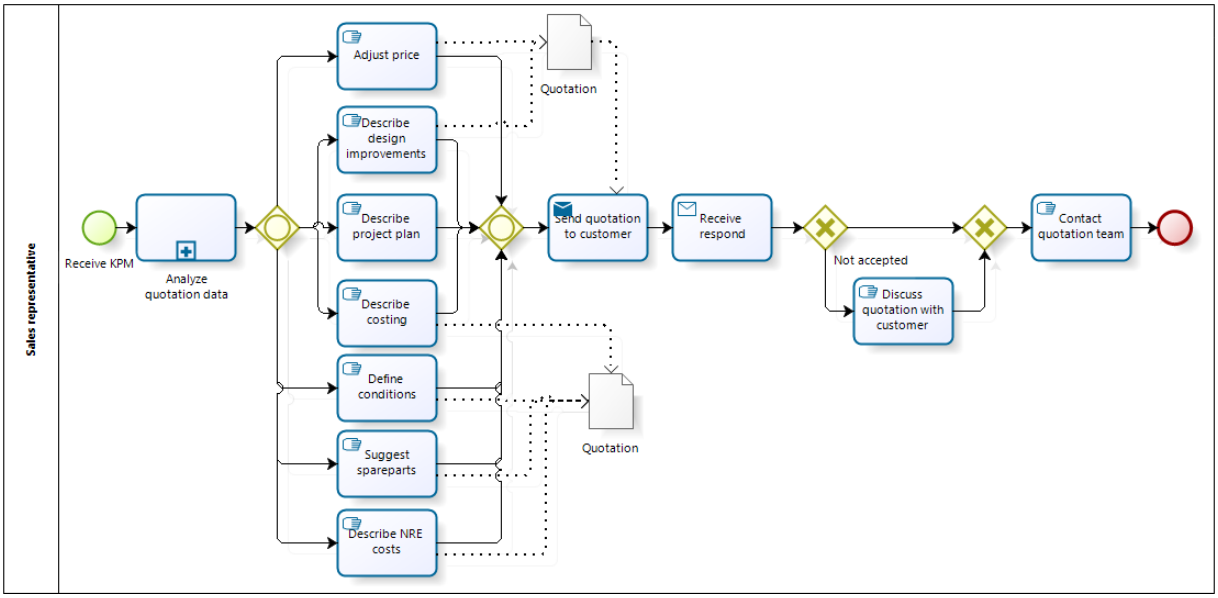


Figure 20: Generate and offer quotation As-Is



Appendix C-3: Information Artifacts

Quote Registration Scheme: an independent spreadsheet that is accessible to everybody involved in the quotation process. It is maintained by the calculator: the RFQ is registered when the request is made, hereafter the status is updated. The main information in the scheme is regarding the customer that made the request, request date, confirmed delivery date, date of acceptance/rejection.

RFQ Feedback Form: a form that is filled out by the calculator during a meeting with the responsible account manager or business line manager of the request. The form is a separate, standardized spreadsheet format that is stored on the network.

KostPrijs Monitor: standardized spreadsheet template that is filled separately for each RFQ by the calculator. The project engineer defines the categorization of the different items that are coupled to the requested assembly. Hereafter the project buyer fills the costs per requested batch possibly with aid of an estimation made by the cost-engineer.

Calculation Tool: a standard calculation tool that is created in a spreadsheet format. Activity Based Costing is used to estimate the production costs of an item that is to be filled in the KPM. The calculation sheet is used by the cost-engineer.

TPD Questionnaire: used by the project engineer and project buyer to capture their questions while analyzing the TPD, formalized in a spreadsheet format.

Quote Evaluation Tool (differs per request): to compare two or more supplier quotations on multiple items, used by the project buyer.

RFQ Template: requests are sent out by the project buyer towards suppliers with use of a standard template. Data is copied from the KPM and included in the template to request multiple items at once at a supplier.

NRE Sheet: template to calculate one-off engineer costs used by the project engineer.

Table 18: Usage of information artifacts in process

	Usage ratio	Users				
		AM/BM	C	CE	PB	PE
Quote Registration Scheme	100%	X	X			
RFQ Feedback Form	50%	X	X			
KPM	100%	X	X	X	X	X
Calculation Tool				X		
Questionnaire	90%				X	X
Quote Evaluation Tool					X	
RFQ template	100%				X	

Appendix D: Case analysis

Appendix D-1: Arguments for selecting cases

The multiple case study aims to explore differences between cases. Therefore the cases have been selected with care:

- Achieved orders: Orders that were accepted are compared with orders that are not achieved.
- Not achieved based on excessive costs: As this is the main attribute that is not deemed within an appropriate range by the customer.
- Specific effort in technical contribution: To check whether design improvements positively influences customer value.
- Technical issues: When there are technical issues included in the TPD, it inhibits the quotation team to appropriately process the request. Resolving these issues appropriately is argued to result in increased customer value.
- Engineer: 6 requests of engineer A are selected and 5 of engineer B to increase validity, the other quotation team resources are the same.

Table 19: Arguments for selecting cases

Case	1	2	3	4	5	6	7	8	9	10	11
Achieved	x	x	x	x							
Not achieved on costs							x	x	x		
Specific effort in technical contribution		x			x				x	x	
Technical issues					x	x					x
Engineer	A	A	A	B	B	A	A	A	B	B	B

In addition there is controlled for:

- Product complexity: Complex products require more time and resources.
- Product importance: There is increased attention for high importance requests.
- TPD quality: argued by the majority of persons that this is highly effecting the quote cycle time.
- Resources: the type and amount of resources spent on generating the request is expected to affect the outcome of the request.
- Quote cycle time: Long quote cycle times could result in dissatisfied customers.

Appendix D-2: Case study interview protocol

All relevant information on the specific requests handled by the project engineer was presented and afterwards the following questions were posed:

General request information

1. Is the indicated status of the RFQ correct and if not achieved, do you agree upon the indicated cause of not achieving?
2 Was it a request on a new product, a redesign or an existing product?
3 In case it was a redesign or existing product, what was the production location at the time the product was requested?
4. Was it a change in strategy or a benchmark request (please indicate if otherwise)?

Technical Product Documentation

5. On a scale from 1 to 5, how would you rate the TPD quality?
6. What issues were included in the TPD?

Customer communication

7. On a scale from 1 to 5, how would you rate the communication with the customer?
8. Did you visit the customer during the quotation process?
9. In case the customer was visited, what was discussed during the visit?

Technical contribution

10. How much commitment was included in providing technical contributions?
11. What kind of technical contributions were made?
12. Did the customer value these contributions?

Other

13. Were there any other issues during this quotation process?

Appendix D-3: Measures case study

Table 20: Multiple-case study measures

Case		Measure(s)	Source
Status		Achieved, not achieved, pending	Quote registration scheme Project engineer interview
Comment on status		Cause of not achieving	Quote registration scheme Project engineer interview
Product type		New, existing or redesign	RFQ feedback form Project engineer interview
Motivation request		Benchmark, outsource decision, global tender, …	Project engineer interview
Request value		Potential turnover Future business New customer	KPM Sales representative interview
Product complexity		Number of components Component interactions Product novelty	KPM
TPD Quality		Very low – very high	Project engineer interview
PE customer visit		No visit, early - late visit	Project engineer interview
Communication		Very bad – very good	Project engineer interview
Technical contribution		No technical contribution, very low – very high	Project engineer interview
Quote cycle time		Difference RFQ date and quote delivery date	Quote registration scheme
Delivery date		Difference requested delivery date and actual delivery date	Quote registration scheme Quotation
Order management costs		Resources spent on quotation	ERP-system
Quotation content	**Costing details**	Number of lines and aspects	Quotation
	Technical remarks	Number of lines and aspects	Quotation
	Project plan	Number of lines and aspects	Quotation
	Sum	Sum of costing, technical remarks and project plan	Quotation

Appendix D-3: Case study results

Case A (achieved):

- RFQ information: Redesign on existing product that was produced in-house at the customer at the time the RFQ was sent. Relative small size but high complexity due to a high ratio of sub-assemblies and custom made items. Importance of the RFQ was low as potential turnover was low and the order did not give a direct opportunity to future business or new market entry.
- Order management costs: high compared to its small size, caused by changes in design made by the customer during the quotation process. Mediated by the high quality of the TPD and high ease of communication that is argued to always be good for this specific customer.
- Technical contribution: limited, some issues were discussed during customer meeting. Customer visited ABC-SA for other reasons; ABC-SA took opportunity to discuss TPD while customer was at ABC-SA.
- Offered quotation: Quotation holds limited information with respect to costing and technical remarks and no project plan and high level approach included.

Case B (not achieved):

- RFQ information: Different sub-assemblies that were produced for a significant time period at other suppliers. Product was requested at ABC-SA for assemblage in Czech to check if costs could be reduced, typical benchmark request. Combined size of the sub-assemblies was relatively high but complexity was below average. Request was important due to the high potential turnover that was related to it.
- Order management costs: very high due to size of the request, incomplete TPD and low quality of TPD. Issues were lately recognized after RFQs were sent to suppliers. Therefore excessive purchasing resources were spent.
- Quote cycle time: very high, caused by the size of the request, but primarily the low quality of TPD and ineffective communication on the recognized issues in the TPD.
- Technical contribution: not performed during the quotation phase as the TPD was inadequate. Customer was visited at a late stage in the quotation process to resolve technical issues by another engineer than the one that performed the majority of the engineering activities in the quotation process.
- Offered quotation: eventually the quotation was not offered at all since there were still technical issues that were to be resolved and the customer was not open to spend any resources to resolve these.

Case C (not achieved):

- RFQ information: Existing product that was produced in-house at the time of request. Specific product is a redesign on a product (87% of item was known at the organization) that was requested in the past but maintained in-house. Relative large and complex product with low annual quantity. Therefore the importance of the request is considered to be moderate.
- Order management costs: Low as the request was similar to request in the past and the quality of the TPD was good.
- Quote cycle time: Longer than necessary for a product with high similarities, caused by ineffective communication with the customer.
- Technical contribution: No technical contribution was delivered in the quotation and during the quotation process.

- Offered quotation: very limited information included in the quotation: elaboration on costing and general conditions.
- Cause of not achieving: product price and leadtime were indicated as the determinants for not achieving the order. Inappropriate leadtime was fully caused by subsequent items with a leadtime that was deemed too high by the customer. Pricing was caused by inappropriate item costs; certain cost drivers were not requested at multiple suppliers. Additionally a part of the NRE costs were included in the sales price of the first batch.

Case D (achieved):

- RFQ information: Existing product that was produced in-house at the time of requesting the product. Product was large, complex and had a significant annual quantity. In addition with the fact that the request was made by the main customer of the organization the request was considered of critical importance.
- Order management costs: very high due to the size and complexity of the requested product and the effort that was included to provide a high quality offer in a high number of batch sizes. Due to the criticality of the project additional resources on project management were spent during the quotation process. High quality of the TPD and efficient communication during the process reduced the required effort to generate the quotation.
- Quote cycle time: relative short in relation to the required effort to generate the quotation. High quality TPD and effective communication shortened the quote cycle time.
- Technical contribution: the technical contribution in the quotation was limited to suggesting several possibilities for cost reductions. Customer was not visited during the quotation since there was the possibility to directly contact the engineer on customer side.
- Offered quotation: includes a very high level of detail; project plan is described, high-level project approach, detailed elaboration on costing, technical remarks, general conditions and risk.

Case E (not achieved):

- RFQ information: product of moderate size and complexity that was produced in-house at the moment of requesting the quotation. A relatively high and ascending annual quantity caused the importance of the request to be above average. The customer requested for specific suggestions for design improvements in its RFQ.
- Order management costs: although additional effort was included on suggesting design improvements the order management costs were of average size. As providing design improvements requires technical knowledge, the majority of the order management costs were made on project engineering resources.
- Quote cycle time: eventually the quote cycle time was large as the quotation was offered twice. The costs included in the initial offered quotation were deemed too high by the customers and a second quotation was offered with cost reductions included.
- Technical contribution: very high as the customer specifically requested for it. To elaborate on the design improvements the customer was visited with the inclusion of a project engineer in the middle of the quotation process. The customer indicated to be satisfied with the offered design improvements.
- Offered quotation: a highly detailed quotation was offered with high elaboration on the design improvements. Additionally open costing was applied.
- Cause of not achieving: thought the customer indicated that costs were too high in the initial offered quotation and a second quotation was offered with cost reductions the costs were still argued to be too high by the customer. Cause for the costs being too high

could be the account manager that placed an additional margin on the open costing structure. It is not known what the difference of the acceptable price and the offered price was.

Case F (achieved)

- RFQ information: three correlated modules that were produced in-house at the moment of requesting the quotation. Customer asked specific for transfer to Czech in the quotation. Low ratio of custom made items but high level of sub-assemblies. Therefore the level of complexity is considered moderate. Size of the combined modules was above average. Due to potential turnover of the request and the future possibilities with this specific customer the request was considered of high importance.
- Order management costs: costs made on generating the quotation were about average. Project engineering and purchasing resources were larger than normal. This is caused by the moderate level of TPD quality and no direct contact with the project engineer on customer's side.
- Quote cycle time: as with the order management costs the quote cycle time was also of average length. Caused by indirect communication on technical issues and large number of requested batch sizes.
- Technical contribution: no specific resources were spent on identifying possibilities for technical contributions.
- Offered quotation: the level of details included in the quotation was very high compared to other quotations. Module costing was highly detailed described, technical remarks were included, project role out was included and additionally there was an elaboration on the transfer.

Case G (pending)

- RFQ information: redesign on product that was produced elsewhere when the quote was requested. Product was of average size and complexity but of large importance as it considered a new customer with high annual quantity, large potential future business and enlargement of the share in a specific market.
- Order management costs: very high, specifically project engineering and cost engineering resources were high. This was caused by multiple factors: the TPD quality was low, TPD was in French and other norms were applied, TPD was not finite, level of communication was very low and specific resources were spent on suggesting design improvements.
- Quote cycle time: very high, due to the fact that it was a new customer and the above mentioned causes.
- Technical contribution: very high to enhance chances on achieving new business with this specific customer. Alternative parts were suggested and the appropriateness of specifications was checked in detail. Customer indicated to be satisfied with the proposed design improvements and made a follow-up request. Also the customer adopted some of the design improvements in its current design. The customer was visited in an early stage with the inclusion of the project engineer to reveal capabilities.
- Offered quotation: costing was described in detail and the potentials of a transfer were included in the quotation. After the initial quotation was offered the customer indicated the costs included in the quotation were 20 to 25% too high. An item list with the differences in the prices the customer currently paid and what was offered by ABC-SA. Further analysis revealed the item costs were inappropriate due to incorrect prices that were filled, not recognizing cost drivers and requesting these at multiple suppliers.

- Status comment: the request is still pending as the customer did not make a finite decision yet. Due to positive feedback of the customer the quotation team and sales representative are confident that the order will eventually be achieved.

Case H (not achieved)

- RFQ information: new product of an existing customer, classified as a 'fast-track' request as the customer requested to quote the proto costs and an indication for the series costs within 1 week. Request was small and of low complexity but with high added value. Therefore the importance of the request is considered low.
- Order management costs: very low due to the size and complexity of the product. Relatively high on cost engineering resources since the items were estimated rather than requested at suppliers. Causing the project buyer resources to be lower than average.
- Quote cycle time: very short since it was requested by the customer and the item costs were estimated.
- Technical contribution: limited, a few issues regarding tolerances identified. Other potential areas for improvement were identified but not discussed. There was no customer visit during the quotation process.
- Offered quotation: low details due to the size and complexity of the product and the required quote cycle time. Technical remarks concerning the tolerances were included in the quotation.
- Cause of not achieving: the series pricing was above the proto price offered by a competitor. Root cause of the price being too high were additional margins that were included to delineate risks. Additionally one of the competitors had experience with similar products and therefore gained better prices and had more knowledge on these items. An evaluation with the customer took place to evaluate the 'fast-track' process that was applied to generate the quotation.

Case I (not achieved)

- RFQ information: request from a new customer on a product that was produced in-house at the time the product was requested. Specifically requested for production in Czech. Small product with low complexity but highly important since it concerns a new customer and above average annual quantity.
- Order management costs: below average since most components were estimated rather than requested by suppliers. Very high share of cost engineering resources and project engineering resources as specific effort was spent on offering design improvements.
- Quote cycle time: very short as most items were estimated by the cost engineer and there was no queuing time on suppliers' quotations.
- Technical contribution: high level of technical contribution that was discussed with the cost engineer and project engineer at the customer. Customer indicated to be satisfied with the suggested design improvements and cost reductions.
- Offered quotation: detailed for a small and low complex product. Elaboration on project approach, module costing, technical remarks and assumptions during the quotation process was included.
- Cause of not achieving: the customer indicated that there was no longer a need for the requested product. As price and technical contribution were satisfying the customer made a follow up request for a larger product.

Case J (not achieved)

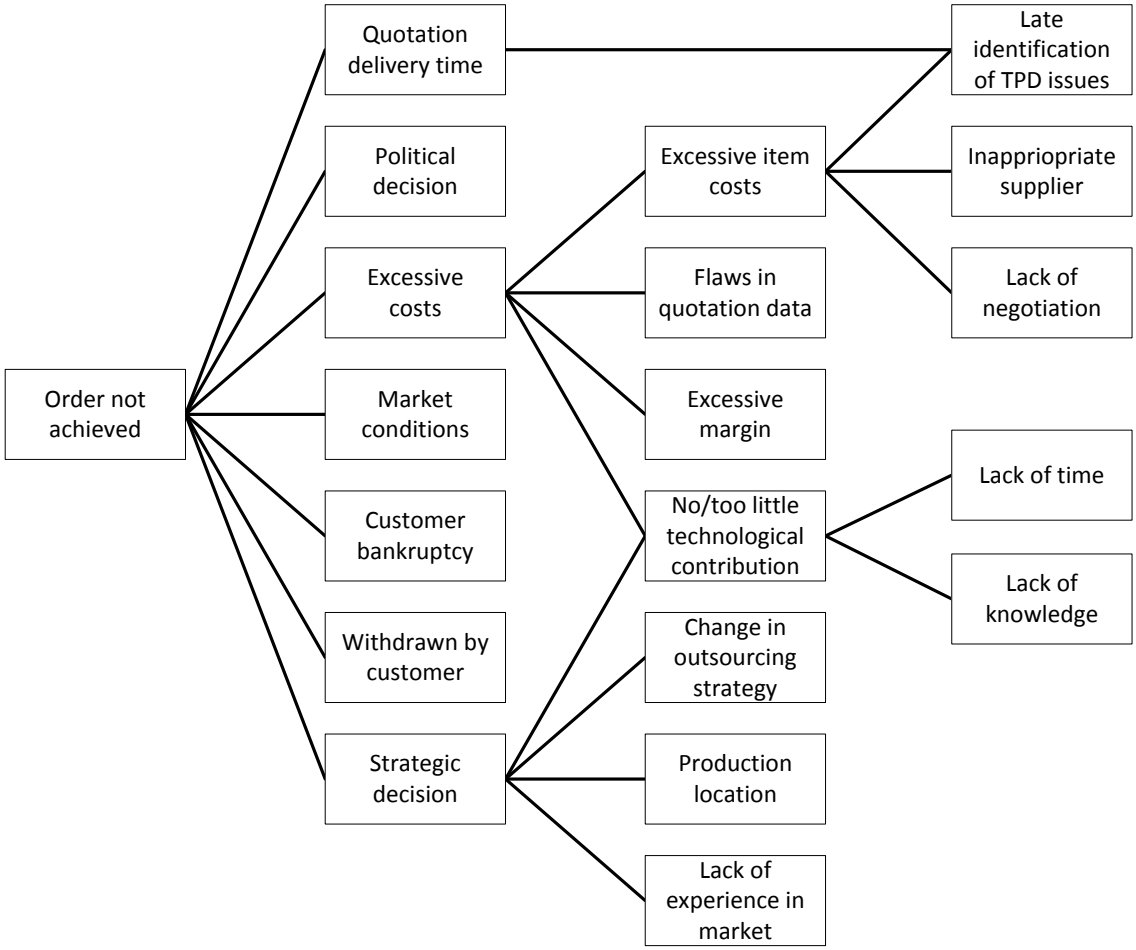
- RFQ information: New product of small size and low complexity. Since the costs are relatively high the request is considered of average importance. The product was requested specifically for assemblage in Czech.
- Order management costs: low since it concerned a small and low complex product. Additionally no technical contributions were made during the quotation process but since the TPD quality was rather low the customer was visited to resolve these issues.
- Quote cycle time: of average size due to issues in the TPD, the customer did not request a quotation delivery date.
- Technical contribution: some suggestions were made on costs and manufacturability but relatively low effort was put in to making these suggestions.
- Offered quotation: Of average level of details considering the size of the request. Elaboration on costing, technical remarks, general conditions and assumptions made during the quotation process were included.
- Cause of not achieving: though there is no finite decision made by the customer yet the proto product is rewarded to a competitor. As chances are low the customer will make a change in supplier after the proto has been produced at another supplier the request is classified as 'not achieved'. Cause for not achieving the proto order is not uniform; the sales representative indicated the quotation was offered too late, the quotation team indicated the customer based its decision 'not in line with ABC-SA capabilities'. The latter is peculiar since the customer made an RFQ to ABC-SA for a reason.

Case K (achieved)

- RFQ information: Three related modules that were produced in-house at the time of requesting the quotation. The combined size of the request was of average size and below average complexity. Due to the large future business at this customer (same customer as case F) the request was considered of high importance.
- Order management costs: Of average size but high project engineering resources due to large ratio of custom made items and some identified technical issues.
- Quote cycle time: quotation delivery date exceeded the date agreed with the customer. Partially caused by the inert communication with the customer that went through a project buyer on the customer's side. Additionally the large ratio of custom made items caused supplier queuing time to be of significant size.
- Technical contribution: not performed in this quotation since the product was produced for a significant amount of time in-house at the customer. Therefore the design is stabilized and offering design improvements was not deemed beneficial. The customer was not visited during the quotation process, to resolve the technical issues a lot of conference calls took place.
- Offered quotation: detailed quotation with specifically details on project role out and high level project plan. Further the costing and technical remarks were highlighted in the quotation.

Appendix E: Cause and effect diagram

Figure 21: Cause and effect diagram not achieved orders



Appendix F: Benchmark study interview

Appendix F-1: Semi-structured interview

After a brief introduction on the research topic and the objectives of the study the following questions are posed:

Context

- Wat is de gemiddelde complexiteit ten opzicht van ABC-SA? (Zeer laag/laag/gelijk/hoog/zeer hoog)
- Wat is de gemiddelde product grootte die wordt aangevraagd ten opzichte van ABC-SA? (Zeer klein, klein, gelijk, groot, zeer groot)
- Hoe groot is het gemiddelde deel van een offerte dat in-house wordt gemaakt? (Zeer klein, klein, gelijk, groot, zeer groot)
- Wat is het gemiddelde niveau van customization? (Modular, flexible, extreme)

Algemeen

1. Hoe ziet het huidige offertetraject eruit?
    - Wie zijn hierbij betrokken en hoe is dit georganiseerd?
    - Is hier een model van beschikbaar en is dit model een weergave van het werkelijke proces?
    - Is dit voor iedere klant hetzelfde?
2. Wat is het huidige percentage van behaalde omzet met offertes ten opzichte van de totale potentiële omzet van offerteaanvragen?
3. Wat zijn voorkomende redenen voor het niet behalen van orders en hoe zijn deze verdeeld?
4. Hoe vaak gebeurt het dat er geen aanbieding wordt gemaakt op een aanvraag en waarop kunnen er aanvragen worden afgewezen?

Kosten

5. Hoe worden kosten bepaald, welke methodes worden gebruikt?
6. Wie maakt make-buy beslissing?

Opleverdatum offerte

7. Wat is de gemiddelde doorlooptijd voor het genereren van een offerte?
8. Welke aspecten zijn het meest bepalend voor de doorlooptijd van de offerte?
9. Hoe vaak wordt de afgegeven opleverdatum overschreden?
    - Hoe en wanneer wordt het gecommuniceerd wanneer dit (waarschijnlijk) gebeurt?

Vaststellen klantwensen

10. Hoe worden klantwensen herkend en vastgelegd?
    - Is er directe communicatie mogelijk tussen engineers met betrekking tot technische vragen?
11. Welke communicatiemiddelen worden er tijdens het offertetraject gebruikt?
12. Hoe worden aanvragen beoordeeld bij binnenkomst?
    - Wordt de slagingskans geschat?
    - Is de motivatie van de aanvraag bekend (benchmark, capaciteitstekort, ontevredenheid huidige leverancier, …) en wordt deze vastgelegd?

Verwerken van informatie

13. Welke systemen/software wordt hiervoor gebruikt?

Extra waarde toevoegen

14. Hoe en hoe vaak wordt er value engineering toegepast tijdens het offertetraject?

Verbeterpunten

15. Welke mogelijkheden tot verbetering zijn er voor het huidige offertetraject?

Appendix G: Evaluation of BPM best practices (Dumas et al., 2013)

Customer Heuristics:

- Control relocation: “Move controls towards the customer”. Controlling the quotation data is essential in achieving a reliable price and therefore can result in losses when the control is not performed accordingly. Relocating this activity towards the customer results in higher probabilities of fraud and therefore requires a high level of trust in the relationship (Reijers & Mansar, 2004). Additionally the customer expects the vendor to be capable of offering a quotation that is in line with its expectations. Requesting the customer to perform the control activities does not contribute to revealing capabilities.
- Contact reduction: “Reduce the number of contacts with customers and third parties”. The main benefit of reducing the number of contacts to both the customer and the supplier is quote cycle time. On the other hand reducing the number of contacts might result in the loss of essential information and thereby a loss in quality of the offered quotation. With respect to customer contact technical issues are captured in a questionnaire and forwarded at once by the project engineer. Therefore the number of contact moments is low in general. Additionally contact reduction contradicts with the argued customer interaction in order to manage product variety (Bramham et al., 2004). The number of contacts on supplier’s side is not tracked in the same matter and is very high in case of technical issues. Essential in reducing the number of contacts with suppliers is therefore early resolving technical issues with the customer.
- Integration: “Consider the integration with a business process of the customer or a supplier”. Contemplated advantages of integrating the quotation process with the customer and supplier processes are increased quality and decreased quote cycle time. General aim for increasing the quality of the quotation is to offer technical contributions and thereby integrate it with the customer’s product development process. In order to provide technical contributions it is recognized that specific production knowledge lies at suppliers. The constraint in requesting the supplier to suggest design improvements and cost reductions is the fact that the supplier has to be made aware of the full functional details on the entire product instead of one single component. Therefore discussing design improvements with the supplier is likely to be time consuming. Additionally mutual dependence during the process grows. However, as ABC-SA suppliers can also be otherABC-Group subsidiaries the involvement of supplier is perceived less troublesome compared to external suppliers.

Business Process Operation Heuristics

- Case types: “Determine whether activities are related to the same type of case and, if necessary, distinguish new business processes”. Identifying alternative routings for different cases results in overall reduction of quote cycle time and low order management labor costs. On the down side the heuristic negatively effects quality and flexibility as it requires for more coordination. On a high level case types are already applied on the quotation process at ABC-SA by differentiating between modified rebuys, direct requests and system requests. A further distinction in system requests by designing different processes for requests that require a different focus might be of use. However, as communication is an issue in the As-Is process and the flexibility is essential since requests might require a distributed focus.
- Activity elimination: “Eliminate unnecessary activities from a business process”. Eliminating unnecessary activities mainly concerns check and control activities that are of large presence in the quotation process of ABC-SA. It is aimed to decrease quote cycle time and order management labor costs but has the disadvantage of a lower quality. By

solely eliminating the control and check activities from the process the reliability of the quotation data will dramatically decrease. To enhance the

- Case-based work: “Consider removing batch-processing and periodic activities from a business process”. Not performing the quotation process in a case-based matter is not beneficial as there is a small number of requests that are processed at the same time.
- Triage: “Consider the division of a general activity into two or more alternative activities”. Since specific tasks in the quotation process require specific knowledge or skills this is already applied.
- Activity composition: “Combine small activities into composite activities and divide large activities into workable smaller activities”. By combining small activities into less composite activities it is aimed to reduce the time that a resource has to become familiar with the process and increase quality. As both the project engineer and project buyer are analyzing the technical documentation and might have separate opinions on determining the costing structure there might be benefits in combining the separate activities in a collaborative assessment.

Business Process Behavior Heuristics

- Resequencing: “Move activities to more appropriate places”. Resequencing activities is argued to save time in the process by relocating these to similar activities or towards activities that are related. In the quotation process of ABC-SA this is specifically applicable on the TPD assessment performed that is performed after the estimation of required resources and the determination of a feasible delivery date. By performing the technical analysis in front of the latter task a more appropriate planning can be made. Additionally an earlier technical assessment can reveal risks than can save resources later on in the process.
- Parallelism: “Consider whether activities may be executed in parallel”. Quote cycle time is argued to decrease with performing activities in parallel. In general parallelism is deemed not applicable as subsequent activities require the input of preceding activities. Thereby performing these tasks in parallel will result in adjustments and feedback moments after performing the activity.
- Knock-out: “Order knock-outs in an increasing order of effort and in a decreasing order of termination probability”. By scheduling the knock-out possibilities in the indicated sequence it is argued to decrease overall costs (i.e. order management labor costs). There are only two moments in which an RFQ can be excluded from the process but these are rarely used.
- Exception: “Design business process for typical cases and isolate exceptional cases from the normal flow”. By excluding exceptional cases from the normal flow the overall throughput time and quality are aimed to increase. The downside of doing so is that the process will become more complex and less flexible. Though new customers and high potential requests require a different approach the general process is the same. As designing exceptional flows increases the complexity of an already complex process this heuristic is deemed inappropriate.

Organization Heuristics

- Case assignment: “Let workers perform as many steps as possible for single cases”. This heuristic is already applied as the quotation team is handling all RFQs and is composed of one person per resource. Several tasks require specific knowledge or skills and therefore cannot be assigned to another resource. It is acknowledged by the organization that this is beneficial since there are cases where multiple project buyers and/or engineers were included and order management costs were exceptional high.

- Flexible assignment: “Assign work in such a way that maximal flexibility is preserved for the near future”. Since this heuristic holds the premise that work can be assigned to multiple resources and the majority of the tasks require specific knowledge or skills, this heuristic is not applicable.
- Centralization: “Treat geographically dispersed resources as if they are centralized”. Not applicable as the quotation team is centralized.
- Split responsibilities: “Avoid shared responsibilities for tasks by people from different functional units”. It is argued that splitting the responsibilities reduces the number of conflicts. This could negatively influence the quotation process as some conflicts need to be resolved in an early phase in collaboration with multiple resources.
- Customer teams: “Consider to compose work teams of people from different departments that will take care of the complete handling of specific sorts of cases”. Recently the organization changed from generating quotations as an ancillary activity by customer focused resources towards a centralized quotation team. It is argued that the performance increased through the application of this change.
- Numerical involvement: “Minimize the number of departments, groups and persons involved in the business process”. Beneficial as it reduces required time due to less coordination errors. Since the current quotation team consists of one person per required resource and there is only one sales representative involved the number of resources is already reduced down to a minimum.
- Case manager: “Appoint one person to be responsible for handling of each type of case”. Currently the calculator acts as a case manager that is managing each RFQ. To enhance the overall understanding of customer needs and expectations and thereby quality and quote cycle time it is suggested that the involvement of customer service might be beneficial.
- Extra resources: “If capacity is insufficient, consider increasing the available number of resources”. The most convenient way to resolve the issue of too few cost estimations and decrease the overall quote cycle time is adding more cost engineering resources. This however also increases order management costs.
- Specialist-generalist: “Consider to deepen or broaden the skills of resources”. The level of specific knowledge per resource is considered to be very high within the quotation team. Therefore increasing the overall technical knowledge and thereby understanding of the product could increase the flexibility within the process and reduces overall quote cycle time.
- Empower: “Give workers most of the decision-making authority instead of relying on middle management”. Empowering workers to make decisions instead of middle management is said to positively influence throughput time and flexibility but to have a negative effect on quality. Currently the strategy is determined by the sales representative in dialog with the calculator. The project buyer is empowered to determine the number of suppliers to request for a quotation and select the suppliers that are requested for a quotation. Increased empowerment is argued to result in more errors and therefore more rework. As the amount of rework already is an issue in the quotation process this heuristic is deemed not applicable.

Information Heuristics

- Control addition: “Check the completeness and correctness of incoming materials and check the output before it is sent to customers”. The benefit of this heuristic is increased quality this is at the expense of costs and time. As there currently are lot of checks and control activities included in the process and quote cycle time is an issue on certain requests this heuristic is deemed not applicable.

- Buffering: “Instead of requesting information from an external source, buffer it and subscribe to updates”. Reduced throughput time and reduced labor costs are the benefits of implementing this heuristic. This requires software or systems that allow for this and the customer/supplier willing to cooperate in the required matter.

Technology Heuristics

- Activity automation: “Consider automating activities”. The advantages of automating activities lie in decreased costs and throughput time. This goes at the expense of flexibility and also quality if not applied accordingly. One of the major issues in the quotation process is the large load of information that is to be processed. Since there are several activities that are similar each time an RFQ is to be processed there are large opportunities for automating these activities. Additionally some of these activities are not performed due to a perceived lack of time, automating these could resolve this.
- Integral technology: “Try to elevate physical constraints in a business process by applying new technology”. The usage of the ERP system is argued to be beneficial in some cases. This holds several limitations and is a large investment that is to be further analyzed before substantial conclusions can be drawn on this.

External Environment Heuristics

- Trusted party: “instead of determining information oneself, use the results of a trusted party”. Trusting an external party to generate required information is already applied with respect to cost determination at ABC-SA; suppliers define the item costs. Though the provoked benefits of this heuristic are decreased costs and increased quality it widely varies. Overall aim of ABC-SA is to increase the ratio of products that is requested at other ABC-Group subsidiaries to increase quality. With respect to providing technical contribution it is troublesome to let external parties derive this information as it often requires an overall image of the requested end product. Sharing the end product is time consuming and is not allowed by the customer in certain cases. Trusting a party to deliver this information is therefore considered as not applicable.
- Outsourcing: “Consider outsourcing a business process completely or parts of it”. Outsourcing is already applied when it is recognized that the requested product is more in line with capabilities of other ABC-Group subsidiaries. These requests are classified as ‘direct requests’.
- Interfacing: “Consider a standardized interface with customer and partners”. The benefits of interfacing towards suppliers are recognized as there is a ‘purchasing portal’ in development that enables the supplier to check upon the requests that are made. Some customers have applied these portals that allow ABC-SA to upload the quotation with specific information. The decision to apply this heuristic however lies at the customer.

Table 21: Requirements/comments on heuristics

Heuristic	Required/comment
Control relocation	Does negatively influence revealing capabilities towards the customer.
Contact reduction (customer)	Is low, further reduction will decrease quality as technical issues cannot be resolved.
Contact reduction (supplier)	Early resolving of technical issues required to reduce need for communication with suppliers.
Integration	General aim of the redesign.

(customer)	
Integration (supplier)	Organizational changes are required.
Case types	Applied on high level (cases are: modified rebuy, direct request and new system request). Further distinction could be on focus (price, product quality, technical contribution, quote delivery date).
Activity elimination	Reduces quality of quotation, automating certain activities might result in the possibility of excluding tasks.
Case-based work	Applied, batch-processing is not beneficial.
Triage	Applied since the majority of the tasks require specific knowledge.
Activity composition	Collaborative assessment of TPD and determination of costing structure reduces the number of individual tasks and amount of rework.
Resequencing	Rescheduling the TPD assessment in front of communicating a feasible quotation delivery date.
Parallelism	Activities require input of preceding activities.
Knock-out	Cases are rarely knocked out the process.
Exception	Increases the complexity of the process. The complexity is one of the issues of the current process. Offering a separate fast-track process is likely to be beneficial.
Case assignment	Applied, further diversion not possible due to required knowledge and skills.
Flexible assignment	Requires more quotation team resources.
Centralization	Quotation team is sitting at one table and therefore centralized.
Split responsibilities	By splitting the responsibilities disagreements on the most beneficial costing structure are identified in a late phase
Customer teams	Team is applied but not focused on one customer, organization changed from this to focus on quotations
Numerical involvement	Applied, the number of persons involved is reduced to a minimum with one person of every required resource
Case manager	Applied, calculator is managing each case. For specific customers CS might be included
Extra resources	Vacancy for cost engineer is open but appropriately assigning tasks to spent resources on might reduce need
Specialist-generalist	Increasing technical knowledge at the project buyer and logistic knowledge at the engineer could increase overall performance. Collaborative meetings will increase knowledge on both sides
Empower	The application of the DSS supports the quotation team in dialogue with the sales representative to make decisions in selecting the appropriate focus and strategy
Control addition	Already high levels of control are included, reliability is still too low, automation and interface can resolve this
Buffering	Could be done with technical issues but it is key to resolve the issues as fast as possible
Activity automation	Macro codes/Excel codes in KPM file
Integral technology	ERP system inclusion needs further investigation
Trusted party	Discussed in the integration heuristic
Outsourcing	Applied for requests with low added value (direct requests)
Interfacing	Internal applied between quotation team and sales department, can also be beneficial towards suppliers (in development)

Table 22: Evaluation of best practices (Dumas et al., 2013)

	Effects[1]					Addressed by				
Heuristic	Time	Costs	Quality	Flexibility	Applicability	Currently applied	Early Technical Assessment	Application of DSS	Sales interface	Automation
Control relocation		-	+		-					
Contact reduction (customer)	+	-	+		-					
Contact reduction (supplier)	+	-	+		+		x			
Integration (customer)	+	+		-	+		x	x		
Integration (supplier)	+	+		-	+					
Case types	+	+	-	-	+	x		x		
Activity elimination	+	+	-		-		x		x	x
Case-based work	+	-			+	x				
Triage		-	+	-	+	x	x			
Activity composition	+	+		-	+		x			
Resequencing	+	+			+		x	x		
Parallelism	+	-		-	-					
Knock-out	-	+			-		x			
Exception	+	-	+	-	±					
Case assignment			+	-	+	x				
Flexible assignment	+	-		+	-					
Centralization	+	-		+	-					
Split responsibilities			+	-	-					
Customer teams			+	-	+	x				
Numerical involvement	+	-		-	+	x				
Case manager		-	+		+	x				
Extra resources	+	-		+	+					
Specialist-generalist	+		+	-	+		x		x	
Empower	+		-	+	±			x		
Control addition	-	-	+		+	x			x	x
Buffering	+	-			-					
Activity automation	+	-	+	-	+				x	x
Integral technology	+	-			?					
Trusted party	+	+		-	+					
Outsourcing	+	-		-	+	x				
Interfacing	+		+	-	+				x	

1: Reijers and Mansar (2004)

Appendix H: DSS

Figure 22: DSS

RFQ Response DSS

Calculator
Project Engineer
Automated

General information			Comment
	Quotation no.		
	Customer		
	Item no.		
	Description		
	Date request		
	Requested quote delivery date		
Sales contact	Name		
	E-mail		
	Tel.		
Engineering conta ct	Name		
	E-mail		
	Tel.		
Sales info			
	Request type		
	Similar to quotation no.		
	Motivation request		
	New market possibilities		
	Related future business		
	Current productino location		
	Competitors		
	Desired initial production location		
	Desired end produciton location		
	NDA applicable		
	Existing supplier agreements by customer		
	Suppliers that are not to be approached		
	Target price [€ / piece]		
Expected turnover [€ / year]	2014		
	2015		
	2016		
	2017		
	2018		
Log info			
	Order-to-order		
	Batch a [#]		
	Batch b [#]		
	Batch c [#]		
	Batch d]#]		
	Log. Contract		
	Duration contract [year]		
Annual quantity [#]	2014		
	2015		
	2016		
	2017		
	2018		
	Additional comments		

Calculator
Account manager / Business Line Manager

Result early technical assessment

	TPD quality		
	Completeness TPD		
Competitive advantages	Mechanic		
	Price		
	Experience in sector		
	Customer relation		
	Organizaional size		
	Production location		
	Amount of items		
Amount of unique items	Custspecs		
	Tradeitems		
	Total		
	Additional comments		

Results

Chance on achieving [1-10]	**1**		
Importance [1-10]	**0**		
Risks [1-10]	2		
Required resources [1-10]	**1**		
		Choice	
Full	**9**	☐	
Request cost-drivers	**6**	☐	
Estimate cost-drivers	**5**	☐	
No response	**1**	☐	
Focus			
Product quality	**8**		
Price	**2**		
Quote delivery date	**5**		
Prodcut leadtime	**1**		
Technical contribution	**9**		
Customer visit	0		
Value engineering	4		
Prijs roadmap			

Workload estimation	Hours	Rate [€]	Costs
Project Engineer		€ 67,50	€ -
Project Buyer		€ 62,50	€ -
Cost Engineer		€ 62,50	€ -
Calculator		€ 67,50	€ -
Project Management		€ 100,00	€ -
Total	**0**		€ -

Quote delivery date

	Specified quote delivery date	
	Confirmed quote delivery date	

Communication

	Communication sales	
	Communication engineering	

Calculator
Project Engineer
Project Buyer
(Cost Engineer)

Colaborative early technical assessment

Calculator
Acc. Man.

Define quotation strategy

Calculator

Calculator
Acc. Man.

Acc. Man.

Offer quotation

Calculator

Appendix I: To-Be process ABC-SA

Figure 23: Assess RFQ and determine strategy To-Be

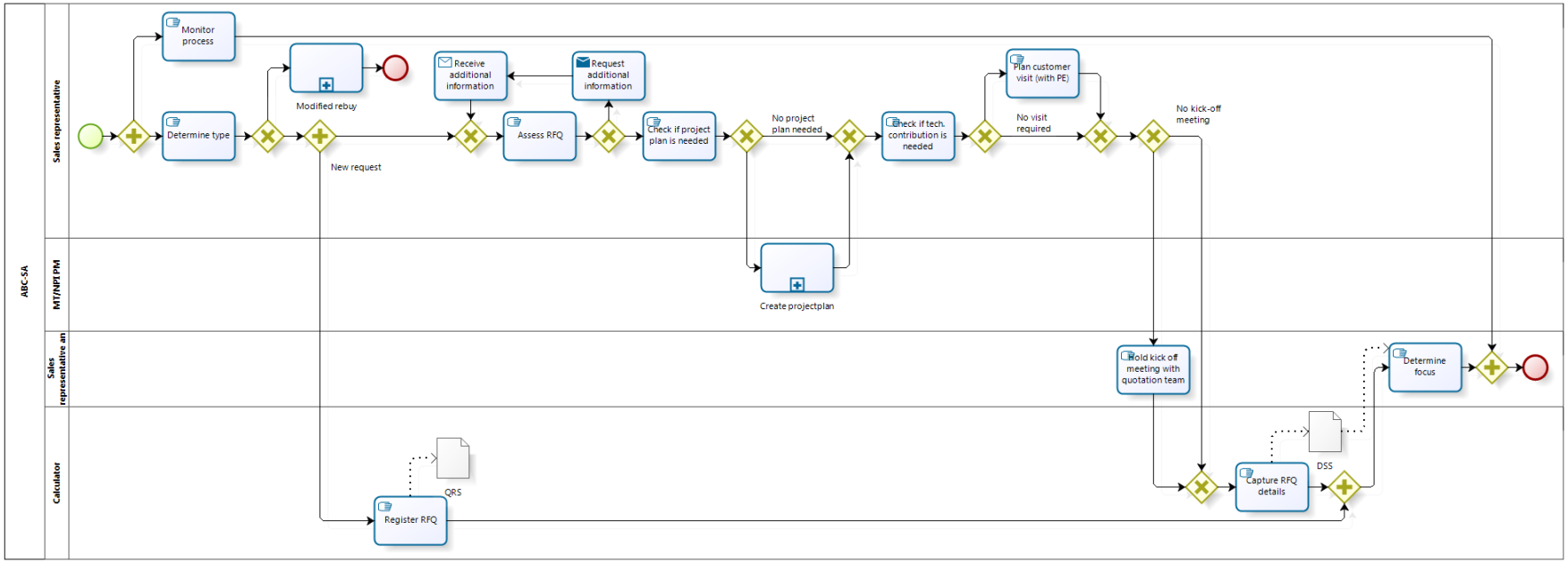


Figure 24: Assess TPD and determine structure To-Be

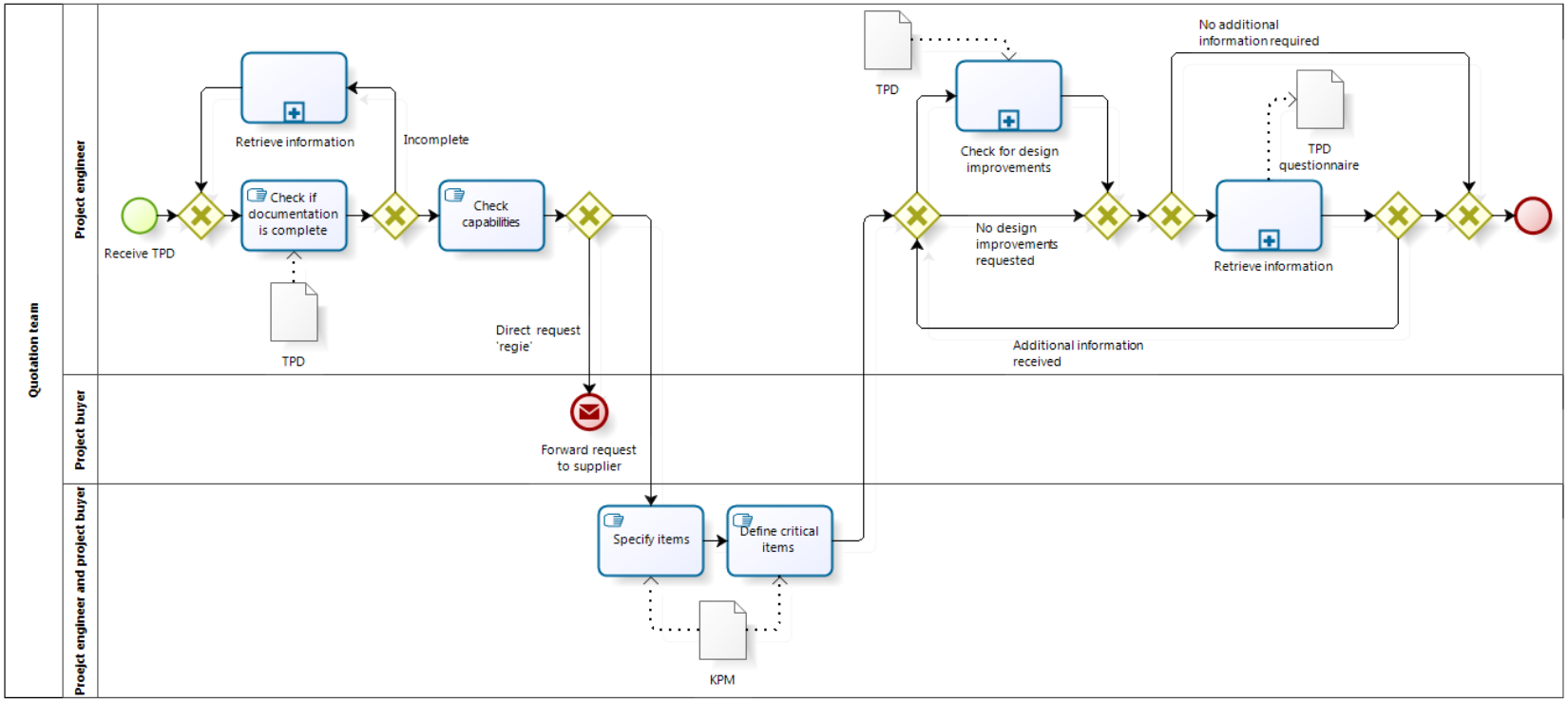
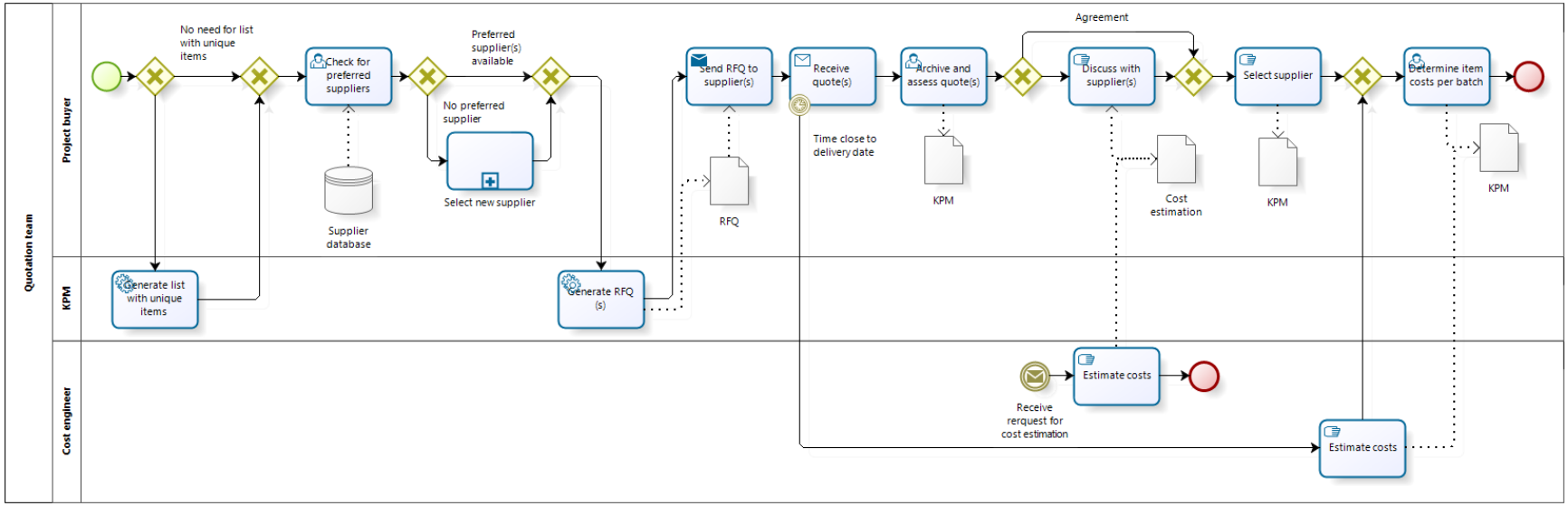


Figure 25: Retrieve item costs To-Be



Appendix J: Validation questionnaire

Sales interface	Strongly agree				Strongly disagree
I think the procedure for using the sales interface will be complex and difficult to follow.	1	2	3	4	5
Overall, I think it will be difficult to use the sales interface.	1	2	3	4	5
I found the rules related to the sales interface clear and easy to understand.	1	2	3	4	5
The sales interface would make it easier to analyze the data.	1	2	3	4	5
The interface will save me time while processing data.	1	2	3	4	5
I think working with the interface will make the process more controllable.	1	2	3	4	5
The sales interface will increase the overall understanding of the requested product and thereby reduce the time spent on communication.	1	2	3	4	5
It will be able to more easily spot incorrect values with the interface.	1	2	3	4	5
I intend to use the interface in the future to process data.	1	2	3	4	5
Advantages interface:					
Disadvantages interface:					

Early Collaborative Technical Assessment	Strongly agree				Strongly disagree
I think early TPD assessment will increase the overall outcome of the quotation process.	1	2	3	4	5
The earlier the TPD is assessed the better.	1	2	3	4	5
Advantages early meeting:					
Disadvantages early meeting:					

Decision Support System	Strongly agree				Strongly disagree
I think the decision support system is difficult and hard to follow.	1	2	3	4	5
Overall, I think it will be difficult to use the decision support system.	1	2	3	4	5
I found the rules related to the DSS clear and easy to understand.	1	2	3	4	5
The DSS could help to identify and quantify risks related to a request.	1	2	3	4	5
It will be easier to make an appropriate planning with the DSS.	1	2	3	4	5
I will not look at the DSS if an RFQ arrives.	1	2	3	4	5
I intend to use the DSS in the future to analyze incoming requests.	1	2	3	4	5

Advantages Decision Support System:					
Disadvantages Decision Support System:					
Activity Automation	Strongly agree				Strongly disagree
I think the procedure for applying automation will be complex and difficult to follow.	1	2	3	4	5
Overall, I think it will be difficult to apply the automation.	1	2	3	4	5
I found the rules related to the automation clear and easy to understand.	1	2	3	4	5
I believe working with a more automated process will increase the reliability of the data.	1	2	3	4	5
It will be able to more easily spot incorrect values with higher levels of automation.	1	2	3	4	5
A more automated process will save me time and increase the quality of my work.	1	2	3	4	5
I intend to adapt my work in order to use the automated processes in the future.	1	2	3	4	5
Advantages activity automation:					
Disadvantages activity automation:					