AN EMPIRICAL INVESTIGATION OF NEW PRODUCT DEVELOPMENT AND CUSTOMER RETENTION IN THE INDUSTRIAL VALVE INDUSTRY

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degree of Doctorate in Business Administration (DBA)

DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of the University of Gloucestershire and is original except where indicated by specific reference in the text. No part of the thesis has been submitted as part of any other academic award. The thesis has not been presented to any other education institution in the United Kingdom or overseas.

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ABBREVIATIONS

AFM	after market
APAC	Asia-Pacific
BCG	Boston Consulting Group
CRM	customer relationship management
DMADVI	Define, Measure, Analyse, Design, Verify and Implement
EMEA	Europe, Middle East and Africa
EPC	engineering, procurement and construction
FEED	front-end engineering design
ISO	International Organization for Standardization
IT	information technology
ITP	Inspection and Test Plan
KAM	Key Account Manager
LNG	liquefied natural gas
PEM	project engineering management
PMC	project management consultancy
R&D	research and development
ROI	return on investment
VDMA	Der Verband Deutscher Maschinen- und Anlagenbau, German Association Mechanical and Plant Engineering
VRIN	valuable, rare, imperfectly and non-substitutable

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ABSTRACT

Industrial valves are extensively used across the world and considered to be essential equipment in a range of industrial plants and in all kinds of flow-related processes. Industrial valves are essential pieces of equipment in all types of industrial plants and processes where different fluids, gases and steam and solids are handled. Given their functionality, industrial valves can isolate media and control flows, and ensure the safe operation of plants. As such, there is considerable demand for these components, given their usage in operations. Industrial valve manufacturers, in general, face significant declining patterns of trade. They have been operating in an increasingly competitive environment due to the recent global recession, which was driven by unstable oil prices, weak economic growth and political instability, and recently the coronavirus pandemic and Russia-Ukraine war. These have had an impact on some emerging markets with implications for the barriers to entry faced by industrial valve manufacturers located in developing countries. In such a highly competitive environment, new product development plays an influential role in business survival and competitive advantage.

The explicit aim of this research is to develop a conceptual model to detail how new product development could facilitate customer retention in the industrial valve industry. The research evaluates new product development in that specific context, and the research will set out to understand customers' requirements with a focus on the demand side of the industrial valve industry. This research analyses customers' behaviour and different purchasing channels for industrial

valves. This will create a benchmark for understanding the nature of new product development and customer retention.

1. INTRODUCTION

The focus on new product development has increased in recent decades, since industry has come to realise the value of the introduction of new products to the marketplace (Goulding, 1983; Bhuiyan, 2011; Trott, 2017). New products are important for businesses because they present businesses with an opportunity to survive, to compete and to drive organic growth. New products also strengthen the customer relationship (Trott, 2017). Indeed, new products are accountable for technical developments, as well as for sustainable employment, and they can increase living standards (Bhuiyan, 2011). Industrial valve manufacturers also realise the importance of new product development and have acknowledged that the introduction of new products has increased the competitive advantage of market leaders in the last decade (Brancaleoni, 2014).

The industrial valve sector is dominated by engineered products; the design of these products starts when requests are received from customers (Brancaleoni, 2014; Mengoni et al., 2016; Micheli et al., 2016a). In terms of engineering supply, customers request manufacturers to manufacture products that have unique features and meet their specifications (Allen, 1998; Oostra, 2001). Most existing literature on new product development focuses on standard products, like consumables, cars, motorcycles, phones, fashion and consumer products, which can be developed independently without customer involvement (Oostra, 2001; Trott, 2017). The main distinction between

standard and engineered products is the decision making that takes place behind product development. In terms of standard products, the manufacturer decides to develop new products based on market knowledge and the findings of marketing surveys. In terms of engineered products, the customer makes decisions about the development of products based on preferences. In this sense, customers play many different roles that influence the development of new products in the industrial valve sector. For example, they might occupy the role of a plant owner or of a contractor involved in building the plant where the equipment will be based, or they might act as a process owner who specifies the design features of necessary equipment. To identify the decision-making power in new product development, and the potential of new product development opportunities in the context of engineered products, this research evaluates the purchasing channels of the industrial valve sector.

Utilising an inductive approach and an embedded case study research strategy, this research asks how new product development could facilitate customer retention in the industrial valve sector.

1.1. Inquiry Overview

Chapter 1 introduces the background of this research and stipulates the basis for this research by describing the research aims and objectives. The related research questions are refined based on the limitations of extant conceptual theories on key drivers of new product development and on the impact of new

product development on customer retention in the industrial valve industry. The rationale for the research is to extend current knowledge in the research area.

The second chapter evaluates the existing literature on products and new products. The research examines the taxonomy of new products, what new product means and which new product development processes exist. Next, the research examines new product development and its competitive advantages, followed by new products and customer relationship management (CRM). The expertise and experience of customers have been increasingly accepted as an essential resource for new product development to support a long-term customer relationship (Parvatiyar & Sheth, 2000; Kohlbacher, 2008; Battor & Battor, 2010; Sofianti et al., 2010; Trott, 2017). The critical literature review considers the relation between new products and customer retention. Furthermore, this research examines the relation between new products and social exchange. Finally, a theoretical framework based on research questions and the result of the critical literature review is established.

Chapter 3 describes the research design. Different paradigmatic assumptions are examined to defend the selected paradigm which supports the research topic: investigation of key drivers of new product development, and new product development and customer retention. This chapter examines qualitative research methodology and argues that qualitative research is a suitable research methodology. The chapter describes case study design which is chosen as the research strategy for this research. In addition, this chapter justifies the sampling strategy, such as sample selection, sample size, participant details, data collection methods and decisions around saturation.

This chapter also describes how investigative research can contribute new knowledge about key drivers of new product development and how new product development can contribute to customer retention in the industrial valve industry. Finally, the ethical considerations are discussed.

Chapter 4 describes the thematic analysis that was identified as a suitable approach for this research. This chapter presents an analysis of interviewees' responses based on interviews with executives, senior managers, managers and experienced people in the industrial valve industry. This chapter provides answers to research questions. The primary research question is: What are the key drivers of new product development in the industrial valve sector? The secondary research question is: How does new product development facilitate customer retention in the industrial valve business? In addition, the following research questions related to the industrial valve industry were addressed:

What are the key new product development processes and to what extent are customers part of this process?

How can co-creation processes integrate customer knowledge to improve new product development?

What are the key drivers of purchasing behaviour in terms of industrial valves, and what are the procurement and sales channels that must be identified to create new product development opportunities?

The interview findings support four major themes that describe participants' views and perceptions: customer intimacy, value, quality and customer service. Finally, the interview findings are discussed.

Chapter 5 describes the conceptual model that is the outcome of the research. This is referred to as "*A new product development and customer retention model in the industrial valve business*". This model addresses the first and second research questions.

Further this model addresses the following research questions:

What are the key new product development processes and to what extent are customers part of this process?

How can co-creation processes integrate customer knowledge to improve new product development?

The chapter contains a synthesis of key findings from the literature review and factual findings from field research on key drivers of new product development, and new product development and customer retention. Furthermore, this chapter discusses the reasoning behind the model.

Chapter 6 describes the brief conclusion of this research. In addition, the contribution of this research to theory and to practice is presented. The chapter also considers principle managerial implications. Furthermore, this chapter addresses the limitation of the research and suggests how researchers can expand the scope of drivers of new product development, and new product development and customer retention concepts, in future research projects.

1.2. Background of the Research

The development of valves can be traced back to the ancient Egyptians and Romans who supplied water to their cities through conduits and pipelines (Brancaleoni, 2014). The functionality and the basics of valve design have fundamentally not changed over the course of time. Due to industrialisation, the requirements of valve design increased because of the development of demanding applications and processes that used a variety of media, and because valves were expected to have high performance and high life cycles. This led to an improvement in valve designs and an increasing number of types of valves for different applications.

Nowadays, industrial valves are extensively used across the world and considered to be essential for use in all kinds of industrial plants and flow-related processes (Weaver, 2004; Freedonia, 2016; VDMA, 2016). These industrial plants and processes are:

- oil and gas,
- petrochemical and chemical plants,
- conventional, hydro and nuclear power plants,
- natural gas,
- oil exploration and transportation,
- iron and steel,
- pulp and paper,
- water treatment and supply,

- desalination plants,
- wastewater plants.

Industrial valves are used to isolate media and control the flow of fluids, gases, steam and solids to ensure the safe operation of industrial plants. Industrial valves can range in size from a few millimetres to many meters and can handle temperatures from deep cryogenic and liquid helium to molten metal. Pressures can range from ultra-vacuum to high pressure. Depending on the application and design conditions, industrial valves can be made of carbon steel, stainless steel, high-alloy steel, aluminium, duplex stainless steel, titanium and special materials. The weight of industrial valves can range from milligrams to triple digits tonnes. There is considerable demand for industrial valves, given their usage in many operations.

Industrial valve manufacturers, in general, face significant declining patterns of trade. They have been operating in an increasingly competitive environment due to the recent global recession driven by unstable oil prices, weak economic growth and political instability as well as the recent coronavirus pandemic and Russia-Ukraine war. These have had an impact on some emerging markets with implications for the barriers to entry faced by industrial valve manufacturers located in developing countries (Micheli et al., 2016a; Freedonia, 2016; VDMA, 2016). Key factors affecting demand and supply are beyond the control of industrial valve manufacturers and they are not in a position to influence market dynamics (Porter, 2008; Freedonia, 2016). In such a highly competitive environment, new product development plays an influential role in business survival and competitive advantage (Clark &

Fujimoto, 1991; Davila & Foster, 2007; Tidd & Bessant, 2009; Ulrich et al., 2020).

Mergers, acquisitions and the globalisation of industrial valve user industries led to a consolidation of customers (Weaver, 2004) and to a combining of their resources, including their procurement processes for industrial valves. The owners of the plants where valves are installed and are in operation often face stiff competition; they implement improvement programmes to increase the efficiency and the profit margin of the plants. Industrial valve manufacturers are therefore challenged to provide intelligent solutions in order to support plant improvement programmes. Because of the stiff competition, most end user industries are investing in their plants in low-cost countries and moving their production to those countries.

Current megatrends in terms of low and zero carbon technologies include alternative energy sources, a circular economy that aims to eliminate waste, smart cities, Industry 4.0 and digitalisation, where traditional products will be replaced by smart products to ensure zero emissions. Hydrogen fuel and intelligent mobility (Robinson et al., 2015) will affect industrial valve manufacturers' traditional products and services; however, they will also offer new product development and intelligent service opportunities. Today, smart valves and smart actuators have the capability to monitor a wide range of process variables, such as pressure, temperature, flow rate, valve position, valve and actuation performance, and noise development and they also enable the transfer of information, such as diagnostics, control instructions and documentation (Weaver, 2004; Freedonia, 2016). Remote access and the

remote transfer of information guides to a plant operator on predictive maintenance can ensure the maximum availability of installed industrial valves and equipment (Kapp, 2019).

Industrial and engineered valves are typically used in large projects; the yearly demand for industrial valves in large projects is more than US$100 billion (Freedonia, 2016; Micheli et al., 2016b; Kapp, 2019). Large projects include: oil, gas, petrochemical and chemical plants; conventional, hydro and nuclear power plants; natural gas; oil exploration and transportation; iron and steel; pulp and paper; water treatment and supply; desalination plants; and wastewater plants (Freedonia, 2016; Kapp, 2019). Large projects are distinguished by large investments, enormous interactions and complicated engineering works with a time span of many years from planning to completion of the project (Badiru & Osisanya, 2013; Kapp, 2019). Many companies are involved at different phases of these projects, in planning, in licencing, in engineering procurement and construction, and in plant operation (Jacoby, 2012; Freedonia, 2016). The process flow of these projects is shown in Figure 1.2-1. The execution of these projects differs from those of other industries, like automotive, automation, standard serial manufacturing and information technology (IT), because of their complexity right from the start of the planning phase (Jacoby, 2012; Badiru & Osisanya, 2013; Kapp, 2019).

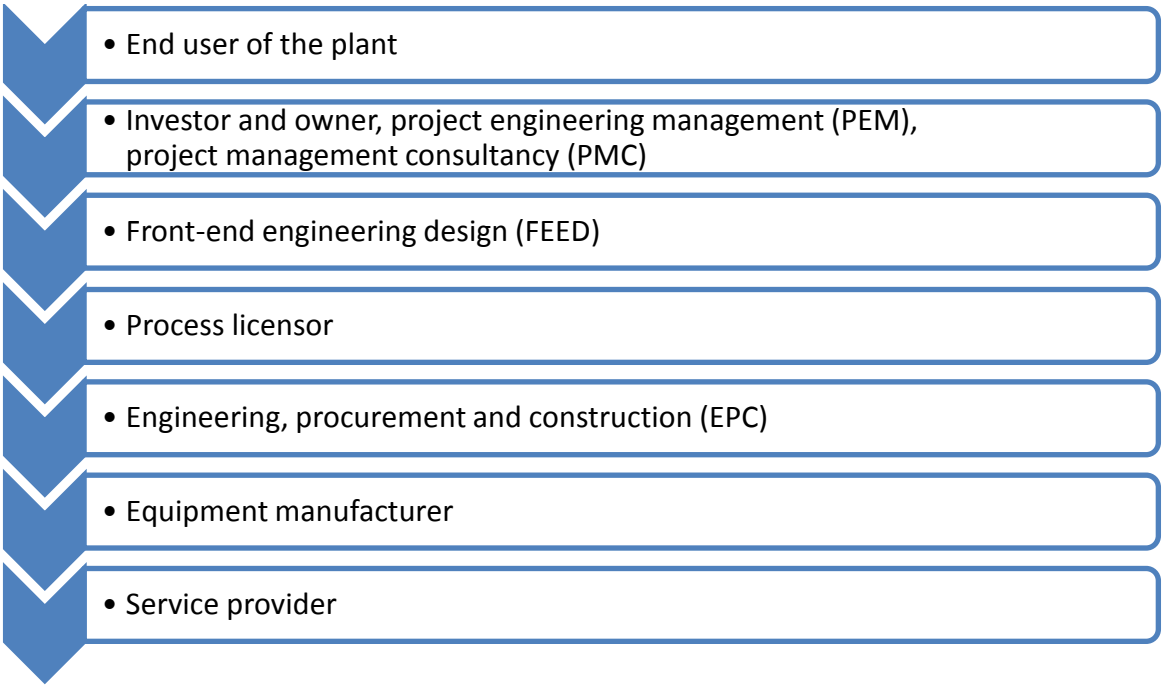


Figure 1.2-1: The process flow of projects. Adapted from Freedonia (2016) and Kapp (2019)

Commonly used terms in projects where industrial valves are required are explained below.

End user of the plant: is the organisation operating the plant that has a target to deliver the planned output within defined operational and financial key performance indicators (Khan, 2006; Bahadori, 2014; El-Reedy, 2016). The end user is responsible for running the process plant based on its design criteria, protecting the environment, implementing health and safety standards, and planning operational expenditure. In addition, the end user is responsible for periodic third party audits to ensure that all safety, quality and environmental-related processes are seamless and fulfil the requirements described in regulations. Furthermore, the end user is responsible for

performing regular maintenance in order to run the plant based on a specified lifetime.

Investor and owner: is an organisation that allocates capital with the expectation of a future return of interest. In large plants there could be more than one investor involved in a high capital request. The owner is the owner of the plant who could also be the end user. The owner can also lease or rent the plant to a third party who runs the plant. The owner is typically not an expert on the processes of the plant and in the case of an investment the owner needs consulting support due to a lack of resources and expertise. Project engineering management (PEM) is offered by organisations that have engineering expertise and specialists on processes and specific processes; PEM can support the owner in any specific engineering subjects and on the selection of related processes of the plant (Tonchia, 2018). Project management consultancy (PMC) is offered by organisations with experts on project management; a PMC could be contracted by the owner and be responsible for monitoring project execution on behalf of the owner (Tonchia, 2018). PMC provides project management services, project management tools, cost control and expertise to the owner.

Front-end engineering design (FEED): following the completion of a feasibility study the investor and owner engage an engineering company to: select the necessary processes with their related licensors, perform the cost estimation and define the investment volume, and prepare the bid documentation for the selection of the engineering, procurement and construction (EPC) company that will execute the project (Khan, 2006; Jacoby, 2012; Bahadori, 2014).

Process licensor: is the owner of a specific technology-related process; the licensor will licence this process against a license fee paid by the plant owner (Khan, 2006; Towler & Sinnot, 2012). The specific task of the process licensor is to specify the technology and to design the main system with defined process input and output (Kapp, 2019). The process licensor specifies the performance and efficiency of the main process equipment to guarantee the effectiveness of the process to the owner and to the end user of the plant. The engineered valves in specific demanding processes are also specified by the licensor and the plant construction company has to follow the licensor's specifications. Usually, the licensor does not execute the projects, but does provide an engineering service for all others who are involved with the project (Kapp, 2019).

EPC: the EPC company executes the project together with the involved parties, investors, owner and end user based on the specification defined by FEED company and by licensors (Towler & Sinnot, 2012; El-Reedy, 2016; Micheli et al., 2016a; Tonchia, 2018). The EPC company is responsible for performing the detailed engineering, including the completion of the specifications for the equipment in line with the licensor's requirements, prior to approval from the involved parties. After approval of the engineering part of the project, the EPC company will start the procurement process and the construction of the plant.

Equipment manufacturers: they are the manufacturers of different types of equipment that are required to build the plant (Kapp, 2019). The key equipment manufacturers, including industrial valve manufacturers, have to be qualified by the licensors, end users and EPC companies for the requested

application before entering the bidding process (Micheli et al., 2016a) in case they have not been qualified before.

Service provider: is an organisation that provides workforce local transportation, logistics and accommodation for the employees where the plant will be built and it also provides solutions to meet the EPC company's daily requirements during the construction of the plant (Khan, 2006).

Large projects have different phases as illustrated in Figure 1.2-2 (Kapp, 2019). Every large project starts with a feasibility study to review the commercial and technical factors and ascertain that the project can be executed. The next phase is conceptual engineering where the concept is confirmed by a study. The basic design should be completed to enable an estimated budget for the plant. In this phase, the vendor list including industrial valve manufacturers may be verified. The FEED phase provides a budget estimate with a higher degree of accuracy and the project will start. In some cases long lead items will be purchased. In the detail design phase, the project design of major equipment, interconnections and layouts will be completed. The technical specifications for the engineered equipment, including engineered valves, will be completed. The construction phase of the plant starts with civil work followed by ancillary equipment, piping and instrumentation. The installation phase includes mechanical and electrical completion of the plant. The start-up and operation phase is the final phase of the project where the plant will start to produce the specified products.

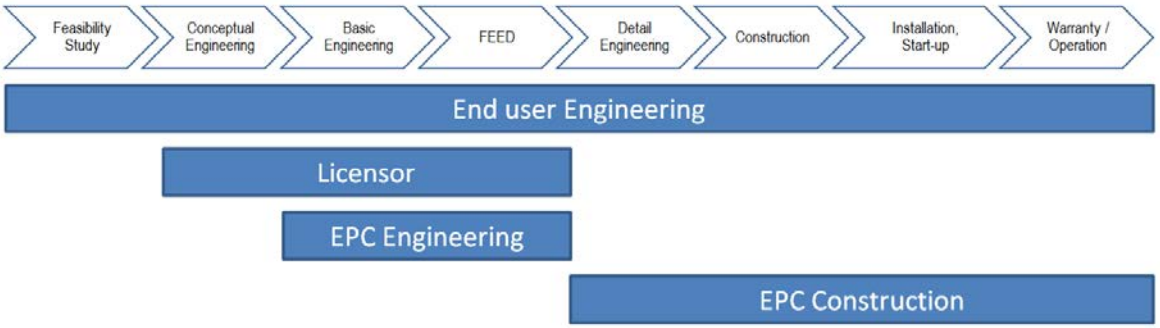


Figure 1.2-2: Phases of large projects. Adapted from Khan (2006) and Kapp (2019). EPC engineering, procurement and construction; FEED front-end engineering design

The most important question on engineered products is what the customers really want or do not want (Kapp, 2019). Typically, the licensors and/or EPC companies would prepare technical specifications for the engineered products in collaboration with end user(s); however, they need input from the equipment manufacturer of engineered products to complete the specification (Towler & Sinnot, 2012; Kapp, 2019). The specific operational requirements of processes have to be considered by the equipment manufacturer in order to develop and design the required equipment (Towler & Sinnot, 2012). The engineering teams of the end users, licensors and EPC companies play an important role in the design of the engineered products, such as turbo machines, pumps and industrial valves, and they are regularly involved in the product development and design of the engineered equipment with equipment manufacturers (Towler & Sinnot, 2012; Jacoby, 2012).

Most product development engineers spend their life developing products based on their own expectations without considering customers' and users' views on the products (Kapp, 2019). In the case of new engineered product development, product developers need to consider the needs and requirements of the customers and end users in order to implement the expected attributes in product development.

Supply chain management and related methods have been implemented in most industries and have been perceived as a strategic weapon to accumulate a competitive position (Jacoby, 2012). The oil and gas industry is growing expeditiously and its conventional supply chain methods have become out-dated (Lisitsa et al., 2019). Industrial valve procurement in the oil and gas industry and in large projects is an important activity and purchasing reliable and high-quality industrial valves is necessary to ensure a flawless commissioning of the plant (Micheli et al., 2016b). For this reason, supply chain management in this industry is much more complex and challenging than conventional supply chain methods in the retail sector, automotive industry and serial production-related industries (Jacoby, 2012; Lisitsa et al., 2019). Nevertheless, supply chain management in the oil and gas industry and in large projects is still in the development phase to drive their supply chain more effectively (Lisitsa et al., 2019). The scale of projects in oil and gas is becoming so large that it drives collaborative approaches between the end users, EPC companies and equipment manufacturers (Jacoby, 2012).

There is a paucity of literature available on the selection of engineered valves for applications (Zappe, 1998; Bahadori, 2014); however, four selection

criteria for industrial valves are mentioned, namely quality, price, lead time and engineering/design/testing capability (Micheli et al., 2016a). A long-term relationship between industrial valve manufacturers and licensors as well as with EPC companies is a fundamental factor for the selection of the right industrial valve for each specific application (Micheli et al., 2016a; Kapp, 2019). Licensors and end users are showing an increased interest in the development of new engineered valves with industrial valve manufacturers for their demanding applications (Freedonia, 2016; Micheli et al., 2016a; Kapp, 2019).

The purchasing process for engineered products is more effective if there are fewer manufacturers providing the right products than using more manufacturers (Walker & Hampson, 2003; Jacoby, 2012). Concerns about the competitiveness of using a limited number of manufacturers were mitigated by licensors', end users' and EPCs' introduction of different types of agreements to avoid price inflation (Jacoby, 2012). Jacoby (2012) defined the most common agreements as follows (p. 68).

Research and development (R&D) agreement: where the licensors and engineered equipment manufacturer jointly develop an engineered product for a specific application.

Licencing agreement: where the licensor develops the engineered product and the engineered equipment manufacturer manufactures the product under licence.

Frame agreement: where the basic design and requirements are specified, including the commercial terms and conditions, such as payment terms, lead

time and warranty periods. In the case of a new project, the end user and engineered valve manufacturers will develop the technical specifications for the required process.

Interaction	Licensor	EPC	End-user
Purchasing from manufacturer	no	yes	yes
Action with manufacturer	Influencing and actively participating on engineered product development process	Pre-Qualification process for the project as potential supplier based on Licensors recommendation	Spare parts supply, supply and replacement of the product on extension projects
Timing	prior to FEED	after the FEED process and during the execution of the project	after start-up of the plant and during the life time of the plant
Decision power	Specifies the engineered product including the name of the manufacturer within the licensed process	follows the process documentation prepared by the licensor with limited decision power on commercial negotiation with the specified manufacturer by licensor	follows the process documentation issued by licensors, in extension project will follow the recommendation of licensor
Collaboration level with manufacturer	Research and development agreement, licence agreement	long term frame agreement	long term service agreement and individual purchase agreement

Table 1.2-1: Purchasing behaviour of customers in industrial valve business. Adapted from Jacoby (2012) and Walker and Hampson (2003). EPC engineering, procurement and construction; FEED front-end engineering design

Table 1.2-1 shows purchasing behaviour and the decision power of the licensors (Walker & Hampson, 2003; Jacoby, 2012). However, rather than rely on customers' past purchasing behaviours, industrial valve manufacturers can continuously review the voice of customers, which will capture changes in their purchasing behaviour (Kapp, 2019). The process licensor has an interest in working with engineered product manufacturers in order to ensure that the process will perform as specified with the selected engineered equipment. Many industrial valve manufacturers are focusing on problem solving as

opposed to selling valves (Micheli et al., 2016b). Solving customers' problems drives a stronger relationship with customers (Weaver, 2004).

Engineered valve procurement and selling via the internet has not started yet, due to the complexity of the customer specification (VDMA, 2016). Some industrial valve manufacturers have recently started using a configurator tool, where the customers can configure the engineered valve via the internet. However, this tool is not widely used yet (Kapp, 2019).

1.3. Research Aims and Objectives

New product development in industrial products and its effect on customer retention have not been widely reported (Barczak, 2012; Preikschas et al., 2014). Therefore the aims of the current research were:

- to evaluate new product development in the industrial valve industry. The research will set out to understand customer requirements with a focus on the demand side of the industrial valve industry. Furthermore, this research analyses the views and expectations of customers, such as end users and EPC companies as well as licensors, regarding their involvement with new product development in the industrial valve industry.
- to develop a conceptual model to detail how new product development could facilitate customer retention in the industrial valve industry.

This research has the following objectives:

1- Critically review existing conceptual models and theoretical issues relating to new product development and customer retention in the industrial valve industry.

2- Critically evaluate the importance of new product development to customer retention in the industrial valve industry.

3- Identify the key success factors of new product development and customer retention in the industrial valve industry.

4- Recommend how new product development can be used to retain customers in the industrial valve industry.

1.4. Research Questions

The principal purpose of this research is to empirically investigate new product development and customer retention in the industrial valve business. The primary research question is: What are the key drivers of new product development in the industrial valve sector? The secondary research question is: How does new product development facilitate customer retention in the industrial valve business? In addition, the following research questions related to the valve industry will be addressed:

What are the key new product development processes and to what extent are customers part of this process?

How can co-creation (Sofianti et al., 2010) processes integrate customer knowledge to improve new product development?

What are the key drivers of purchasing behaviour in terms of industrial valves, and what are the procurement and sales channels that must be identified to create new product development opportunities?

1.5. Rationale for the Research

The focus on new product development has increased in recent decades, since industry has come to realise the value of the introduction of new products to the marketplace (Goulding, 1983; Bhuiyan, 2011; Trott, 2017). New products are important for businesses because they present businesses with an opportunity to survive, to compete and to drive organic growth. New products also strengthen the customer relationship (Trott, 2017). Indeed, new products are accountable for technical developments, as well as for sustainable employment, and they can increase living standards (Bhuiyan, 2011). Industrial valve manufacturers also realise the importance of new product development and have acknowledged that the introduction of new products has increased the competitive advantage of the market leaders in the last decade (Brancaleoni, 2014). However, the literature surrounding how industrial valve manufacturers undertake the development of new products is scant.

The industrial valve sector is dominated by engineered products; the design of these products starts when requests are received from customers (Brancaleoni, 2014; Mengoni et al., 2016; Micheli et al., 2016a). In terms of engineering supply, customers request manufacturers to manufacture products that have unique features and meet their specifications (Allen, 1998; Oostra, 2001). Most of the existing literature on new product development focuses on

standard products, such as consumables, cars, motorcycles, phones, fashion and consumer products, which can all be developed independently without customer involvement (Oostra, 2001; Trott, 2017). Standard products in the industrial valve industry are called commodity valves (Weaver, 2004); they are mainly used in general process applications and can be developed independently and without customer involvement. Freedonia (2016), a leading international business research company that publishes industry research studies, stated that engineered valves represent the majority of global industrial valve demand. Engineered valves are purpose-built for a specific process application and are based on customers' requirements. Furthermore, engineered valves are developed based on a particular process requirement.

The main distinction between standard and engineered products is the decision making that takes place behind product development. In terms of standard products, the manufacturer decides to develop new products based on market knowledge and the findings of marketing surveys. In terms of engineered products, the customer makes decisions about the development of products based on preferences. In this sense, customers play many different roles that influence the development of new products in the industrial valve sector. For example, they might occupy the role of a plant owner or of a contractor involved in building the plant where the equipment will be based, or they might act as a process owner who specifies the design features of necessary equipment.

Customers seeking to select industrial valves for their different processes have a variety of industrial valves to choose from, but they seem to be dissatisfied

(Sofianti et al., 2010). Industrial valve manufacturers invest in R&D, but they are not able to get the expected benefit from it. Sustainable growth and value creation have become the highest priorities on the agenda of the leaders and managers of valve manufacturing companies. Therefore, industrial valve manufacturers have increasingly focused on understanding customers' requirements to enhance the benefits of new product development.

Most of the processes where industrial valves are installed were developed and licenced by licensors; therefore, licensors have a strong influence on product development and the valve selection process for each process (Kapp, 2019). Licensors' knowledge of specific processes and end users' knowledge of the performance of the installed valves are great assets for industrial valve manufacturers on new product development.

The licensor has the right to define the key equipment and industrial valves, which are important to deliver the specified process efficiency; therefore, the end user is obliged to follow the product selection defined by the licensor. EPC companies contracted by the end user to build the plant also have to follow the product selection defined by the licensor. The PEM and/or PMC appointed by the end user, following the end user's interest in terms of all involved parties, fulfils contractual obligations, including product selection as defined by the licensor.

External forces, such as decarbonisation, reduction of hydrocarbon-related processes and digitalisation, have become important factors in the product

development decision-making processes of industrial valve manufacturers (Robinson et al., 2015).

New product development focuses on increasing the efficiency and life cycle of industrial valves, which may reduce the end user's operational costs and may increase the value of the product (Goulding, 1983; Freedonia, 2016). Providing new product development capability with identified technological advantages, production techniques and continuous improvements to quality are essential factors for industrial product manufacturers in order to increase their reputation and customer retention (Platzer, 2004). New product development in engineered valves in the industrial valve industry is an area not well researched in the new product development literature; therefore, a detailed understanding of the key drivers of new product development and its implication for facilitating customer retention in the industrial valve industry are identified as being in need of further research.

A critical literature review was conducted to examine extensive academic literature on new product development and customer retention. Some literature is available on new product development in engineered equipment, however, there is limited literature available on the impact of product development on engineered products and customer retention in the industrial valve industry (Barczak, 2012; Preikschas et al., 2014). This research therefore focused on new product development in the context of engineered products, and the consequences for customer retention in the industrial valve sector.

Purchasing channels also play an important role in new product development (Sofianti et al., 2010). Globalisation and mergers and acquisitions of industrial valve end users have reduced the number of customers and led to a consolidation of their procurement activities. Furthermore, they seek global alliances with innovative industrial valve manufacturers (Weaver, 2004). Most industrial valve manufacturers are focused on providing solutions to customers' problems with valves, instead of selling the industrial valves (Micheli et al., 2016b). Furthermore, in the face of declining prices, industrial valve manufacturers are also focusing on providing additional services, such as an upgrade on installed products and maintenance and repair, including products supplied by competitors.

The purchasing channels of the industrial valve sector were evaluated to identify the decision-making power in new product development and the potential of new product development opportunities in the context of engineered products.

There is a limited amount of academic literature available that speaks to the supply chain configuration of industrial valve manufacturers. There is also a paucity of literature that looks at what customers require from specific purchasing channels to drive new product development (Brancaleoni, 2014; Micheli et al., 2016a).

The researcher has occupied different roles within the industrial valve business globally since 1986. Schön (1983) argued that reflection is a vital element of all effective practitioners; practitioners can reflect on their experience and learn

from their experience. This research will benefit from the researcher's reflection on the global industrial valve industry.

This research contributes to knowledge about key drivers of new product development and customer retention in that specific sector. The findings of this research could help industrial valve manufacturers to better understand their customers and be able to focus on how new product development could play a part in a coherent strategy based on long-term collaborations with customers. The findings could also help industrial valve manufacturers gain a competitive position with a new product development strategy in increasingly challenging market conditions.

This research is based on a qualitative research methodology. Qualitative research begins with the application of social constructivism and the use of theoretical frameworks which inform the area of research (Creswell, 2014). The procedures of qualitative research – in other words, its methodology – emerge through inductive reasoning, and this is constructed based on the researcher's experience of collecting and analysing data (Creswell & Poth, 2018). Using this approach, it is important to remain as objective and as neutral as possible in the collection, interpretation and presentation of qualitative data. In this way, knowledge is developed inductively through the crystallisation of verified data (Snape & Spencer, 2003). This research is performed using the social constructivist paradigm and an interpretivist approach (Denzin & Lincoln, 2018). Social constructivism holds that individuals seek to understand the world in which they live and work (Creswell & Poth, 2018, p. 29).

1.6. Summary

This chapter outlined the objectives and aims of the research on new product development and customer retention in the valve industry. The rationale has been explained to underline why this subject was chosen. Figure 1.6-1 displays a summary of Chapter 1 and the progress of the research.

Background of the research

- Industrial valves are extensively used worldwide and are essential equipment
- Megatrends, where traditional products will be replaced by smart products, will affect industrial valve manufacturers' traditional products and services; however, they will open new product development and intelligent service opportunities for them
- Purchasing channels and behaviour related to engineered valves are influenced by process licensors

Research aims

- To evaluate new product development in the industrial valve industry. The research will set out to understand customer requirements with a focus on the demand side of the industrial valve industry. Furthermore, this research analyses the views and expectations of customers, such as end users and engineering, procurement and construction companies as well as licensors, regarding their involvement with new product development in the industrial valve industry
- To develop a conceptual model to detail how new product development could facilitate customer retention in the industrial valve industry

Research objectives

- Critically review existing conceptual models and theoretical issues relating to new product development and customer retention in the industrial valve industry
- Critically evaluate the importance of new product development to customer retention in the industrial valve industry
- Identify the key success factors of new product development and customer retention in the industrial valve industry
- Recommend how new product development will be used to

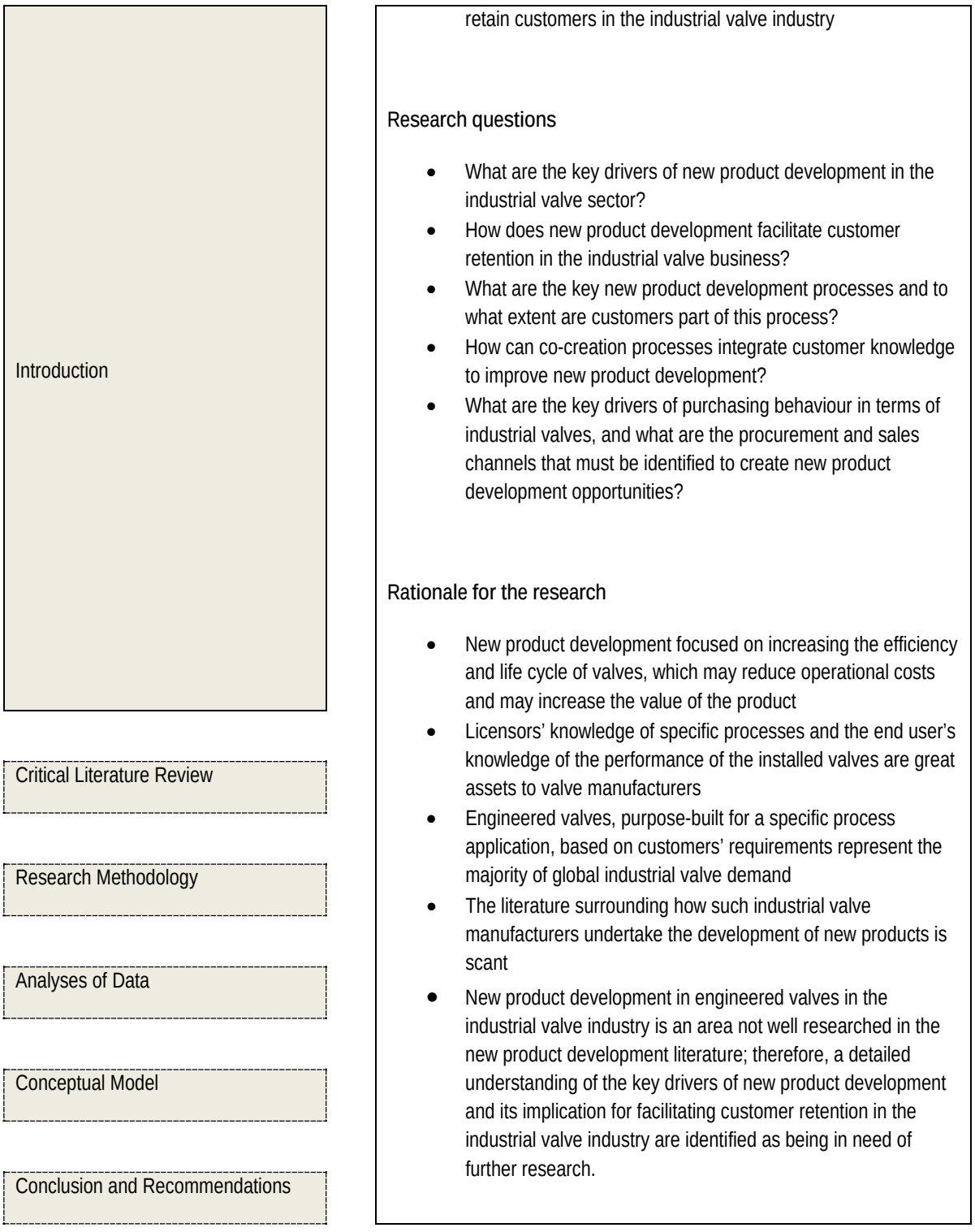


Figure 1.6-1: Summary of the chapter and progress of the research

2. CRITICAL LITERATURE REVIEW

2.1 Introduction

Chapter 1 described the foundation of the research. The aims and objectives of the research were examined and the research questions were defined. The contribution of the research to existing knowledge on new product development and customer retention was outlined.

This chapter will critically review the existing academic literature on definitions of product and new product, the new product development process, new product development and competitive advantages, new products and customer relationship, new products and customer retention, and new products and social exchange theory in order to gain a theoretical understanding of this field. The literature related to new product development and customer retention is extensive and complex ranging from broad-brush examinations to in-depth research and it is conducted across numerous types of products, small to large companies and a wide range of industries. Finally as result of the critical literature review, the theoretical framework is proposed in Section 2.8.

2.2 Conceptual Clarification: Product and New Product

What is a product? There are a variety of definitions of product within the literature and the definition is not standardised. The *Cambridge Dictionary*

defines product as "*something is made to be sold, usually something is produced by an industrial process or, less commonly, something that is grown or obtained through farming*" and *Oxford Dictionary* describes a product as "*a thing is grown, produced or created, usually for sale*". Crawford and Di Benedetto (2011) defined product as "*an object of the exchange process, the thing which the producer or supplier proposes to the potential customers in exchange for something else where the supplier perceives it as of equivalent or greater value*" (p. 41). Doyle and Stern (2006) defined a product as "*anything that a firm offers to satisfy the needs or wants of customers*" (p. 33). Another product definition is *"a product is offered by a company according to a design specification in form, substantiveness and structure by itself and in relation to others for intended benefits in marketplace and structure"* (Pan & Pan, 2017, p. G29). Product is also defined as *"a value offering to a customer that consists of a combination of tangible and/or intangible components*" (van der Merve et al., 2015, p. 60). Cooper (2017) defined a product as *"anything referred to an external marketplace for sale, use, or consumption*" (p. 24). However, Cooper (2017) excluded freebies from the definition, such as free user training or free maintenance provided by a technical service and support group (p. 25).

Product is used as a term to describe all goods, services and knowledge sold (Kahn, 2013, p. 462). Products are defined by functions, features and uses and can be tangible or intangible. Physical goods are classified as tangible, whereas provided services or system supports are classified as intangible products (Kahn, 2013; Trott, 2017; Ulrich et al., 2020). The main tangibles in a product are the design features, quality in terms of reliability and performance-

related features, and layout (Jacobs & Chase, 2018). The intangibles of a product are defined as components of product offering and are invisible and cannot be measured by any technical devices. Providing financing for a product, availability, renting service, guarantee, and service and user support are typical examples of intangible product attributes (Trott, 2017; Jacobs & Chase, 2018; Ulrich et al., 2020). In today's highly competitive global marketplace, providing only tangible goods is insufficient (Kotler et al., 2019). Companies need to encompass their core product offering with additional attributes and benefits, which have to be selected based on users' expectations. The mix of tangible and intangible attributes is important for product differentiation in competitive markets (Kotler et al., 2019). Researchers have attempted to define the intangibles of products, but it is still a topic of debate today due its abstract properties. Intangible value has no standard metric and is strictly qualitative (Driskill et al., 2005).

There are different definitions of product based on different perspectives, for example, from a marketing perspective, a product is a bundle of attributes, whereas from an organisational perspective, a product is an artefact resulting from an organisational process. From an engineering design perspective, a product is a complex assembly of interacting components, whereas from an operational management perspective, it is production process steps (Krishnan & Ulrich, 2001). Product attributes can vary from the user's perspective and they affect product positioning and pricing in the market. Products for consumers have defined attributes, functions, features, uses and services (Trott, 2017), whereas the attributes of industrial products, called engineered products, have to be specified based on the application where the product will

be used or installed (Khan, 2006; Kapp, 2019). Technical performance, size, shape, material selection, function and functional reliability, lifespan and service are typical attributes of products in the engineering industry (Kapp, 2019).

Crawford and Di Benedetto (2011) clustered products into four groups (p. 44):

1. purely service,
2. primarily service and partly a good,
3. primarily a good and partly service,
4. purely a good.

Products are, in general, in a relation with businesses or corporations (Cooper, 2017). The products are required to serve customers' needs and organisational needs (Trott, 2017). From a strategic viewpoint, a product and a product portfolio may play a key role in driving short-, mid- and long-term growth and increasing market share (Trott, 2017).

Products are categorised into consumer, industrial (Claessens, 2021) and engineered products (Kapp, 2019) (see Figure 2.2-1). Consumer products are divided into convenience products, shopping products, speciality products and unsought products (Claessens, 2021). Claessens (2021) classified the type of consumer products as follows.

Convenience products are easily accessible products and regularly bought by consumers. Consumers are familiar with these products, which can be found in almost every location. Examples of convenience products are books, detergents, sugar and pencils.

Shopping products are products where the consumer wants to compare the process, quality and the style at the time of purchase. Consumers usually like to make this comparison across several resources, such as stores and internet platforms. Examples of shopping products are phones, televisions and clothing.

Specialty products are those which have some particular attributes for the consumer, other than price, which persuades the consumer to make a special effort to select the product. Speciality products cover expensive products, such as sports cars and designer clothes.

Unsought products are only purchased by the consumer when they are required. Examples of unsought products are life insurance and funeral services.

Industrial products are purchased by individuals or by organisations to use in the production of other products to be sold to others or to assist companies in conducting their business (Claessens, 2021). Claessens (2021) catogorised industrial products as follows.

Capital items are products that a company uses in the production process to manufacture products and services. Examples of capital items are buildings, machinery, equipment and tools.

Materials and parts are products that become part of the final product through the production process. Examples of materials and parts are raw materials, components and parts such as gears.

Business services and suppliers cover operating supplies and intangible goods. Operating supplies are items that primarily serve to maintain business

functionality, such as lubricants, writing paper and pencils. Intangible goods include maintenance and services.

Consumer products can have substitutes or can easily be replaced; however, advanced industrial products are more difficult to replace and substitutes are hard to find (Carlson & Hansson, 2016).

Engineered products are designed for a specific purpose (Kapp, 2019), to fill previously unmet requirements. Typically, the engineered product is engineered and manufactured after receipt of an order from a customer (Jacoby, 2012). The substantial difference between industrial and engineered products is the person who decides on the product's attributes: for an industrial product, in most instances, the manufacturer selects the attributes based on the voice of customers, whereas customers mainly specify the attributes of an engineered product based on their needs (Oostra, 2001; Khan, 2006; Kapp, 2019).

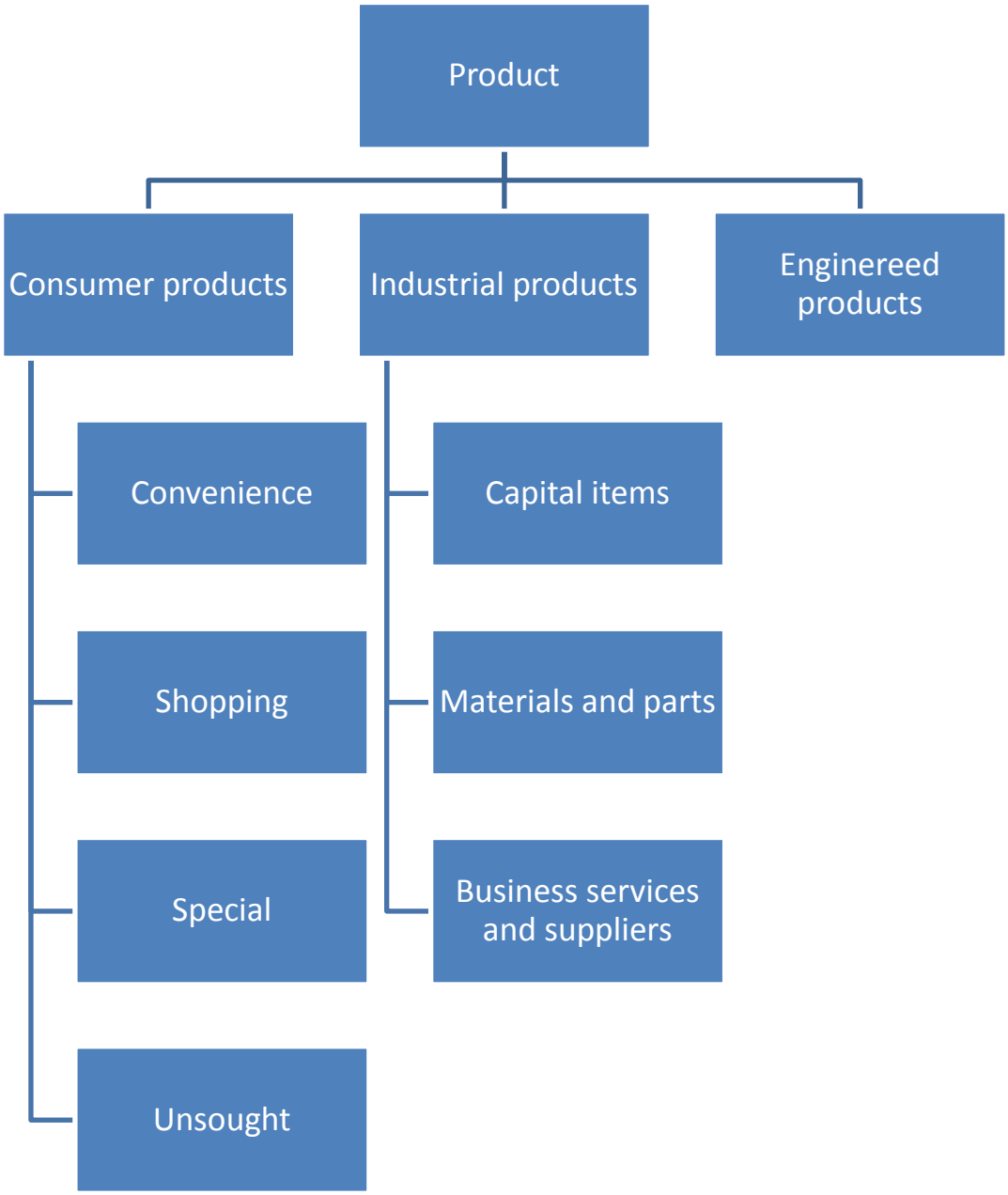


Figure 2.2-1: Categorisation of products. Adapted from Oostra (2001), Kapp (2019) and Claessens (2021)

Industrial valve manufacturers are mainly involved in engineered products (Freedonia, 2016), which are manufactured according to customer specifications.

What is an engineered product? The definition of an engineered product is that it is the object of an exchange process between a supplier and a customer, where the customer specifies the key design features of the product that the supplier has to fulfil (Jacoby, 2012; Micheli et al., 2016a; Kapp, 2019). Typically, engineered products are produced for a purpose defined by the customer, and the specification issued by the customer includes acceptance criteria with a test procedure (Kapp, 2019). Designing engineered products requires designation of the key benefits of the engineered product to the customer, determination of the engineered product's attributes based on the customer's specification and realisation of the engineered product in a shape that meets the specification and provides the expected benefits (Jacoby, 2012; Kapp, 2019). Definition of the engineered product is essential in terms of an alignment between the customer's specifications and expectations and the company's internal processes for the realisation of the engineered product. The success of the engineered product is characterised by how closely the engineered product meets the customer's specifications when launched (Jacoby, 2012). An important element of this success is that the product specification should remain unchanged during the entire production stage of the product (Kapp, 2019). The differences between an engineered product and a consumer type of product are shown in Table 2.2-1.

Criteria	Consumer product	Engineered product
Definition	Is a thing referred to an external marketplace for sale, use or consumption	Is the object of an exchange process between a company and customer, where the customer specifies the key design features of the product which the company has to fulfil
Design attributes	Defined by the manufacturer based on market research, consumer behaviours and voice of customers	Defined by the customer based on application and where the product needs to be installed
Typical performance metrics	Fit with market, market share and consumers' utility	Functional reliability, number of install bases, application-based references, trusted partner
Decision variables	Product attributes meet the consumers' expectations on price, quality and service	Product attributes meet the customer's requirements, price, quality, service capability, lifespan and return on investment
Critical success factors	Product positioning and pricing	Product reliability, innovative design, solving customer's problem, customer retention

Table 2.2-1: Comparison between consumer product and engineered product. Adapted from Krishnan and Ulrich (2001), Khan (2006), Jacoby (2012), Kapp (2019) and Claessens (2021)

The main characteristic distinguishing consumer products from engineered products is the definition of the design attributes, where the design attributes of a consumer product are defined by the manufacturer, whereas the design attributes of an engineered product are specified by the customer. Further, product positioning and pricing are the critical success factors for consumer products. However, for engineered products the critical success factors are

based on solving the customer's problems with innovative design. Interestingly, the price of an engineered product is not mentioned as a critical success factor because the focus is on solving the customer's problems (Jacoby, 2012; Kapp, 2019).

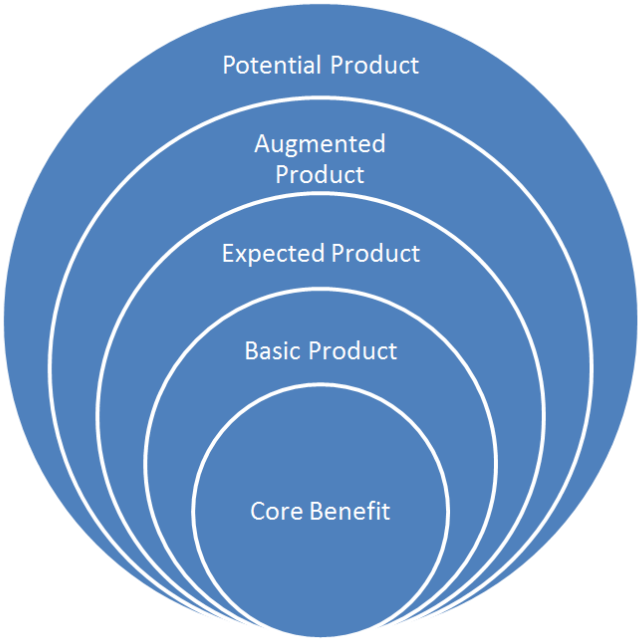


Figure 2.2-2: The five levels of a product (Kotler et al., 2019, p. 452)

Kotler et al. (2019) argued that marketers need to address five benefit levels when they are planning to market a product (see Figure 2.2-2). Each level adds more customer-perceived value:

1- Core Benefit; the essential level is the core benefit where the customer is really buying the benefit. An engineered product should have core benefits, such as safety, and reliability on functionality and availability.
2- Basic Product; at the second level, the marketer must turn the core benefit into a basic product. On an engineered product, the tangible attributes need to be defined.

3- Expected Product; at the third level, the marketer prepares an expected product, which has a set of attributes and conditions that buyers normally expect when they purchase this product. For engineered products, the customer expects that all the specified tangible attributes meet their expectations.
4- Augmented Product; at the fourth level, the marketer prepares an augmented product that exceeds customer expectations. For an engineered product this would be, for example, a smart solution that has the capability to monitor a wide range of process variables and enable the transfer of information, such as diagnostics, instructions for controls and documentation (Weaver, 2004; Freedonia, 2016).
5- Potential Product; at the fifth level stands the potential product, which encompasses all the possible augmentations and transformations that the product or offering might undergo in the future. Here is where companies search for new ways to satisfy customers and distinguish their offering. The manufacturer of an engineered product could provide intangible attributes to differentiate its product from the competition's product. Manufacturers need to focus on engineered solutions and on demonstrating that their products will work in arduous conditions.

What is a new product? Goulding (1983) argued that much of the literature fails on the definition of new products (p. 6). The commonly accepted definition of new products is classified into six major categories (Crawford & Di Benedetto, 2011; Perryman, 2014; Cooper, 2017; Trott, 2017):

- ***New product lines*;** they are also called “new to the company products” because the new products are new to the company and not to the marketplace. A new product line generates additional business opportunities for companies to enter an existing marketplace for the first time.

- ***New to the world products*;** they are also called “really new products” and are innovations and breakthroughs that create a new market. In this category, the new products steadily retain essential technological development and enable manufacturers to lead the market. Due to the challenge of technological breakthrough innovations combined with the risks involved to the companies, new to the world products represent a small percentage of all new products. Typically, large companies launch this category of new products with considerable technical and marketing resources.

- ***Repositioning*;** they are products refocused for a new use or new applications. These types of new products are related to consumers’ reception, and to branding and packaging as new product developments.

- ***Additions to existing product lines*;** these new products are line extensions to expand the product line to the company’s existing markets. The new product will be significantly different from the existing product, but not as different as a new line. Mainly medium- and small-sized companies are involved in this type of new products development to compete with the originating company’s product.

- ***Cost reductions*;** replacing current products with a new product at a lower cost. This new product provides similar performance but without a new benefit to consumers compared to the current products. However, companies will gain financial benefits due to reduced manufacturing cost and optimised manufacturing processes by removing waste and using cost effective

alternative materials. In today's global competitive market, companies will compete in the market for profits and reduction of costs in order to improve their profits.

- ***Product improvements and revisions to existing products*;** these are existing products that have been improved with better performance and reliability. Since the consumers and the manufacturers benefit from the improved new product, this category represents a significant percentage of all new product introductions.

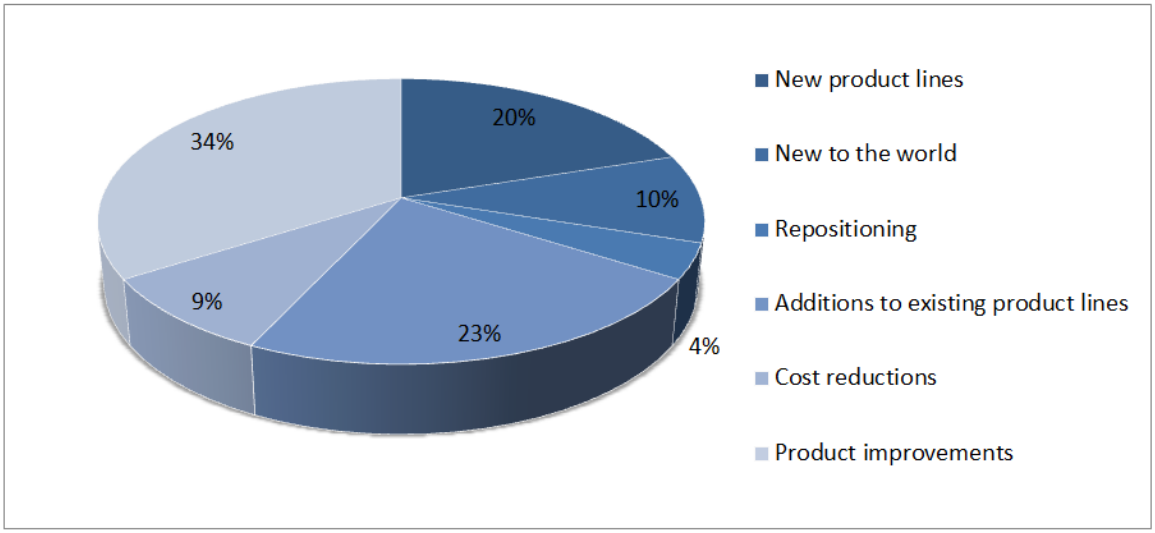


Figure 2.2-3: A company's average new product portfolio. Adapted from Cooper (2017)

Figure 2.2-3 illustrates a company's average new product portfolio; note that 66% of the new products are related to improvements, cost reduction and additions to existing product lines. The new to the world products (really new products), which create new markets, represent 10% of a new product portfolio.

A new product incorporates the management of all activities involving the process of idea generation, technological development, manufacturing, logistics and marketing of a new product or manufacturing process (Trott, 2017). The technological activities of engineered products are more important than the marketing activities, such as marketing strategy, marketing assessment and pilot product testing with customers. Trott (2017) argued that new product development is context dependent, which means the management of the new product development process is dependent on the type of product being developed. Trott (2017) simply divided the extensive range of activities in new product development into technological and marketing activities (Figure 2.2-4). Based on this classification the technological activities in engineered and industrial products development are much higher than in consumer goods development.

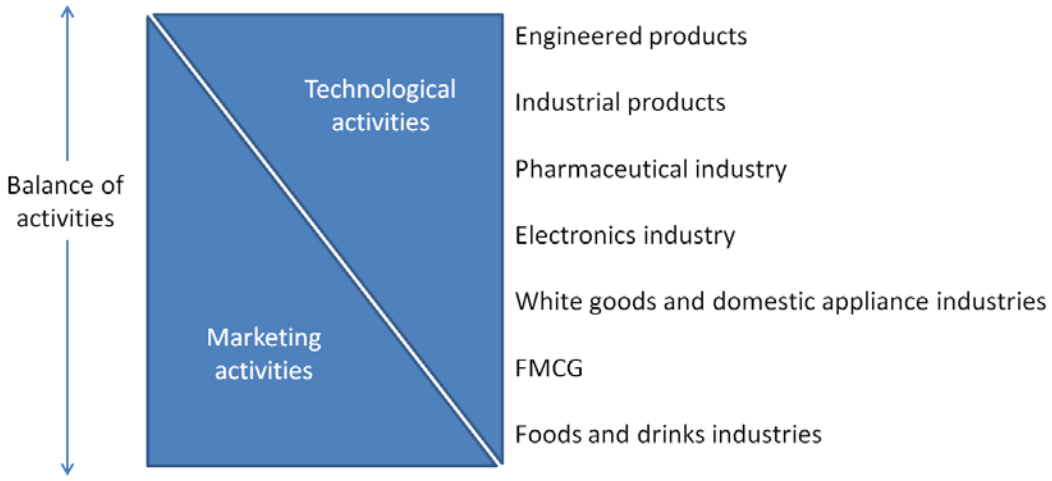


Figure 2.2-4: Classification of new product development activities in different industries. Adapted from Trott (2017) and Kapp (2019). FMCG fast-moving consumer goods

This classification makes it clear that the balance of activities for engineering products, such as engineered valves, differs in several ways from the balance of activities for a new consumer product, such as a new soft drink (Freedonia, 2016; Trott, 2017; Kapp, 2019). In the latter case, the focus will be on promotion and packaging to introduce the product to consumers, whereas the engineered valve will have been designed and manufactured based on a customer's specifications that concentrate on the functional aspects of the product (Khan, 2006; Trott, 2017).

The product strategy for a consumer new product is less innovative than the product strategy for an engineered new product (Hultink et al., 2000; Kapp, 2019). The market strategy for a consumer new product is focused on mature markets and targeted at several markets, whereas the market strategy for an engineered new product is targeted at fast-growing niche markets; this is because the objectives for a new consumer product are focused on competitors, whereas the objectives for a new engineered product are focused on technology. The pricing of consumer new products is similar to the pricing of the competition's products, whereas the pricing of engineered new products is higher than the competition's pricing (Hultink et al., 2000; Kapp, 2019). Consequently, the margin on engineered new products is much higher than on consumer new products. The promotion tactics used for consumer new products are based on mass advertising, whereas the promotion tactics used for engineered new products are based on customised promotion (Hultink et al., 2000; Kapp, 2019). The differences between consumer new products and engineered new products are summarised in Table 2.2-2.

Criteria	Consumer New Product	Engineered New Product
Product strategy	Less innovative Short time to market Existing product modifications	More innovative Long time to market Completely new to the world
Market strategy	Introduced into mature stage of the product life cycle Introduced into mature markets Targeted at several market segments	Introduced in the introductory stage of the product life cycle Launched into fast growing markets Targeted at a niche market
Competitive stance	Represents incremental improvements Launched into market with many competitors New product development objectives are competitor and market focused	Represents performance improvements Launched into markets with few competitors New product development objectives are technology focused
Company strategy	Mainly market driven and aims for technological parity with competitors	Mainly technology driven and aims for technological innovation
Product tactics	More brand extensions, broader assortment than competitors	Greater use of company name, broader technical solutions focused on product portfolio rather than on competitors
Distribution tactics	Existing channels Expenditure parity with competition	New channels Distribution expenditure less than competitors
Pricing tactics	Pricing parity with competitors Penetration pricing	Higher pricing than competitors Skimming pricing
Promotion tactics	More expenditure than competitors More mass advertising	Expenditure parity with competitors More customised promotion

Table 2.2-2: Differences between companies' strategies and tactics for consumer and engineered new products. Adapted from Hultink et al. (2000) and Kapp (2019)

Boston Consulting Group (BCG) published a table of the 50 most innovative companies of 2020 (Figure 2.2-5) and argued that the world's most innovative companies are getting bigger. The revenue of a typical small company on BCG's 2020 list of the 50 most innovative companies is US$30 billion, which is up by more than 170% from US$11 billion in their first survey in 2005. Based on this survey, innovation is a top-three leadership priority for almost two-thirds of the companies. However, this was the lowest level since the financial crises in 2009, which might reflect the uncertain economic outlook. Committed innovators make up 45% of the total, confirming innovation as a top priority and investing a significant amount in new product development. Sceptical innovators, 30% of the total, see innovation as neither a strategic priority nor a significant target of investment. Confused innovators, 25% of the total, are between the committed and sceptical innovators, with a mismatch between the strategic importance of innovation and their level of investments. The highest proportion of committed innovators are in the financial and pharmaceutical sectors and the lowest proportion are in industrial goods and wholesale and retail. Committed innovators are growing faster than sceptical and confused innovators. Out of the total of committed innovators, 60% generate a rising portion of sales from new products and services compared with only 30% of sceptical and 47% of the confused innovators (Ringel et al., 2020).

The 50 Most Innovative Companies of 2020

1	Apple (+2)	11	Tesla (–2)	21	Siemens (–5)	31	JD.com (new)	41	Toyota (–4)
2	Alphabet (–1)	12	Cisco (+5)	22	Target (return)	32	Volkswagen (+6)	42	Nestlé (return)
3	Amazon (–1)	13	Walmart (+29)	23	Philips (+6)	33	Bosch (new)	43	ABB (new)
4	Microsoft (+0)	14	Tencent (return)	24	Xiaomi (return)	34	Airbus (return)	44	3M (–5)
5	Samsung (+0)	15	HP (+29)	25	Oracle (return)	35	Salesforce (–2)	45	Unilever (–13)
6	Huawei (+42)	16	Nike (return)	26	Johnson & Johnson (–12)	36	JPMorgan Chase (–16)	46	FCA (new)
7	Alibaba (+16)	17	Netflix (–11)	27	SAP (+1)	37	Uber (return)	47	Novartis (new)
8	IBM (–1)	18	LG Electronics (+0)	28	Adidas (–18)	38	Bayer (–14)	48	Coca-Cola (return)
9	Sony (return)	19	Intel (return)	29	Hitachi (return)	39	Procter & Gamble (return)	49	Volvo (new)
10	Facebook (–2)	20	Dell (+21)	30	Costco (return)	40	Royal Dutch Shell (–10)	50	McDonald's (–29)

Figure 2.2-5: Boston Consulting Group survey result 2020 (Ringel et al., 2020, p. 16). The figures in parentheses show the ranking in 2019

It is surprising that only five new companies were added to the list of the 50 most innovative companies (Figure 2.2-5). BCG indicated that the ranking was based on a survey of 2,500 global innovation executives and assessed on four dimensions: global mindshare, industry peer view, industry disruption and value creation.

Minor et al. (2017) argued that there is a significant correlation between innovation and growth in profit and that innovative companies tend to have profitable growth. Healthy innovation and profitable growth are the result of a culture of innovation in a company. Therefore, companies need to encourage their employees to generate more ideas; implementing those ideas would generate profitable growth (Minor et al., 2017).

New engineered product development is a cross-functional effort and requires the involvement of stakeholders, including those external to the company (Majava et al., 2013). Today's engineered products may have defined and undefined elements, in which stakeholders external to the company and located across the world will be involved in product development (Freedonia, 2016). There are four main drivers of new product development: technological advances, customers' changing needs, shortening of product life cycle and increased globalisation (Trott, 2017; Cooper, 2017; Ulrich et al., 2020). However, the drivers of new engineered products development include technology convergence, safety and environmental factors, and local and global governmental standards in conjunction with customers' specific requirements (Brancaleoni, 2014; Freedonia, 2016; Ulrich et al., 2020). Furthermore, customers' new technological and process development strategies are also classified as one of the key drivers of new engineered product development (Micheli et al., 2016a). New products emerging from a new product development process can support an increase in revenue, share price, market share and profit as well as shareholders' expectations (Cooper, 2017).

A company's strategic direction in relation to a customer's new technological and process development is an important driver of its new engineered product development strategy (Trott, 2017). In engineered product development, the company's product development strategy needs to fit their customers' and potential customers' technologies development strategy (Acur et al., 2012). In this context, time should be considered in addition to the external driver; for example, customers' and potential customers' technological changes and

developments may be faster than the company's response, and its previously developed products would become obsolete quickly (Acur et al., 2012). Furthermore, a competitive environment should be considered an external driver (Cooper & Kleinschmidt, 1993; Convay & Steward, 1998; Cooper, 2017, 2019).

The main drivers of engineered product development can be summarised in internal and external drivers:

Internal drivers – technological advances, shortening product life cycle, increased globalisation, organisation, organic growth strategy, improvement to financial results.

External drivers – time, customers' changing needs, customers' technological and process development strategy, competition, safety and environmental factors, governmental standards, fulfilment of shareholders' expectations and the results of megatrends.

The differences between a product and a new product can be summarised as: products have existed in the market for a long time, whereas new products are newly developed and recently introduced to the marketplace. The sales and marketing activities for well-established products differ from those for new products (Dodgson et al., 2008). The marketing of an existing product is much easier than marketing a newly developed product (Trott, 2017).

The intangible attributes of new product and new engineered product development have become more important because the market is saturated

with products and they have become more similar in technology and function than ever before (Driskill et al., 2005).

2.3 Taxonomy of New Products

The focus on new product development has increased in recent decades since industry has come to realise the value of the introduction of new products to the marketplace (Goulding, 1983; Bhattacharya et al., 1998; Bhuiyan, 2011; Trott, 2017). The history of new product development-related literature goes back to the 1950s and the literature has grown considerably over the years (Brown & Eisenhardt, 1995; Convay & Steward, 1998; Eveleens, 2010; Cooper, 2017). New products are critical for businesses (Brown & Eisenhardt, 1995), since they are seen as an opportunity to reduce losses, to survive, to renew the organisation, to compete and to drive organic growth (Tabassum & Ozuem, 2019). Trott (2017) argued that new product development is a potential source of competitive advantage for many companies. Industrial valve manufacturers also realise the importance of new product development; the number of new products introduced has increased in order to increase the competitive advantage of the industrial valve market leaders in the last decade (Brancaleoni, 2014).

Trott (2017) stated that it is difficult to provide a single definition for a new product because of the multidimensional aspects of a product, such as technology, level of service, brand name, quality requirements, features and packaging. A new product has four factors: first, what does a new product contribute in terms of tangible and intangible elements; second, the time factor

in terms of the product availability to the market; third, a minimum development time is involved; and fourth, a minimum investment is made (Perryman, 2014; Cooper, 2017). A new product can be a product that has not been manufactured before by any company (Cooper, 1983; Dodgson et al., 2008; Trott, 2017; Cooper, 2017) and is characterised as new to the world. Cooper (2017) argued that a new product should be furnished with new functionality, features or benefits that are apparent to customers or users and taken at least 50 person days to develop (p. 25). Designing and introducing a new product to the marketplace requires classification of the product's key benefits to target customers and its competitiveness (Ulrich et al., 2020). A new product planning process depends on a changing competitive environment and the involvement of the senior management of the company in new product planning decisions to form the new product development strategy (Trott, 2017). New product development opportunities are classified into four types (Trott, 2017, p. 453):

a) New product platform; this type of project involves a major product development effort to generate a new family of products based on a new and common platform. This will be described from the R&D perspective as development of a new core technology with the target to support completion of existing products.
b) Derivatives of existing platforms; usually, this type of product development is used to develop an existing platform to ensure that existing products are updated. This will create products with an advantage against the competition.
c) Incremental improvements to existing products; to keep a product up to date and competitive, modification of the existing product is required.

These improvements might reduce the manufacturing cost, improve the manufacturing process, change the design slightly or improve the packaging.

d) Fundamentally new products; this type of project involves a radically different product or manufacturing technologies to support a company's entrance into new and unfamiliar markets. This type of project is very risky; however, it may help to secure the long-term future of the company.

A new product should be revolutionary and transformational; the success of a new product depends on its capability to fulfil customers' needs and expectations (Cooper, 2019). Trott (2017) argued that only 10% of all new products are truly breakthrough and innovative solutions. New products are linked with a time frame: new products are defined as available in the market for three years or less (Crawford & Di Benedetto, 2011; Cooper, 2019). The fact is that a high proportion of new products fail: the failure rate is in the range of 25 to 45% (Cooper, 2017). A new product failure will lead to sales remaining below expectations, which will lead to a low percentage of margins due to the excessive development cost and excessive investments (Cooper, 2017). One example of a new product failure is a company's project team developing a product that is much the same as the competition's product and without any additional value to the customers, and sales of the new product fail to materialise (Perryman, 2014; Cooper, 2017, 2019). For this reason, the effectiveness of new product definition is a crucial success factor (Cooper & Kleinschmidt, 1993; Cooper, 2019). In a highly dynamic market environment, time to market becomes an important factor of the success of a new product.

In some cases, the collected information on new product definition at an early stage can become obsolete by the time the new product is introduced to the market (Morgan et al., 2018). The key success factors of new products are (Cooper, 1990, 2017, 2019):

a) New products deliver unique and real benefits to users that are not available from a competitor's product. The new product meets customers' requirements and expectations better than the competition's products with a higher product quality and less cost. The new product solves a problem that the customer had with the competitor's products in an innovative way. The key element of benefits is that the benefits have to be defined not only by the R&D engineers but also by the customers. Those benefits have to be appreciated by customers and have to deliver value proposition to the customers.
b) Strong market orientation should prevail throughout the entire new product development process.
c) New products are defined effectively prior to product development considering the targeted market, the customers' requirements and the customers' preferences. A focus on new product definition is essential to a successful new product development. Sharp and early new product definition improves the odds of the new product being successful.
d) Quality of product development execution, preliminary technical assessment, product development and prototype testing as well as pilot production.
e) Technological synergy between the new product development project team and resources such as R&D, engineering, production resources and skills.

f) Quality of execution of new product development activities with highly skilled project manager and project team.
g) Marketing synergy of the new product with a company's strong sales force and distribution organisation, advertising resources and skills, market intelligence resources and company's customer service capabilities.
h) Quality of the execution of marketing activities which contain preliminary market due diligence, market study and marketing research, and customer analyses and surveys.
i) New product market attractiveness with a higher growth rate and with higher profitability where the customer has a high need for a new product and considered the purchase to be important.
j) Company organisation and top management involvement to support the new product development process. Highly skilled employees in a global organisation need to collaborate strongly on new product development with the support of the top management.

However, among the success factors for the introduction of new products the speed of product development was not considered in Cooper's (1990, 2017, 2019) research. The speed of new product development (Morgan et al., 2018; Euchner, 2021), based on today's highly dynamic environmental and market conditions, is an important key success factor. Morgan et al. (2018) argued that speed in new product development allows companies to better respond to market demands and can create sustainable competitive advantages. Delay in a new product development process could lead to higher costs than budgeted and acceptance of the new product by the market could fail. Furthermore, the

product life cycle needs to be considered for a new product's success. The life cycles of products are increasingly shortening due to increased technological change in combination with changing demand (Trott, 2017). A product's life cycle comprises four key life stages from its introduction to the end of the product's life: introduction, growth, maturity and decline (Nadeau & Casselman, 2008). In addition, the product life cycle cost to the customer is an important factor that affects the success of new products (Kapp, 2019). If the total life cycle cost of a new product is lower for a customer than the total life cycle cost of another new product, then the customer will select the new product with the low life cycle cost (Kapp, 2019). The life cycle cost includes energy consumption, maintenance and service of the new product, return of investment and recycling costs.

New products may set new industry standards that make it difficult for competitors to enter the newly generated marketplace (Dodgson et al., 2008). On the other hand, the failure of new products can be of huge cost to companies and incur a loss of reputation (Kahn, 2013).

New product development processes

A new product development process is defined by the Product Development and Management Association as "*a disciplined and defined set of tasks and steps that describe the normal means by which a company repetitively converts embryonic ideas into saleable products or services*" (Kahn, 2013, p. 458). A structural methodology and execution is described in the majority of the literature on new product development process (Goulding, 1983; Cooper &

Kleinschmidt, 1993; Brethauer, 2002; Trott, 2017; Cooper, 2017). The advantages of a structural methodology and execution have been widely described in the literature (Cooper, 1983, 2017; Trott, 2017). Various structured models and methods have been analysed and formed (Goulding, 1983; Kahn, 2013; Cooper, 2017). Most of the models and methods are directly accompanied by Stage-Gate® models that propose the defined criteria that should be completed before starting the next stage (Goulding, 1983; Cooper & Kleinschmidt, 1993; Brethauer, 2002; Kahn, 2013). Activity-based and stage-based methods for new product development dominate the literature (Kahn, 2013). The stage process starts with a collection of ideas to build a new product defined by the customers or by the manufacturer (Osteras et al., 2006; Cooper, 2017). The stage process ends with the launch of the newly developed product into the market (Osteras et al., 2006; Cooper, 2017).

Stage-based process

The Stage-Gate process (Figure 2.3-1), innovated by Cooper (Kahn, 2013; Cooper, 2017), specifies a series of key steps and each step has to be fully completed and aligned with the project specification before the next step starts (Cooper, 2017). The Stage-Gate model has six main stages (Cooper, 2017, p. 123), which are illustrated in Figure 2.3-1 and described below.

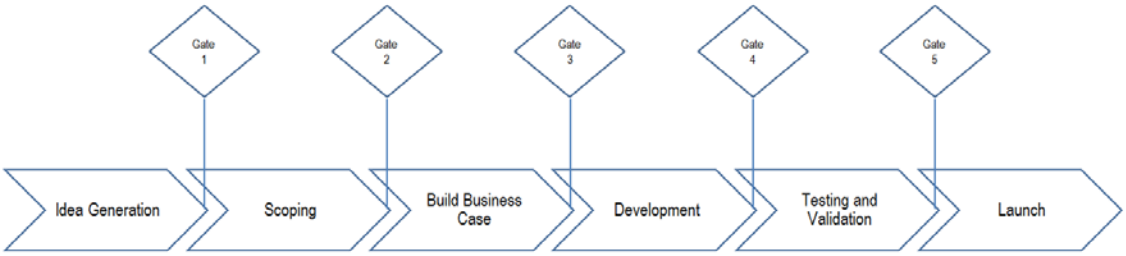


Figure 2.3-1: Stage-Gate® model. Adapted from Cooper (2017)

Idea generation is the starting stage of the new product development process to create new product concepts (Kahn, 2013). The sources of the new idea generation are internal, such as research and engineering, sales, marketing, production departments and executives of the company, and external, which include the customers, competition and technical requirements (Perryman, 2014; Cooper, 2017). The voice of the customer to identify unarticulated needs and expectations, and gap analyses on customers' needs, are important external sources of the idea generation process (Perryman, 2014; Cooper, 2017). A detailed review of competitors' products and analyses of competitors' market position will lead to idea generation (Kahn, 2013).

Scoping covers the preliminary market and technical assessments, and business and financial scope and review (Cooper, 2017). The objectives of the assessments are to appraise the development and operation process, identify the supply chain and investigate the financial and legal risks (Cooper, 2017). As a result of the preliminary assessments, the preliminary product definition, business case and the actions for the next stage are defined (Cooper, 2017).

Build business case stage contains product definition, project justification and a detailed project action plan (Cooper, 2017). The result of the completion of the business case is the key element for the decision to continue or to stop the new product development process. For this reason, a detailed assessment of product development and a complete risk analysis have to be executed (Kahn, 2013).

Development, in this stage the product is developed, manufactured and partially tested; the manufacturing processes are designed (Cooper, 2017).

Testing and validation, in this stage the developed product will be tested technically and/or in the market to validate the new product (Cooper, 2017).

Launch, in this stage the newly developed product is implemented in the real world (Eveleens, 2010).

At each gate, management make decisions on deliverables, criteria and outputs (Cooper, 2017). The decisions are based on the outcome of the previous gate on specified deliverables. Before starting the next stage, the new product development project will be evaluated on specific criteria: knockout questions are used to eliminate projects, but projects for new products that have desirable factors are prioritised (Cooper, 2017). The decision on go/kill/hold/recycle will be based on the defined output of each gate and the decisions on each gate made by senior managers (Cooper, 2017).

The Stage-Gate method is widely utilised in industry, such as the chemical and electronic industries, and by the manufacturers of engineered products (Crawford & Di Benedetto, 2011; Ulrich et al., 2020)**.** Most leading companies have implemented a Stage-Gate new product development process (Cooper, 2017) and some of them modified the Stage-Gate process based on their own product development process (Cooper & Kleinschmidt, 1993; Cooper, 2017). Companies recognised for leading new product developments include 3M, DuPont, Dow Chemical, Exxon Chemical and Corning Glass (Cooper, 1994, 2017).

The Stage-Gate new product development process has been developed over time. Cooper (1994, p. 5) referred to the third-generation Stage-Gate process (Figure 2.3-2), which has four fundamentals F's in order to improve the Stage-Gate process:

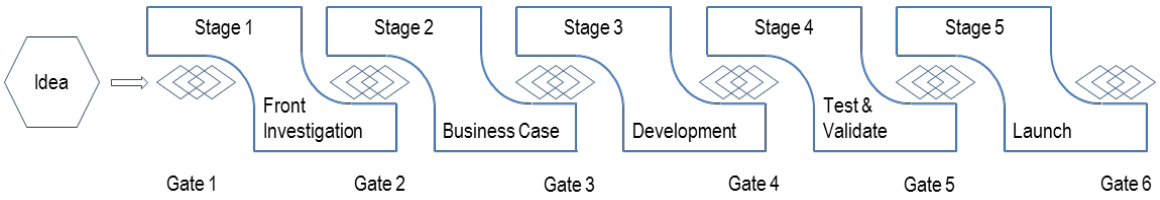


Figure 2.3-2: Third-generation Stage-Gate® process. Adapted from Cooper (1994, p. 5)

Fluidity – it is fluid and adaptable, with overlapping and fluid stages.

Fuzzy gates – conditional go decision depending on the situation.

Focused – it builds on prioritisation of entire portfolio of projects and focuses on resources.

Flexible – it is not a rigid gate system; each project is considered individually and has its own routing during project execution.

Due to the four F's, the third-generation Stage-Gate process is characterised by efficiency, by shorter process flow and by optimised allocation of resources (Cooper, 1994; Trott, 2017). The leading companies on new product development modified and adjusted the Stage-Gate process due to increasing requirements; they based the modifications on improving its adaptability and flexibility to accelerate the new product development process (Cooper, 2008). Variations of stage processes, XPress (Figure 2.3-3), Lite (Figure 2.3-3) and Spiral (Figure 2.3-4), were described by Cooper (Cooper, 2008, p. 223). XPress is utilised for new product development projects with a moderate risk: improvements and modifications to existing products as well as on product extension of a product portfolio. Lite is applied to small new product development projects.

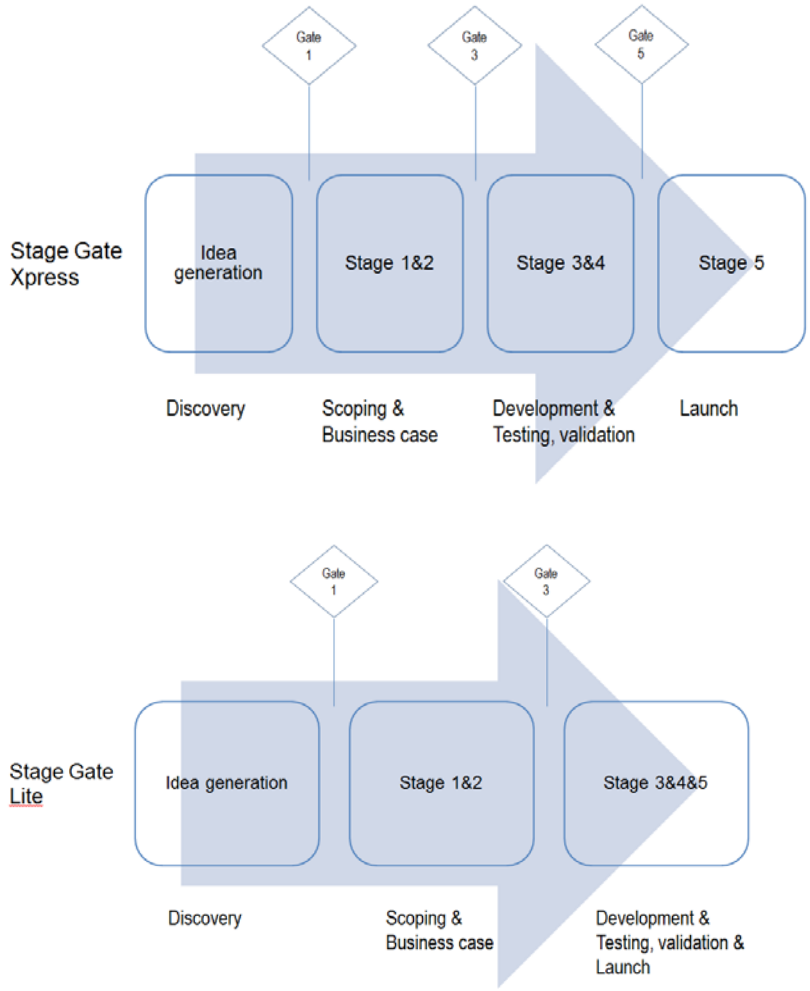


Figure 2.3-3: XPress and Lite processes. Adapted from Cooper (2008, p. 223)

The Spiral process is based on the voice of the customer and integrates customers' expectations into the new product design and its iterative validations with customers lead to fast prototyping (Cooper, 2008, 2017; Ulrich et al., 2020; Trott, 2017).

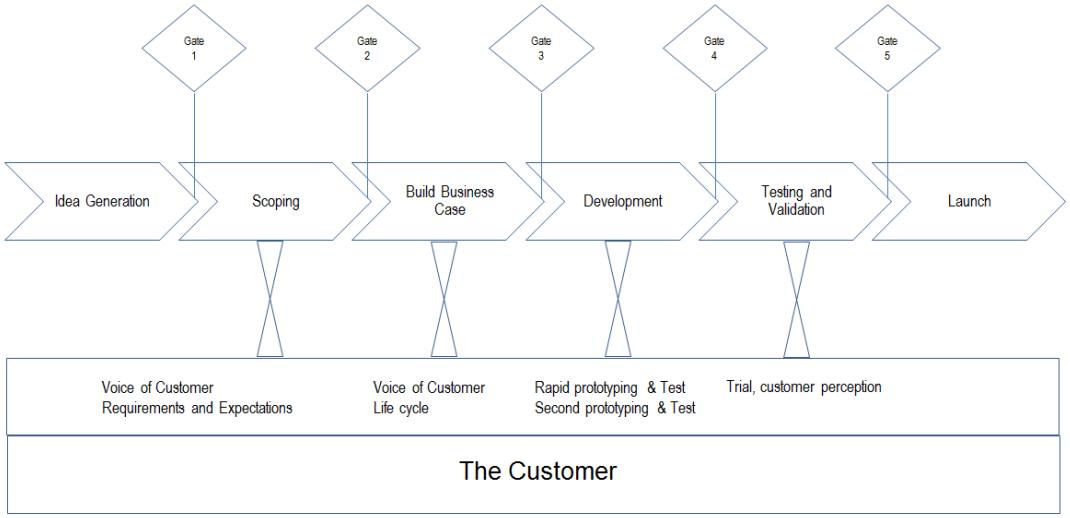


Figure 2.3-4: Spiral process. Adapted from Cooper (2008, p. 225)

Agile-Stage-Gate Process

A Stage-Gate new product development system describes the product development process in stages from idea generation to market launch (Cooper, 2017). The gates precede each stage and they mark go, kill or investment decision points. Traditional Stage-Gate systems are no longer suitable for today's businesses (Cooper & Sommers, 2018).

A hybrid model called Agile-Stage-Gate (see Figure 2.3-5), which integrates elements of both Agile and Stage-Gate, can support companies to capitalise on the strengths of both. In this hybrid model, the Agile way of working is embedded within the stages and the traditional project management tools are replaced by Agile tools and processes (Cooper & Sommers, 2018). The benefits of the Agile-Stage-Gate new product development process are increased flexibility, improved productivity, communication and coordination among project team members, and better focus on projects, which result in better prioritisation of time and efforts and raised team effort. Agile-Stage-

Gate processes reduce the new product development process by 30% compared to the traditional Stage-Gate new product development process (Cooper & Sommers, 2018).

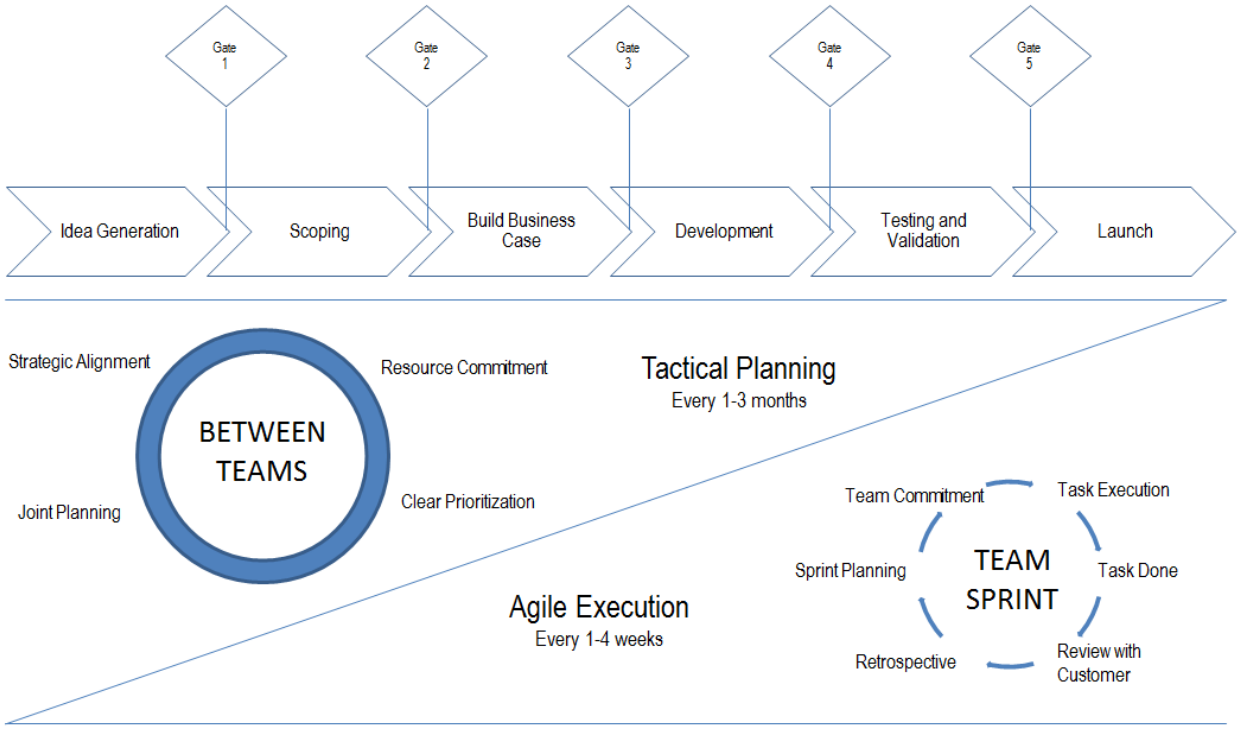


Figure 2.3-6: Agile-Stage-Gate. Adapted from Cooper and Sommers (2018, p. 19)

Define, Measure, Analyse, Design, Verify and Implement (DMADVI) process

DMADVI is a Six Sigma-based product development process implemented by General Electric in the late 1990s (Belair & O´Neill, 2006). The DMADVI product development process is described in a linear fashion, similar to Stage-Gate new product development, for explanation purposes (Figure 2.3-6); however, practically, it is implemented in a non-linear fashion (Belair & O´Neill, 2006). The new product development process is accompanied by Measure, Analyse and Design phases at the same time. The DMADVI process suggests that all activities specified for the phases need not be completed as described in the Stage-Gate process. The new product development team members can decide to move forward if they have enough satisfactory information and are supported by the key actors in the new product development (Belair & O´Neill, 2006).

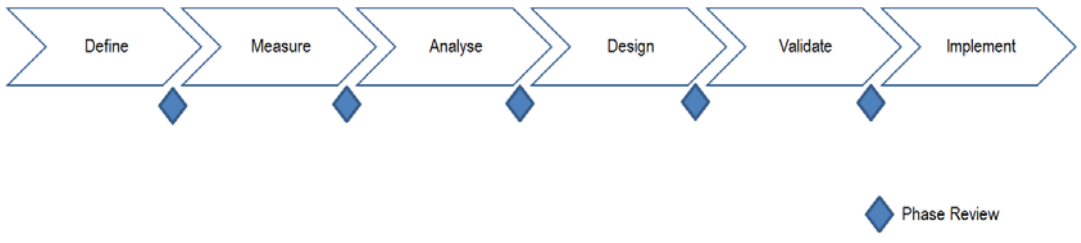


Figure 2.3-7: Define, Measure, Analyse, Design, Verify and Implement process. Adapted from Belair and O´Neill (2006, p. 52)

Activity Stage process

The Activity Stage process (Figure 2.3-7) was developed by Crawford in 1997. In this process, the activities of the new product development process, from strategic planning through to commercialisation, occur at the same time but vary in their intensity (Trott, 2017, p. 505).

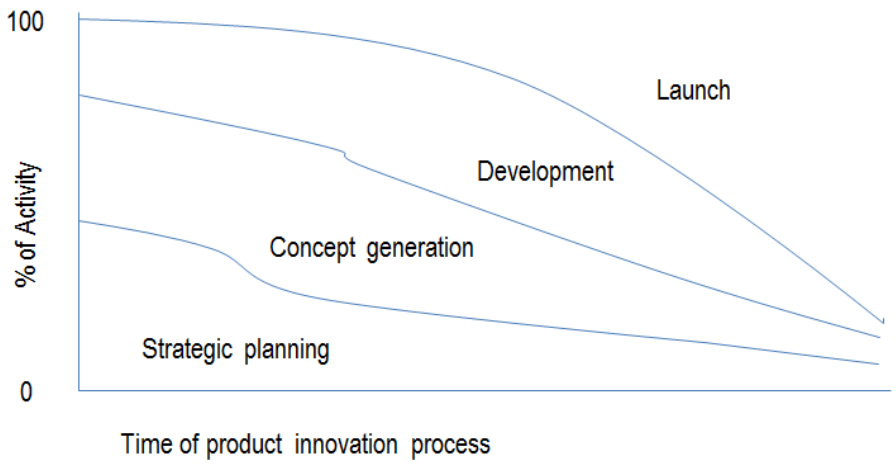


Figure 2.3-8: Active Stage process. Adapted from Trott (2017, p. 505)

Network process

The Network process is based on an accumulation of the knowledge across an organisation with external inputs on new product development. The Network process (Figure 2.3-8) was developed in 1997 and represents the latest process on new product development (Trott, 2017).

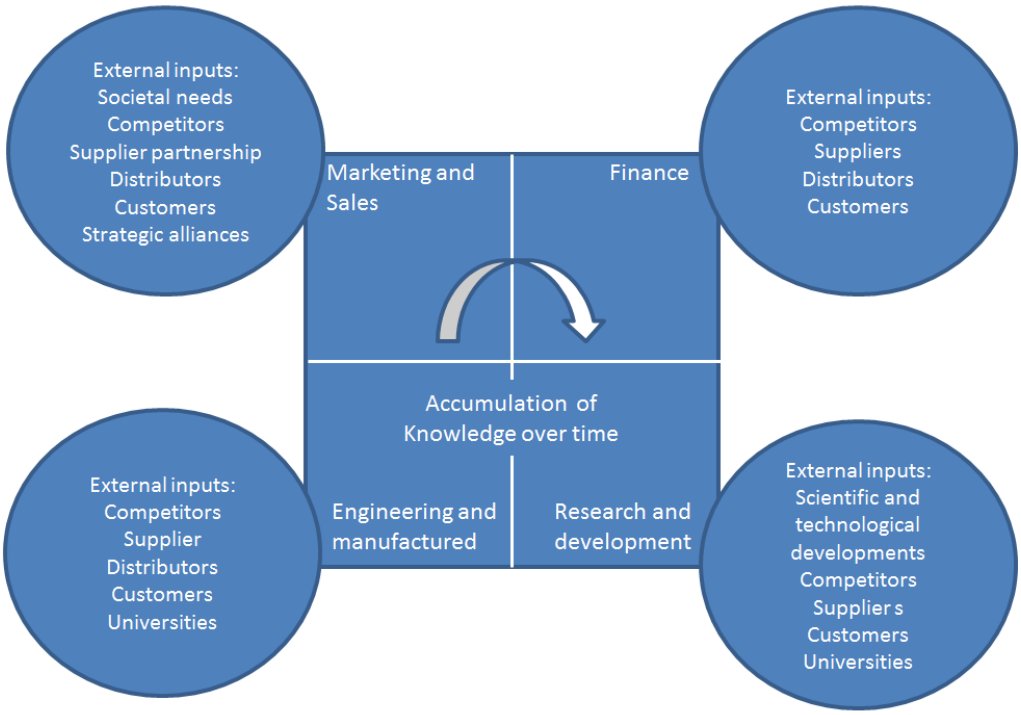


Figure 2.3-9: Network process. Adapted from Trott (2017, p. 508)

Open Innovation process

The Open Innovation process uses purposive inflow and outflow of knowledge to accelerate a company's new product development process and to expand the markets for external use of innovation to generate additional value (Noble et al., 2014; Chesbrough et al., 2006). The Open Innovation process (Figure 2.3-9) has received increased attention in the last decade and the benefits of this process and its popular techniques were increasingly noted, such as co-creation, crowdsourcing and collaborative design (Noble et al., 2014). The Open Innovation process proposes that companies should use external and internal ideas since useful knowledge is widely distributed (Chesbrough et al., 2006).

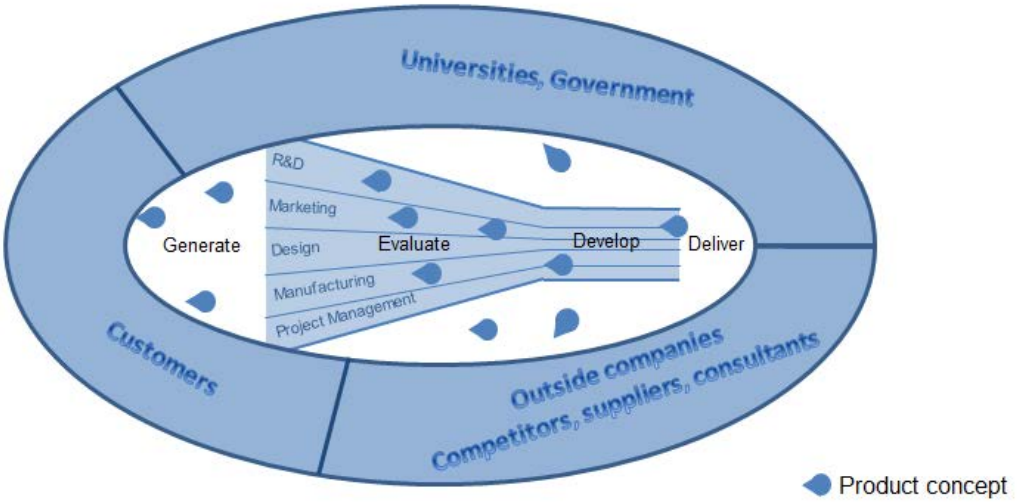


Figure 2.3-10: Open Innovation process. Adapted from Noble et al. (2014, p. xiv)

Discontinuous Innovation process

The Discontinuous Innovation process is mainly characterised as architectural (Figure 2.3-10); it changes the new product development patterns and combines the elements in a new way without introducing any essentially new product development methods (Veryzer Jr., 1998; Picaud, 2013).

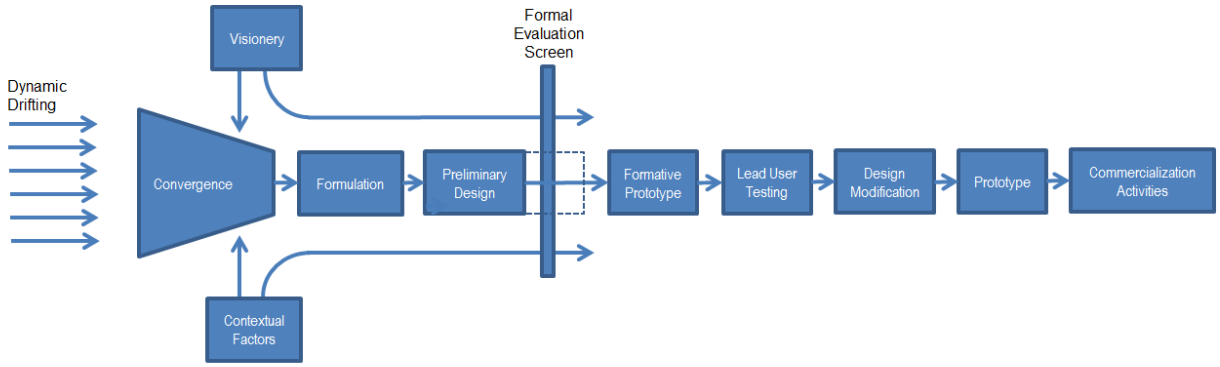


Figure 2.3-11: Discontinuous Innovation process. Adapted from Veryzer Jr., (1998, p. 317)

Individual product development process

The new product development processes described earlier are generic; individual processes will vary depending on the company's strategy, on the new product and on new product development projects (Jacobs & Chase, 2018; Ulrich et al., 2020). A generic new product development process is used mostly in a market-pull situation; that is, in response to a market opportunity, a company begins new product development and utilises available technologies to satisfy market needs. In addition to the market-pull new product development processes outlined in Figures 2.3-1 to 2.3-5 there are several variants as presented by Jacobs and Chase (2018) and by Ulrich et al. (2020): technology-push products, platform products, process-intensive products, customised products, high-risk products, quick-build products, product-service systems and complex systems.

Technology-Push Products; technology-push products are characterised by the development of a completely new technology which is applied to appropriate products in different markets. Technology-push new product

development usually does not involve market research; the generic product development process can be used with minor modifications on technology-push new product development. The technology-push process begins with the planning phase, where the defined technology is matched with a market opportunity. Once this matching has occurred, the remainder of the generic development process can be followed. The new product's success is based on its competitiveness and on the unavailability of alternatives (Jacobs & Chase, 2018; Ulrich et al., 2020).

Platform Products; a platform product is built around a pre-existing technological subsystem. Tremendous investments are made in developing such platforms, and every attempt is made to incorporate them into several different products. In some sense, platform products are similar to technology-push products where a team begins a development effort with the assumption that the product concept will embody a particular technology. The primary difference is that in platform products a technology platform has already demonstrated its usefulness in the marketplace in meeting customer needs (Jacobs & Chase, 2018; Ulrich et al., 2020).

Process-Intensive Products; characteristics of the product are highly constrained by the production process. Either an existing production process must be specified from the start, or both product and techniques must be developed together from the start. Usually, process-intensive products are manufactured in high volumes and are mass products rather than individual products (Jacobs & Chase, 2018; Ulrich et al., 2020).

Customised Products; customised products can be identified by the presence of variations of a standard product design and are typically developed in response to a specific order by a customer. When customers order a new product, the company executes a structured design and development process to develop the product to meet the customers' needs (Jacobs & Chase, 2018; Ulrich et al., 2020).

High-Risk Products; high-risk products are those that entail unusually high technological or business-related uncertainty in such a manner that there are significant technical or business risks. The generic new product development process is modified to face high-risk situations by taking steps to address the largest risks in the early stages of product development (Jacobs & Chase, 2018; Ulrich et al., 2020).

Quick-Build Products; rapid modelling and prototyping make for several iterations of design-build-test. Following concept development in this process, the system-level design phase entails decomposition of the product into high-, medium- and low-priority features. This is followed by several cycles of design, build, integrate and test activities, beginning with the highest-priority items. This process takes advantages of the fast prototyping cycle by using the result of each cycle to learn how to modify the priorities for the next cycle (Jacobs & Chase, 2018; Ulrich et al., 2020).

Product-Service Systems; services are largely intangible product offerings and are often provided in combination with tangible products (Ulrich et al., 2020, p. 22). Services are largely developed using the generic product

development process; however, service design teams pay careful attention to the service delivery process, since customers are involved in the service delivery process. Many services are produced and consumed at the same time; therefore, matching supply with demand is critical (Ulrich et al., 2020, p. 22).

Complex Systems; larger-scale products such as airplanes, turbo engines and automobiles are complex systems composed of many interacting subsystems and components. The system is decomposed into several subsystems and many parts. Subsystems and components are developed by many teams working in parallel, followed by system integration and validation (Jacobs & Chase, 2018; Ulrich et al., 2020).

Table 2.3-1 summarises an individual product development process.

Process Type	Description	Features	Examples
Market-Pull Products (Generic)	It is a linear model of product development, where researchers begin with a market opportunity and select suitable technology to fulfil customers' requirements	Starts with concept development, followed by pre-design, detail design, prototyping and testing, production and ramp-up, marketing	Sporting goods, tools
Technology-Push Products	Technology-driven product development, where the researchers develop a new technology and find a related marketplace	Planning phase includes matching the technology and defining the market	Rainwear, skiing
Platform Products	The new product will be developed around a settled technological subsystem	Concept development around the proven technology	Electronics for consumers, computers, printers

Process Type	Description	Features	Examples
Process-Intensive Products	New product development by restricted production process	Planning phase involved defining the production process or both product and production process must be in development from the beginning	Semi-conductors, chemicals
Customised Products	New product variances based on existing pattern	Since the pattern exists, the development process is highly structured	Furniture, equipment for oil and gas industry
High-Risk Product	Uncertainty in involved technology and market generate high risk of failure	Potential risks are identified in the beginning of the development process and addressed through the process. Testing will start in early stages	Pharmaceuticals, space systems
Quick-Build Products	Prototyping and modelling allows design-build-test cycles	Detail design and testing phases are repeated several times until the product is completed	Software, mobile phones
Product-Service System	Product and related service developed together	Product and service developed based on customer experience and process flow	Financial services, restaurants
Complex System	System will be divided into several subsystems and many components	Subsystems and components are developed by many teams in parallel and coordinated by project management team for integration and validation	Turbo engines, airplane, car

Table 2.3-1: A generic product development process. Adapted from Jacobs and Chase (2018, p. 47) and Ulrich et al. (2020, p. 19)

New product development challenges

Developing a new product is very challenging and developing a great product is much harder (Ulrich et al., 2020). The success rate of developing a great product is very low (Trott, 2017) and is a fundamental challenge for the R&D team. However, not all challenges are technical and some of the challenges

are due to external factors. Typical non-technical challenges are trade-offs, dynamics, details, time pressure and economics (Ulrich et al., 2020, p. 6) (Table 2.3-2).

Characteristics	Description	Challenge
Trade-off	A product can be designed more compact to maximise the success of the product	Managing the risks for cost increase and for supply chain
Dynamics	Technology improves, competition introduces new products and the market environment shifts	Decision-making process in constantly changing environment
Details	Design details, such as type of fasteners, in complex products	Implication of higher costs
Time pressure	Decision must be made quickly even without complete information	Risk for decision process and delay to launch
Economics	A large investment is involved in product development and marketing	Return on investment, risk whether customers will accept the product

Table 2.3-2: Challenges of product development. Adapted from Ulrich et al. (2020, p. 6)

Summary of new product development processes

New product development processes are described in the literature individually. The reviewed processes vary in methodology and in execution of new product development. Table 2.3-3 summarises a comparison of the reviewed new product development processes in the literature. Most of the

new product development processes are suitable for developing engineering and industrial products. However, some of them do not fully consider customers' participation during the development process, such as the Phased Review process and the Discontinuous Innovation process, whereas others, such as Network process, Open Innovation process and Spiral process, consider collaboration and co-creation methods. Collaboration with customers, suppliers and stakeholders leads to effective and efficient new product development. Collaboration is a form of teamwork that consists of detailed parts; the purpose of collaboration is to achieve common goals (Arina & Rustiadi, 2018). Co-creation with customers occurs when customers contribute to the new product development process by sharing their views and knowledge with the company; they can be directly involved in the product development and manufacturing process in order to meet customers' needs effectively (Barbu & Militaru, 2019).

Some of the processes are flexible and not as rigid as the Stage-Gate process, where each step has to be fully completed and aligned with the project specification before the next step starts (Cooper, 2017). The Stage-Gate new product development process has been recognised as a process of bringing a structure to the sometimes chaotic process of new product development (Trott, 2017). However, the Stage-Gate process is criticised because of the amount of time it consumes, its time wasting activities, its bureaucratic process and restrictions of learning opportunities, as well as a lack of provision for focus (Kasper et al., 2020). Furthermore, Stage-Gate is not adaptive enough and does not encourage experimentation, which may lead to a rigid and fixed mindset so that product definitions and project plans

tend to be locked in at too early a stage. This approach conflicts with today's fast-paced and often quickly changing world in which more innovative or dynamic new product projects are handled (Kasper et al., 2020). Cooper, the inventor of the Stage-Gate new product development process, recognised these problems and Cooper and Sommer (2018) introduced a hybrid model in which the Agile way working was embedded within the Stage-Gate model. However, the stages of new product development are still part of the new product development process.

The time to market of new products depends on the selected new product development process. In today's fast-paced and often quickly changing market conditions, the speed of the new product development process is very important in order to address customers' needs in a timely manner to gain competitive advantages. Smolnik and Bergmann (2020) argued that the new product development process must be flexible and adapted to changing market conditions and customer requirements. The best-performing companies implement an efficient, less complex, agile and adaptive new product development process to ensure the processes of the original Stage-Gate process, which represents a ridig framework, are accelerated (Smolnik & Bergmann, 2020).

Criteria	Phased Review Process	Stage Gate Process	Third Generation Process	Next-Gen Stage Gate
Year of Introduction	1960 s	1964	1991	2000
Developed by	NASA	Procter & Gamble	Procter & Gamble	Procter & Gamble
Methodology	Engineering	Cross functional	Cross Functional	Cross Functional
Function	Task driven	Linear, Gate decision Go / Kill	Fluid, Fuzzy gates, Focused, Flexible	Xpress, Little, reduced number of stages
Decision Process	Single Management Review	Several senior Manager Reviews	Team and Team Leader Reviews	Team and Team Leader Reviews
Time to Market	Very long	Long, project must wait at each gate until all tasks have been completed	Moderate	Short
Focussed	on Engineering side of the development	Functional oriented	Functional oriented	Functional oriented
Capture	Product Development	From idea through to launch	From idea through to launch	From idea through to launch
Market Orientation	Narrow	Focussed on delighting the customer	Focussed on delighting the customer	Customer focussed, Voice of Customer
Industry	Engineering Products	Consume, Industrial Products, Engineering Products	Consume, Industrial Products, Engineering Products	Industry products

Criteria	Spiral Gate Stage Process	Agile-Stage-Gate Process	DMADVI Process	Activity Stage Process
Year of Introduction	1994	2018	Late 1990`s	1997
Developed by	Cooper	Cooper & Sommers Chamberlein, Danfoss, GE, Honeywell, LEGO, Tetrapak	General Electric	Crawford
Methodology	Cross functional	Cross functional and sprint	Six Sigma based cross functional	Cross Functional
Function	Build, Test, Feedback, Revise	Linear and scrum	Define, Measure, Analyse, Design, Verify, Validate, Implement (DMADVI)	Integrated feedback loops
Decision Process	Team and Team Leader Reviews	Team and Team Leader Reviews	Team and Team Leader Reviews	Team and Team Leader Reviews
Time to Market	Agile	Agile	Agile	Moderate
Focussed	Value stream	Value stream	Performance oriented	Project oriented
Capture	From VOC to product	From idea and VOC through to launch	Define to Implement	From Strategic planning through to commercialization
Market Orientation	Customer and Market are part of the process	Voice of Customer	Voice of Customer	Market oriented
Industry	Industrial products	Industrial products	Engineering Products	Industrial products

Criteria	Network Process	Open Innovation Process	Discontinuous Process
Year of Introduction	1991	2000	1990`s
Developed by	Nonaka and Takeuchi	Chesbrough	Individual
Methodology	Cross Functional	External & Internal cross functional	Cross Functional
Function	Spiral, knowledge accumulation	External and Internal resources	Continuous innovation
Decision Process	Team and Team Leader Reviews	External and Internal Team and Team Leader Reviews	Team and Team Leader Reviews
Time to Market	Short	Agile	Long
Focussed	Knowledge oriented	Result oriented	Exploratory
Capture	From idea through to launch	From idea to product	From vision to commercialization
Market Orientation	Customer and Market are part of the process	Focussed on external resources	Less customer driven
Industry	Software, high tech industry, automotive	Industry products,	Industry products

Table 2.3-3: An overview of new product development processes. VOC voice of customers

2.4 New Product Development and Competitive Advantage

Competitive advantage has a long history and has generated a large volume of academic output (Powell, 2001; Sigalas, 2015); there are many definitions of competitive advantage throughout the literature in the field of strategic management (Porter, 1980; Barney, 1991; Ma, 2000; Powell, 2001; Sigalas et al., 2013). However, there is no clear definition of competitive advantage (Ma, 2000) and there is no standardised definition. Sigalas et al. (2013) stated that there is a need for further academic research in strategic management due to the lack of definition of competitive advantage. Sigalas et al. (2013) argued that the first stipulative definition of competitive advantage was provided by Peteraf and Barney (2003): "*the capability of a firm to create more economic value than the least efficient competitors*" (p. 314). However, this definition does not cover any antecedents of performance, and competitive advantage is not defined in terms of financial profitability (Sigalas et al., 2013). Sigalas et al. (2013) identified a second clear stipulative definition of competitive advantage as "*the degree to which a company has exploited opportunities, neutralized threats and reduced costs"* (Newbert, 2008, p. 752). Sigalas et al. (2013) reworded the definition since the definition is focused on company competitiveness and not on competitiveness with comparable competitors within an industry, as "*the above industry average manifested exploitation of market opportunities, neutralization of competitive threats and reduction of costs*" (p. 327). Although the terms "competitive advantage" and "performance" are often used as synonyms, the two constructs are recognised

to be conceptually different (Powell, 2001). Competitive advantage refers to an organisation's performance and resources relative to their competition (Sigalas et al., 2013). Organisational competence leads to competitiveness and generates a solid competitive advantage (Newbert, 2008).

The resources of an organisation used to gain a competitive advantage are characterised as tangible and intangible resources (Grimm, 2005; Mamoun, 2012). Tangible resources are classified into:

- Financial resources – a company's loan capacity and its internal funds generation, which verify the company's resilience and capacity for investment.
- Physical resources – a company's production possibilities that impact its cost position, which include the size, location, technical condition and flexibility of its plant and equipment, buildings and reserves of raw materials.

Intangible resources are classified into:

- Technological resources – technical and scientific employees, research facilities and equipment, patent portfolio, copyright and trade secrets.
- Reputation – the reputation of the company with customers through the brand, trademarks, product portfolio and quality of service and reliability. The reputation of the company with suppliers, banks and financiers, employees, government and the community.
- Human resources – education, training and experience of the employees, the skills and adaptability of employees in relation to the strategic flexibility of the company, and the social and collaborative skills of employees. The commitment and loyalty of the employees.

The competitive advantage of a company is related to the value and rareness of its tangible and intangible resources (Newbert, 2008). A specific resource may enable a company to gain a competitive advantage in a specific industry (Peteraf & Barney, 2003). Newbert (2008) argued that resources and capabilities must be utilised in combination to contribute to rareness to give a competitive advantage. If a company's resource capability combinations are rare, then the company should attain a competitive advantage. Likewise, the rarer the resource capability combinations, the greater a company's competitive advantage (Newbert, 2008).

Tangible and intangible resources should meet the following requirements in order to generate competitive advantage: the resources should be valuable and they should increase the efficiency of the company; they should be rare because to gain a long-term competitive advantage it should not be possible to substitute the resources (i.e., there should be no other resources in place that could generate comparable performances); and the resources should be inimitable (Barney, 1991; Duschek, 2004; Newbert, 2008; Ulrich et al., 2020).

One of the essential sources for establishing a competitive advantage is the value chain approach. Many leading companies implement reverse logistics and source reduction processes to accumulate competitive advantage (Jayaraman & Luo, 2007).

A company able to generate more economic value than a competitor edging in on its market has a competitive advantage (Peteraf & Barney, 2003).

Economic value is usually generated by producing products and services with greater benefits at the same cost compared to competitors or the same benefit at lower cost compared to competitors (Peteraf & Barney, 2003). Competitive advantage results from owning more valuable resources than other companies in an industry, where there is a heterogeneous distribution of resources (Barney, 1991). Barney (1991) stated that a company's resources must have four attributes to create advantages; the four attributes are valuable, rare, imperfectly and non-substitutable (VRIN) (p. 105):

a. it must be **V**aluable to customers, in the sense that it exploits opportunities and/or neutralises threats in a company's environments,
b. it must be **R**are so that the company's current and potential competitors cannot obtain it,
c. it must be **I**mperfectly imitable and
d. **n**on-substitutable (i.e., there cannot be strategically equivalent substitutes).

Porter (1980) stated that five forces are important for sustainable competitive advantage: current competition, potential new entrants, suppliers, buyers and substitution. Competitive advantage is based on an organisation acquiring attributes to outperform the competition and on identifying the attributes of new products that have value-creating distinctions so that the competition cannot imitate the new product and the development process (Porter, 1980).

The correlation between new products and competitive advantage was analysed by various writers who proposed that new product introduction leads to a competitive advantage (Lawless & Fisher, 1990; Trott, 2017; Ulrich et al.,

2020). Cooper (2017) claimed that it was difficult to sustain the competitive advantages of products because of rapid changes in the market and the launch of many new products by competitors in a "*leapfrog world"* (Cooper, 2017, p. 7). Porter (1980) discussed the relation between a new product and competitive advantages where the new product's attributes alone do not guarantee competitive advantage unless the new product influences competitive advantage (Ulrich et al., 2020). The companies with highest product reliability will lose competitive advantage if a guarantee period for their new product is reduced because the attribute of the reliability of a new product does not reflect the guarantee period and the competition can provide a longer guarantee time period for a similar product (Porter, 1980).

Indeed, new product development is essential for companies' competitiveness (Cooper, 2017) and entrepreneurial growth (Fuchs, 2007). New products are important for long-term financial success and provide sustainable competitive advantage (Trott, 2017; Cooper, 2017). Companies spend huge amounts of money on R&D activities that result in a new product to achieve a competitive advantage in a specific market (Crawford & Di Benedetto, 2011; Akroush, 2012; Mamoun, 2012).

New product development plays an important role in the global market, since new product development leads to improved products and services, better financial performance and sustainable long-term competitive advantage (Kahn, 2013; Trott, 2017). The benefits of gaining competitive advantage by introducing new products are: revenue and profit increase, product development, productivity and operational efficiency (Perryman, 2014).

Smolnik and Bergmann (2020) argued that the main asset of an organisation is its creativity, which leads to the introduction of new products and the gaining of competitive advantages. A company is considered to have a sustainable competitive advantage when its strategy is adapted by none of its competitors, whether current or potential. Carter (2021) proposed three types of competitive advantage gained from new product introduction: first, premium, innovative and differentiated products with high price and high value; second, competitively priced products that differentiate on minor factors; and third, low-cost products where often the quality is good enough (p. 7). These advantages will drive profit increase for the innovating company until their competition is in a position to introduce an effective solution.

A successful new product introduction leads to a clear competitive advantage by meeting the customers' needs and making it unavailable to competitors (Ulrich et al., 2020). New products that offer a highly innovative solution and greater quality to customers will gain greater competitive advantage (Swink & Song, 2007). Porter (1980) claimed that technological improvements alone are not important in terms of the relation between competitive advantage and new product development, rather it is important that the technological improvements influence competitive advantage and industrial structure.

Mamoun (2012) argued that product quality and speed to market are two essential factors of new product competitive advantage. The factor of speed is essential to new product development, so as to be first in the market and to be the number one in the competitive environment (Bacon et al., 1994; Swink & Song, 2007; Mamoun, 2012; Kahn, 2013). This is related to the shortening of

new product development cycle time and manufacturing and marketing time. Porter (1980) underlined the importance of quick responsiveness to competitive advantages and specified quick response capability factors, such as uncommitted cash reserves, reserve borrowing power, excess plant capacity and unintroduced but on-the-shelf new products. A new product development project schedule and length of time related to time to market are considered important factors of new product success. Researchers affirmed that rapid new product development will provide considerable competitive advantages (Swink & Song, 2007). Integration of marketing and manufacturing during the business and market analyses stage during new product development will positively influence competitive advantage (Swink & Song, 2007). Sustaining competitive advantages and gaining profit from new products for the longest possible time is a strategic approach for innovative companies (Carter, 2021).

A company's core competence, where the company can do things better than the competition, will drive the creation of new products to gain a competitive advantage and retain customers (Kahn, 2013). Core competence contributes significantly to customers' benefits, and is widely recognised and applied to many products and is difficult for competitors to imitate (Cooper, 2017).

In order to keep the competitive advantage of a new product, the features of the new product need to be patented to avoid imitations (Ulrich et al., 2020). Patents protect the design features and functionality of a new product; the patent has a set of numbered phrases that define precisely the essential elements of the invented new product (Trott, 2017). A patent owner is in a

position to protect a new product from imitators based on the described design features (Ulrich et al., 2020). Trott (2007) proposed seven components that affect strategic non-imitability: product form, product function, product intangibles, pricing, promotion, distribution and company characteristics.

In addition to a new product, non-product-related elements like marketing communications, reputation of the company, distribution channels and technical support can create competitive advantage (Kahn, 2013). The utilisation of organisational resources plays an important role in terms of developing new products which leads to increased profits (Akroush, 2012).

New products resulting from design improvements or from innovative solutions enable companies to build competitive advantage in the marketplace (Fuchs, 2007). It is necessary to establish a competitive advantage by improving a product and processes, and initiating and dealing with disruptive changes, to generate growth (Fuchs, 2007). The internet platform creates a competitive advantage for new products in terms of marketing advantages in an information-based marketplace (Ozuem et al., 2007).

Based on a review by the American Productivity and Quality Center in 2013, the best performers are more effective at proposing key benefits to their customers, offer better value for money to their customers and superior performance in comparison to their competitors (Kahn, 2013). A clear understanding of potential customers' requirements, of the nature of the market where the new product will be marketed as well as of the competitive environment are key elements to a successful new product introduction and to

sustainable competitive advantage (Kahn, 2013). A strong marketing channel combined with powerful brand awareness and a large sales basis, including the ability to implement new technologies in an existing product line, are defined as important factors of sustainable competitive advantage (Cooper, 2017). Close collaboration with customers to create knowledge to drive new product development is the key to sustainable competitive advantage in a global economy (Sofianti et al., 2010).

The reduction of emissions and protection of the environment based on new technology will become a critical competitive advantage globally, especially in the oil and gas, petrochemical, chemical and nuclear industries (Valencia, 2011). Implementation of new technologies within industries will gain them a competitive advantage because a reduction in greenhouse gases will increase the value to society and customers and increase financial benefits (Valencia, 2011). To reduce greenhouse gases, the oil and gas, petrochemical, chemical and nuclear plants will need to install equipment, such as engineered valves, in their plants, which will need to be newly developed in order to meet customers' requirements as well as legislation on emissions.

2.5 New Products and CRM

The expertise and experience of customers have been increasingly accepted as an essential resource for new product development to support a long-term customer relationship (Trott, 2017; Ismana-Ilisan, 2018; Tabassum & Ozuem, 2019; Yan et al., 2021). New product development and the launching of new products are important ingredients to leverage a company's market position favourably (Tabassum & Ozuem, 2019). Developing and launching new products and services generate potential new growth occasions but they also contain massive risk that can result in financial losses for companies (Peljhan & Marc, 2021). The new product development failure rate has remained high in recent years and companies are looking for solutions to address this important problem (Floren et al., 2017). Many errors, due to complex, inaccurate, contradictory and incomplete product specifications of customers' requirements during the early and late stages of the new product development process, can lead to tremendous costs and can delay the launch of a new product because of design correction and retesting of the new product (Floren et al., 2017; Zhang et al., 2021). The failure rate at the commercialisation stage of new product development projects is nearly 40% and only 13% of new product development efforts achieve their profit objective (Zhang et al., 2021). Aligning a new product development process with market expectations would be a useful strategy to reduce the failure rate of new products and would increase the success of new products in the market. In line with this strategy, Ernst et al. (2011) proposed utilisation of CRM, which can provide customer orientation and customer knowledge to new product performance in

order to increase the likelihood in new product development for a successful new product introduction. To develop successful products companies should accurately understand customers' needs; however, the task is becoming more challenging as customers' needs change rapidly in today's complex market environment (Smolnik & Bergmann, 2020; Euchner, 2021). CRM will allow companies to understand user needs in order to transfer user needs to the new product development process. The result of a study carried out by Guerola-Navarro et al. (2021) showed that customer relationship has a strong influence on new product development and on company performance. Thus, companies with better utilisation of CRM applications will be better able to design and develop innovative products and services due to a better and deeper understanding of their customers (Guerola-Navarro et al., 2021). Basically, CRM is concerned with fully understanding customers' behaviour (AlQershi et al., 2021).

The launching of a new product requires a closer relationship with customers (Buttle & Maklan, 2019). The Identify, differentiate, interact and customise model, which was developed by Peppers and Rogers a consultancy company, suggests that companies should take four actions in order to build a closer relationship with their customers (Buttle & Maklan, 2019, p. 19);

- Identify; the first action is to identify who your customers are and collect as much information as you can in order to better understand their needs and purchase behaviours.
- Differentiate; the next action is to differentiate or segment the customers based on their current and projected lifetime value. By differentiating customers based on their value to the company, relationship efforts can be

prioritised on the most valuable customers in order to gain best profitability now and in the future.

- Interact; the third action is to ensure that customers' expectations and their relationships with other suppliers are understood.
- Customise; following the documentation of customer interactions, the data should be analysed in order to develop offers and communications and to ensure that the expectations of customers are met.

CRM has become very popular in recent years (Astani & Duplaga, 2017, Chaudhry et al., 2018); it enables companies to grow the value of their customers (Ismana-Ilisan, 2018). The term CRM was integrated with IT in the mid-1990s and is often used to describe a technology-based CRM solution (Buttle & Maklan, 2019). There is no agreed definition of CRM and various authors offer various definitions of CRM, which proves that this area is still in a phase of exploration and development (Chaudhry et al., 2018; Ismana-Ilisan, 2018). One definition of CRM is, "*a comprehensive strategy and process of acquiring, retaining, and partnering with selective customers to create superior value for the company and customer"* (Parvatiyar & Sheth, 2000, p. 6). Another definition of CRM is, "*a term for methodologies, technologies and e-commerce capabilities used by companies to manage the customer relationship"* (Stone & Woodcock, 2001, p. 3). Kincaid (2003) defined CRM as, "*strategic use of information, processes, technology, and people to manage the customer's relationship with the company (Marketing, Sales, Services and Support) across the whole customer life cycle"* (p. 41). Buttle and Maklan (2019) defined CRM as, "*a core business strategy that*

integrates internal processes and functions, and external networks, to create and deliver value to targeted customers at a profit" (p. 15).

CRM is identified as one of the methodologies and techniques of a new product development process (Trott, 2017). To develop successful products, companies should be in a position to understand customers' needs (von Hippel, 2001; Dayan & Arnolds, 2012; Kotler et al., 2019) and a close interaction with customers (Buttle & Maklan, 2019) is an effective way to improve new product introduction success (Ismana-Ilisan, 2018). Understanding new customers' needs well and in detail is often associated with high costs to the company: these costs are five times higher than for existing customers (Astani & Duplaga, 2017). The potential of CRM has been researched only in the context of existing products and CRM's potential influence on new product development has been neglected (Ernst et al., 2011). However, CRM could be mobilised to provide customer-related information in order to assist in the alignment of a new product development process with market requirements to improve the success of a new product and company performance (Buttle & Maklan, 2019). Yan et al. (2021) argued that mobilising CRM would have a stronger impact on new product development performance than a single aspect of customer orientation. A new product development process is costly and the return on investment (ROI) is related to the sales of the new product; CRM could bring added value through the new product development process as well as to the introduction of the new product (Dayan & Arnolds, 2012). An effective CRM with potential and targeted customers during the early and late stages of a new product

development process could be an important contributor to new product success (Astani & Duplaga, 2017).

From a strategic point of view, CRM is not an IT solution which is implemented to acquire and grow a customer base, it involves a strategic vision to understand customer value and to utilise information management and a higher quality of operations and services with improvement to existing product and new product development processes (Ismana-Ilisan, 2018; Buttle & Maklan, 2019). Therefore, it is important that a company focuses on customer selection in their CRM effort (Ismana-Ilisan, 2018) because not all customers are equally profitable for the company in relation to planned new product development (Gaspar et al., 2014).

Yan et al. (2021) stated that in a turbulent market environment, product development management in new product development appears to be important because innovative products are more likely to be favoured by customers, and companies with advanced knowledge can produce innovative products to lead the future market (p. 35). Therefore, product development management and CRM are important for new product development performance to generate value to customers (Zhang et al., 2021). Customer-centric strategies become eminent in order to identify customer preferences, value provision, and product and service customisation (Kumar & Reinartz, 2018). Kumar and Reinartz (2018) argued that ceating and sustaining value for customers is at the heart of business in general, and that marketing and CRM specifically are vehicles through which companies can deliver value to their customers (p. 18). Strategically employed CRM can improve customers'

perception of an offering and meet the demand of solutions to customer-specific needs (Buttle & Maklan, 2019).

Despite the advantages of CRM to new product development, Kapp (2019) described the importance of face-to-face communication, especially for new engineered product development, and he described CRM as a useful tool. Kapp (2019) argued that CRM can measure and present a lot of data, but the outcome of CRM in isolation cannot be judged since it is based on pure data that needs to be analysed and interpreted based on the actual circumstances. Furthermore, he argued that CRM can be complex to operate, require an enormous amount of time and effort in order to keep information current, and often needs to be customised, which is associated with high cost, to reflect the specific business the company is operating. Often, the CRM system is an island solution that does not integrate well with other communication and enterprise resource planning systems (Kapp, 2019).

Actually, CRM has a significant IT element, which has led some companies to hold their IT department responsible for CRM implementation without considering a CRM strategy; this will lead to limited usability and effectiveness in delivering valuable results from the CRM tool. CRM tools should be defined as supplementary to the company's strategy for building an effective customer relationship. A comprehensive CRM strategy and customised CRM implementation are important factors for a company's successful new product development programme and marketing activities (Parvatiyar & Sheth, 2000; Gruner & Homburg, 2000). CRM involves getting close to customers, understanding their needs and preferences, and determining how to profitably

satisfy those needs (Battor & Battor, 2010). Thomke (2003) argued that the information about what customers want resides with the customer and how to satisfy those needs lies with the manufacturers (p. 244). CRM is a vehicle to manage the collection of the required information and knowledge on new product development (Thomke, 2003). Most of the required information in new product development is tacit and resides with entities outside the boundary of companies and with other stakeholders, such as competitors, suppliers and business partners (Kohlbacher, 2008, p. 341).

Leading edge companies develop their interactions between customers and employees since they now have a far greater influence on new product and service development and market strategy implementation (Maklan et al., 2007). Customer value is created by customers since they are using the products. Therefore, customers are fundamental to the value creation process and not solely a passive receiver of manufacturers' well-described proposals (Maklan et al., 2007).

2.6 New Products and Customer Retention

Providing new product development capability with identified technological advantages, production techniques and continuous improvements on quality are essential factors for engineered product manufacturers in order to increase their reputation and customer retention (Platzer, 2004). Customer retention is an important factor to sustain and improve the profitability of a company. Retaining customers is more profitable to companies than the acquisition of new customers (Kumar & Reinartz, 2016). Improvement of customer retention may lead to a noticeable increase in profitability; the profitability increase is a result of lower marketing and reduced administration costs, higher effectiveness in providing customers with the products they want and increased revenue per customer (Kumar & Reinartz, 2018). Based on the general marketing 80/20 rule, nearly 80% of a company's future profits will be generated from 20% of existing customers (Hwang, 2016). Hwang (2016) also argued that 80% of the costs are generated by the top 20 unprofitable customers.

Customer retention is defined as companies keeping their existing customers based on an established good relationship and the repeated buying of their products (Kotler et al., 2019). Customer retention underlines the long-term relationship and commitment between the customer and product manufacturer; long-term customer retention generates significant mutual benefits for the customers and for the companies (Venetis & Ghauri, 2004; Athanasopoulou, 2009). Due to the highly competitive business environment,

special attention is paid to customer retention (Aspinall et al., 2001; Ozuem et al., 2007); customer retention is described as a cost effective and profitable strategy (Kotler et al., 2019). Customer retention is a strategic approach driven by customers' purchasing behaviour (Venetis & Ghauri, 2004). Customer retention also includes the activities that companies pursue to animate customer behaviour to continue purchasing from the company and to continue to promote its brand (Wu et al., 2014). Customer retention has beneficial effects on profitability; companies are increasingly implementing IT to increase customer retention and loyalty (Ismana-Ilisan, 2018). A successful CRM implementation can lead to efficient and effective acquisition and retention of profitable customers by selectively initiating, building and maintaining an appropriate relationship with the customers, which means the indicators of CRM success will be the attraction and retention of loyal customers (Frow & Payne, 2009; Dayan & Arnolds, 2012). An increase in customer retention is a key performance indicator of CRM success. The customer retention element of CRM is responsible for up to 20% of revenue growth in companies (Crosby & Johnson, 2005). In addition, up to 95% of profit is generated from long-term customers while, according to different studies, acquiring new customers costs 3 to 25 times more than keeping existing customers (Crosby & Johnson, 2005; Gallo, 2014).

Customers' knowledge of engineered product features will drive their post-purchasing decisions and the relationship quality between customers and engineered product manufacturers is seen as the key element for customer retention (Hennig-Thurau, 2000). Furthermore, the quality and reliability of engineered products are important factors in customer retention (Platzer,

2004). Hennig-Thurau (2000) argued that to increase customer retention, customers' post-purchasing skills should be increased through investment in the customers themselves.

Customer retention focuses on preventing customer attrition or churn (Bijmolt et al., 2010). Customer attrition or churn refers to the situation where the customer stops buying the product from the same company without notice, either straight away or gradually over a very short period (Borle et al., 2016). The key performance indicator of customer retention is the ratio between the frequency of purchase and the length of time of the relationship between the customer and company (Hamilton et al., 2017).

A positive customer–employee relationship leads to the building of trust between the customers and the company, which creates a high repurchasing rate and fosters customer retention (Soltani & Navimipour, 2016). Milan et al. (2015) argued that to maintain or increase customer retention, building trust through proven experience and relationship management is important. The response time to a service request by a customer is also an important factor of customer retention. A company's response to service failure affects the trust, affection and loyalty of customers (Iglesias et al., 2020). Iglesias et al. (2020) argued that customers' trust will survive a service failure, but their loyalty and affection often do not survive. For this reason, companies should implement and execute a recovery plan that focuses on affection and encourages customers to re-engage with the companies emotionally (Iglesias et al., 2020).

The following attributes have a positive influence on customer retention:

- customer relationship (Venetis & Ghauri, 2004; Athanasopoulou, 2009; Soltani & Navimipour, 2016; Kumar & Reinartz, 2016, 2018; Hwang, 2016; Matthews & Schenk, 2018; Kotler et al., 2019),
- customer knowledge (Hennig-Thurau, 2000; Matthews & Schenk, 2018),
- customer value and customer satisfaction (Kumar & Reinartz, 2018; Kotler et al., 2019; Buttle & Maklan, 2019),
- collaboration with customers and suppliers, and creating knowledge (Sofianti et al., 2010),
- capability of new product development to meet changing needs of customers (Hennig-Thurau, 2000; Platzer, 2004; Kumar & Reinartz, 2018),
- pre-qualification process and the result, executed by the customer on new supplier's location (Kapp, 2019),
- providing new technologies (Fuchs, 2007),
- production capabilities (Fuchs, 2007),
- after sales service capability and response time (Kapp, 2019; Trott, 2017),
- quality, zero defects (Platzer, 2004),
- implemented continuous improvement processes (Platzer, 2004),
- the central role of trust in building long-term relationship (Doney & Cannon, 1997; Milan et al., 2015),
- selective intangible attributes (Driskill et al., 2005).

The capability of new product development to meet customers' needs and increase customer retention is the focus of this research. Customers should

view new products as unique and superior and they should deliver unique benefits and value to the customer (Cooper, 1983).

Buttle and Maklan (2019) stated three fundamental customer value propositions: operational excellence, product leadership and customer intimacy (p. 191).

- Operational excellence; companies do a limited number of activities very efficiently, at very low cost and pass on those savings to customers. Operational excellence is underpinned by Lean manufacturing, efficient supply chains, rigorous quality and cost controls, process improvement and management of customer expectations.
- Product leadership; companies aim to provide the best products, services or solutions to customers. Product leadership is reflected in a culture that encourages innovation, a risk-oriented management style and investment in R&D.
- Customer intimacy; companies are able to adapt their offers to meet the needs of individual customers. Customer intimacy is based on customer insight. Adaption and customisation based on deep understanding of customer requirements underpin customer intimacy.

Customers are often categorised as one of the key resources for new product development, because they often have knowledge and great experience gained through their regular usage of products (Zogaj & Bretschneider, 2012).

Product innovation is a main leverage for expanding into new markets, introducing new products and attaining a higher level of customer retention (Kumar et al., 2011). Successful marketing leads to fully engaged and satisfied customers, profitability and retention of customers (Kotler et al., 2019). Most companies understand the importance of satisfying their customers in order to develop customer retention, which can deliver a sustainable competitive advantage (Kotler et al., 2019). Preikschas et al. (2014) categorised four key future behaviours of customers that customer retention can lead to:

1- intention to repurchase,
2- cross-selling where the customer may purchase additional products and services,
3- recommendations and
4- price behaviour.

However, there is limited research available in the field of new product development in industrial markets and its effect on customer retention (Barczak, 2012; Preikschas et al., 2014). The impact of new product development on customer retention could be an area for researchers to research further.

2.7 New Product and Social Exchange Theory

The rapidly changing, volatile, uncertain, complex and ambiguous world drives companies to develop new products faster and to produce new products with additional value-added components that are cheaper than the competition's (Nieto & Santamaria, 2007). Furthermore, because of the increase in workplace complexity, it becomes more important that employees take advantage of available opportunities, organise themselves to work effectively and be more innovative (Murphy & Coughlan, 2018).

The marketing literature considers customers to be rational actors (Casidy et al., 2020) and they are part of social exchange. Social exchange theory is one of the most influential theories in organisational behaviour (Cropanzano & Mitchell, 2005) and is one of the oldest and most analysed theories (Cook et al., 2013). The root of social exchange theory goes back to 1958, Homans, Blau and Emerson were the key theorists who developed the original theories of social exchange (Lawler, 2001).

Social exchange is described as a mutual activity, involving two or more actors, where each actor gets value from the activity (Di Domenico et al., 2009). The expected task in social exchange is to create benefit for each actor by exchanging behaviours or goods that the actors cannot create alone (Lawler, 2001; Cropanzano & Mitchell, 2005).

Homans (1958) and Blau (1986), two pioneers in the field of social exchange theory, have two theoretical standpoints. Homans (1958) was mainly influenced by psychological behaviour, whereas Blau (1986) was influenced by economic behaviour in which individuals engage in social exchange to receive rewards that they are unable to achieve by themselves. Homans (1958) outlined social exchange as the exchange of a tangible or intangible activity, which is more or less rewarding or costly, between at least two persons. According to social exchange theory (Blau, 1986), social exchange refers to the voluntary actions of individuals who are motivated by the returns they expect to get and typically do in fact get from others. Blau (1986) argued that social exchange involves the principle that one person does another a favour, and while there is a general expectation of some future return, its exact nature is definitely not stipulated in advance (p. 93).

Alliances, cooperation, collaborations and co-creations are popular in many industries (Sofianti et al., 2010; Lee et al., 2012; Castañer & Oliveira, 2020) and have become an essential strategic instrument (Hoang & Rothaermel, 2005). New product development primarily originates from strategic instruments because joint product development within well-organised collaborations increases the probability of realising new products (von Hippel, 2001). The strategic instruments of cooperation, collaboration and co-creation are defined as follows.

Cooperation originated from the Latin *cum operare*, which means “operating together with other” (Castañer & Oliveira, 2020, p. 967). The *Oxford Dictionary* defines cooperation as “*the fact of doing something together or of working*

together towards a shared aim". Many individuals are involved in cooperation and supporting each other's target achievements, where there is no common target or goal (Castañer & Oliveira, 2020).

Collaboration; the *Oxford Dictionary* defines collaboration as "*the act of working with another person or group of people to create or produce something"*. Castañer and Oliveira (2020) stated that collaboration comes from the Latin *cum laborare* and means working together with others, which could be identified with a broader notion of joint action than the one assigned to coordination (p. 967). In a collaborative work, a group of individuals work closely with a strong commitment to achieve the defined common goal (Castañer & Oliveira, 2020).

Co-creation should be seen as a process that provides an opportunity for on-going interaction, where the organisation is willing to share its world with external stakeholders, and, in return, insights are generated from their engagement (Ind & Coates, 2013, p. 92). Co-creation in connection with new product development is described as *"a collaborative new product development activity in which customers actively contribute and select various elements of a new product offering"* (Mandolfo et al., 2020, p. 1). Mandolfo et al. (2020) argued that co-creation covers a wide range of activities, such as proposing ideas for new product and service development or for the improvement of existing product and service in terms of supporting the design phase, evaluating ideas and alternatives, or contributing to the definition of the launch campaign (p. 1).

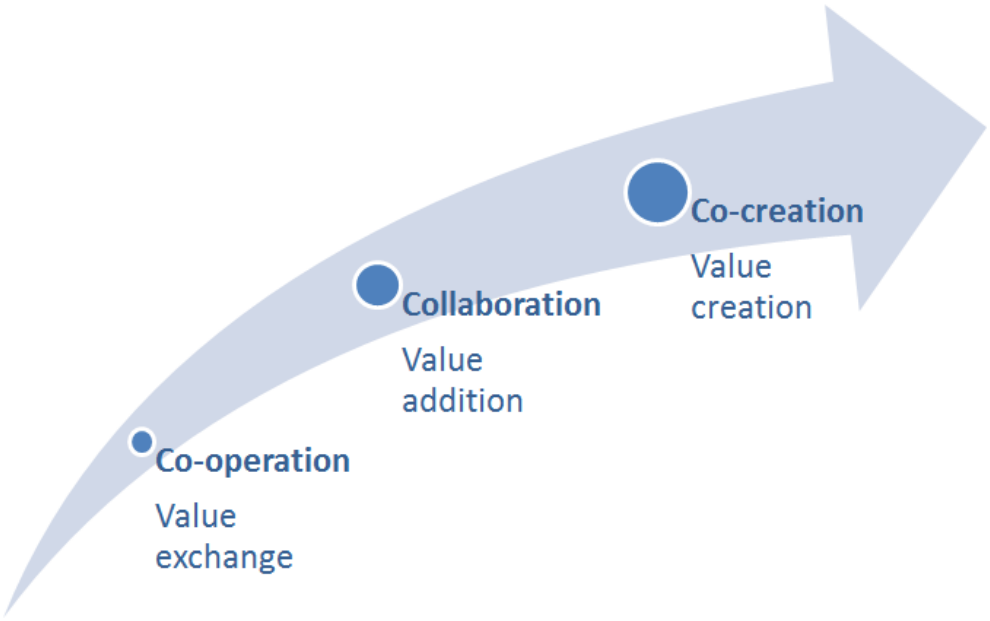


Figure 2.7-1: Cooperation, collaboration and co-creation. Adapted from Castañer and Oliveira (2020) and Mandolfo et al. (2020)

Figure 2.7-1, illustrates the level of value of cooperation, collaboration and co-creation in a new product development process. In co-creation the involved parties, customers, manufactures and suppliers have an aligned target and common interest, namely value creation on new product development.

The relationship between a company's capability to conduct new product development and its skills and attributes has become a popular topic in academic research (Freel, 2005). The level of new product development capability and competitiveness may not depend on skills that companies can identify and develop within their own organisations, but on the effectiveness of their access to external sources of skills and knowledge (Edmondson & Nembhard, 2009). However, access to the right resources of skills and

knowledge is very challenging in the market (Freel, 2005). The selection of the right partner with whom to exchange knowledge and skills on new product development is essential (Nieto & Santamaria, 2007); an agreement between collaborating companies defines the basics of the relationship to allow the parties to condense their resources and to make use of their strengths on product development (Das & Teng, 2000). Many factors could influence companies' selection between internal and external resources for product development (Nguyen et al., 2018) and the selection of the right technological partner is crucial. There are significant distinctions between types of partners that can determine how the collaboration is managed and what kind of new product will be developed (Whitley, 2002). The collaboration will be much more efficient if a company selects a partner with resources that complements its own and that are relevant to the planned new product development. The downside of joint new product development activities are costs such as coordinating, managing and controlling the activities of the involved parties (Nguyen et al., 2018).

Vertical collaboration, which is a type of collaboration with customers and suppliers, enables companies to attain significant knowledge about new technologies, market and process improvements (Whitley, 2002) and it has a significant impact on new product and process development (Miotti & Sachwald, 2003). Collaboration with customers and suppliers at an early stage of product development should deliver the development result in a shorter time period (Nguyen et al., 2018). Collaboration with customers and suppliers creates knowledge that is beneficial for all parties: customer, manufacturer and supplier (Sofianti et al., 2010).

Collaboration with competitors is beneficial to basic research to establish standards; companies are likely to work with competitors on shared common problems outside their area of influence, such as regulatory change (Tether, 2002). However, collaboration with competitors on new product development is not appropriate because the risks of information leakage, misalignment and hold-ups are greater with competitors than with other groups (Nieto & Santamaria, 2007).

Research organisations, such as universities and technological institutes, are important potential collaboration partners on new product development since governments have encouraged these institutions to perform more research in order to improve the competitiveness of industry, and funding has forced universities into greater collaboration with industry (Tether, 2002).

Collaboration with consultants, instead of relying only on internal resources on new product development, is increasingly appreciated (Tether, 2002). A company's internal designers, who are familiar with the company's processes and products, often become priggish and fail to generate innovative ideas for new product development. External consultants may provide fresh ideas; collaboration with external consultants tends to be more effective since this provides more opportunities to generate added value on knowledge about the company and its products (Tether, 2002).

Decades ago, companies and customers took separate positions of production and consumption. Nowadays, customers simultaneously hold two positions of

value creation and consumption, which is named co-creation (Barbu & Militaru, 2019). In the co-creation process, customers are allowed to influence the design of products and services in order to meet their needs (Morgan et al., 2018). Two parties with different motivations are involved in the co-creation process: the customers and the companies. The customers' motivation to engage in co-creation processes is their dissatisfaction with companies' products or services. Furthermore, customers are motivated to participate in a co-creation process through sharing their own ideas, receiving monetary rewards, learning and intrinsic interest in co-creation (Barbu & Militaru, 2019). Companies' motivation to participate in a co-creation process is based on improving their sustainable manufacturing performance, such as new product development, Lean manufacturing, supply chain management and environmental performance. However, the speed of a new product development process is the common motivation of customers and companies (Morgan et al., 2018).

Collaboration and co-creation differ: in collaboration the customer and company act together to achieve a common goal, whereas in co-creation the customer is actively involved in a company's manufacturing process to create value (Arina & Rustiadi, 2018). The core principle of co-creation is engaging people to create value that had not existed before. Well-managed co-creation can produce a new product, service or manufacturing process, whereas collaboration outputs are driven by teams producing familiar types of products (Arina & Rustiadi, 2018).

Academic interest has been focused on new product development-related topics (Malmström & Johansson, 2016). Successful product developments support the development of successful organisations, and society as a whole benefits as new companies become established and grow (Chesbrough et al., 2006). Collaboration with different organisations working on new product development projects facilitates the exchange of knowledge, experiences and relevant information, accelerates learning and drives new ways thinking in the organisations (Edler & Rigby, 2005; Sofianti et al., 2010; Malmström & Johansson, 2016). All collaborations consist of economic and social exchange; collaboration in this context means the ability of two individual groups to line up their activities, communicate across boundaries and generate common goals (Murphy & Coughlan, 2018). Malmström and Johansson (2016) thought that a close collaboration between organisations is essential for a better outcome of new product development. There is discussion about the extent of the influence and the role that collaboration has on the outcome of new product development (Malmström & Johansson, 2016). Collaboration between organisations on new product development is anticipated to bring added value to collaborating partners. However, the results of studies indicate that collaboration between organisations for new product development alone does not assure a successful outcome and in some cases collaboration on new product development does not deliver the expected result (Miles et al., 1999). The failure of product development in a collaborative relationship is not only due to technological challenges and lack of skills, but also to the social relations between the collaborating companies (Malmström & Johansson, 2016).

Surprisingly few researchers have published studies that explored the value of social exchange in collaborations to develop successful products and the limitations of a collaborating partner's ability or willingness to exchange information in product development, which would have a negative effect on the outcome of collaborative product development projects (Knudsen, 2007). Collaboration between companies requires a form of social exchange; Malmström and Johansson (2016) argued that social exchange is important for collaboration outcomes concerning new product development. Social exchange theory has the capability to explain collaborations in new product development projects (Brass et al., 2004). According to social exchange theory, an exchange requires a bidirectional exchange over time which results in a mutually profitable transaction (Homans, 1958; Scott, 2011). Homans (1958) argued that social exchange theory is constructed on a cost-benefit outlook based on self-interest. The involved parties only mobilise resources when they notice that their input will be paid off (Malmström & Johansson, 2016). Social exchanges are similar to economic exchanges since both suppose that an individual's exchange behaviour depends on reciprocal and equivalent rewards gained in return (Murphy & Coughlan, 2018). The significant discrepancy between social and economic exchange is that social exchanges give no guarantee that the reciprocal rewards will be equivalent to the invested cost, but in an economic exchange there are rules and agreements that govern the interaction. The belief that the other party will reciprocate can only be established in a social exchange because each party feels forced to maintain a cooperative relationship with the other party (Murphy & Coughlan, 2018).

The factors affecting the social exchange of knowledge sharing in new product development mentioned in the existing literature are (Lee & Nguyen, 2019):

- Individual cognition
    - organisational commitment
    - perceived benefits.
- Interpersonal interaction
    - social interaction
    - trust.
- Organisational effort
    - organisational support
    - reward system.

Organisational commitment contains forerunners, processes and consequences of adherences. The important element of organisational commitment is the process of identification of individuals. Competent management of knowledge is essential to successful product development in an organisation (Cabrera & Cabrera, 2005). Organisational commitment can inspire individuals to share knowledge based on a sense of responsibility to support others (Lee & Nguyen, 2019).

Perceived benefits are individuals' subjective perceptions of gain from their behaviours (Forsythe et al., 2006). Active participation may be beneficial for individuals and some individuals anticipate that their contribution will improve their position within the organisation (Lee & Nguyen, 2019).

Social interaction generates the possibility of an exchange between individuals and may lead to the exchange of knowledge on new product development (Lee & Nguyen, 2019).

Trust is defined as the perceived credibility and goodwill of a target of trust. Trust plays a central role in knowledge exchange for new product development in an organisation (Lee & Nguyen, 2019). Trust-building processes will lead to the exchange of knowledge between individuals (Lee & Nguyen, 2019).

Organisational support includes an organisation valuing the contributions of its employees and caring about the well-being of its employees. The relationship between an employer and employees is constructed on the trade of effort and loyalty for benefits such as pay, support and recognition (Lee & Nguyen, 2019).

Reward system is defined as an incentive provided by an organisation to its employees to improve their performance (Lee & Nguyen, 2019) and behaviours. Cabrera and Cabrera (2005) argued that knowledge sharing will be greater if rewards are involved in the sharing of knowledge.

Social exchange plays a central role in the success or failure of collaboration on new product development (Malmström & Johansson, 2016). For the successful outcome of a collaborative new product development project, the collaboration model needs to address the social exchange of all types of capital focusing on the collaboration objective. Furthermore, collaboration models should enable trust, commitment, consistency and direct collaborative contacts in the exchange of all types of capital.

2.8 Conclusion and Theoretical Framework

The underlying aim of the critical literature review was to review the existing academic literature on:

- definition of product and new product,
- new product development process,
- new product development and competitive advantages,
- new product and customer relationship,
- new product and customer retention,
- new product and social exchange

in order to gain a theoretical understanding related to the defined research questions:

- What are the key drivers of new product development in the industrial valve sector?
- How does new product development facilitate customer retention in the industrial valve business?
- What are the key new product development processes and to what extent are customers part of this process?
- How can co-creation (Sofianti et al., 2010) processes integrate customer knowledge to improve new product development?
- What are the key drivers of purchasing behaviour in terms of industrial valves, and what are the procurement and sales channels that must be identified to create new product development opportunities?

The literature review revealed that there are several gaps in current new product development process-related literature in relation to engineered products. Much of the new product development literature concentrates on general new product development and the product development process, mainly involving consumer products. Little research is available on the new product development process in industrial and engineered products. Furthermore, customers' needs and role in new product development are mainly restricted to marketing and marketing research literature. There are no new product development processes for products that have been particularly designed to fully meet customer needs and to fully integrate customer knowledge in the product development process of engineered products. Customer involvement in new product development has only been considered by a few researches in industrial products (von Hippel, 2001; Kapp, 2019). Furthermore, the relation between new industrial and engineered product development and customer retention is rarely discussed within the existing literature (Sofianti et al., 2010).

Nevertheless, much of the work carried out by previous authors on new product development, competitive advantages, customer relationship, customer retention and social exchange in new product development has been used as a basis for this research.

The result of the critical review of key articles suggests that new product development and customer retention conceptualisations in the industrial valve industry consist of four main elements: first, definition of the key drivers of new

product development as a competitive advantage; second, new product development process on engineered valves; third, customer's relationship; and fourth, customer involvement in new product development process.

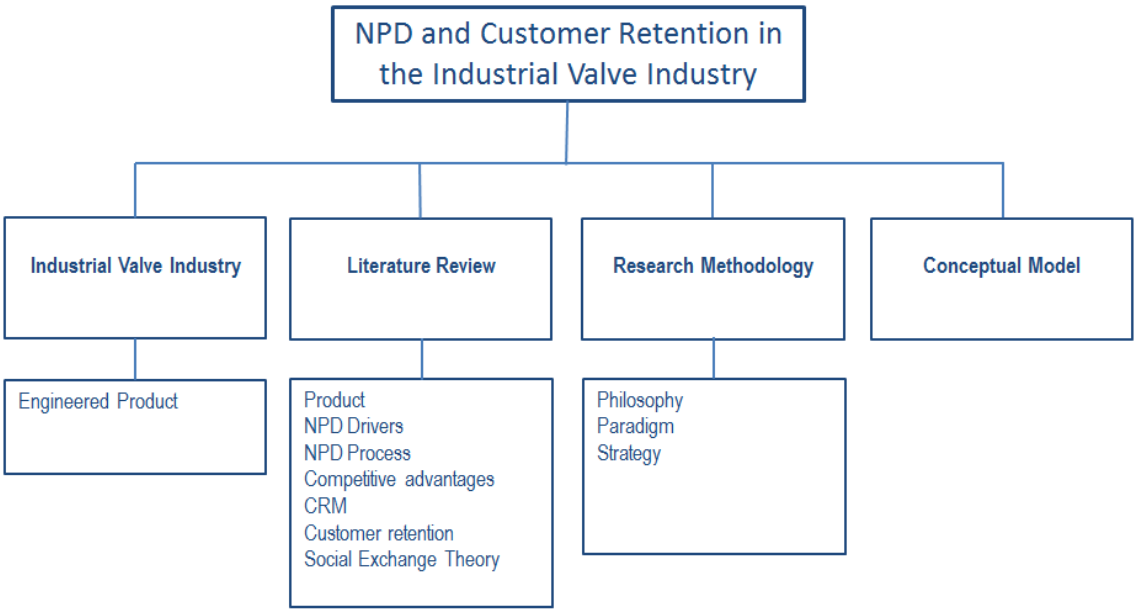


Figure 2.8-1: Theoretical framework. NPD new product development, CRM customer relationship management

2.9 Summary

Figure 2.9-1 illustrates the progress of this research consequent to the above critical literature review.

Introduction

Conceptual clarification: product and new product

- Product is used as a term to describe all goods, services and knowledge sold; products are defined by functions, features and uses and can be tangible or intangible
- An engineered product is the object of an exchange process between the supplier and customer, where the customer specifies the key design features of the product that the supplier has to fulfil
- A new product is the management of all activities involving the processes of idea generation, technology development, manufacturing, logistics and marketing of a new product or manufacturing process
- The product strategy for consumer new products is less innovative than the product strategy for engineered new products; the pricing of engineered new products is higher than the competition's, consequently the margin on engineered new products is much higher than on consumer new products

Taxonomy of new products

- The history of new product development-related literature goes back to the 1950s and the literature grew considerably over the years
- A new product is based on four factors: first, what a new product contributes in terms of tangible and intangible elements; second, time factor in terms of the availability of the product to the market; third, a minimum development time is involved; and fourth, a minimum investment is made
- The success of a new product depends on the fulfilment of customers' needs and expectations
- New products may set new industry standards which make it difficult for competitors to enter the newly generated marketplace
- New product development process is defined by Product Development and Management Association as "a disciplined

Critical Literature Review	and defined set of tasks and steps that describe the normal means by which a company repetitively converts embryonic ideas into saleable products or services" (Kahn, 2013, p. 458) • The success rate of developing a great product is very low and is a fundamental challenge for the research and development team New product development and competitive advantage • It is difficult to sustain the competitive advantages of products because of rapid market changes and the launch of many new products by the competition in a *leapfrog world* • New product development is essential for the competitiveness and entrepreneurial growth of companies • In the oil and gas, petrochemical, chemical and nuclear industries, the reduction of emissions and the protection of the environment based on new technology will become a critical competitive advantage globally New products and customer relationship management • The expertise and experience of customers have been increasingly accepted as an essential resource for new product development to support a long-term customer relationship • Companies should accurately understand customers' needs to develop successful products; however, the task is becoming more challenging as customers' needs change rapidly in today's complex market environment • The purpose of customer relationship management in relation to new product development is a partnering to enter new markets and develop new products • Leading edge companies are developing their interactions with customers and employees because they now have far greater influence on new product and service development and market strategy implementation New products and customer retention • Providing new product development capability with identified technological advantages, production techniques and continuous improvements on quality are essential factors for engineered product manufacturers in order to increase their reputation and customer retention • Product innovation is a main leverage for expanding into new markets, introducing new products and attaining a higher level of customer retention • There is limited research available in the field of new product

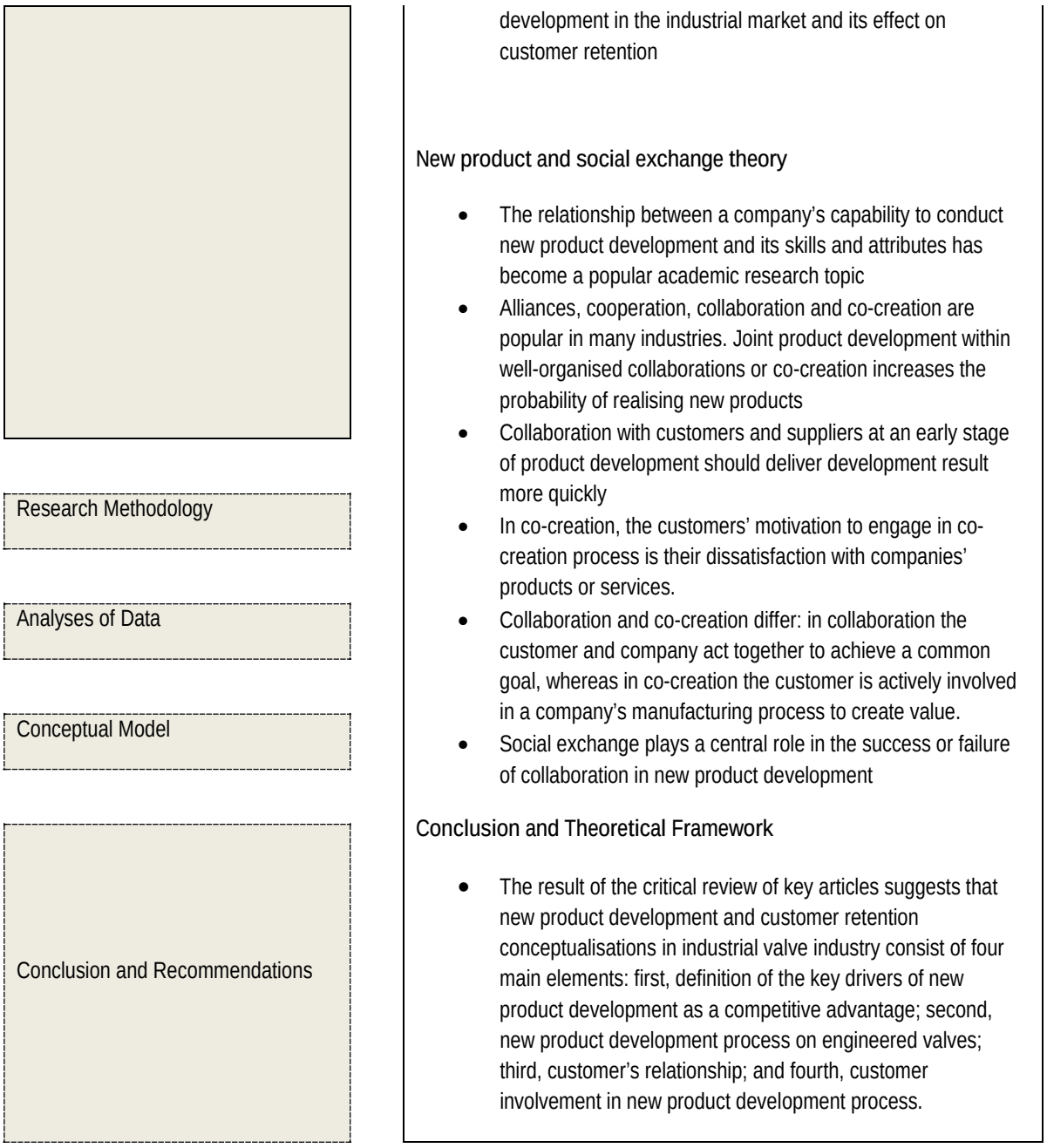


Figure 2.9-1: Summary of the chapter and progress of the research

3. RESEARCH METHODOLOGY

3.1 Introduction

The previous chapter presented a general view on new product development and customer retention; literature on new product development and customer retention in the industrial valve sector, and its engineered products, is scarce (Barczak, 2012; Preikschas et al., 2014).

The fundamental aim of this chapter is to describe the selected research method. Different paradigmatic assumptions will be examined in order to select a suitable paradigm that supports the research topic under investigation: new product development and customer retention in the industrial valve sector. This chapter continues by analysing and defending qualitative research as a suitable methodological approach. The chapter will describe the case study design that was chosen as the research strategy for this research. In addition, this chapter provides justification for sample selection, sample size and data collection methods. This chapter describes how the research approach to investigative research contributes new knowledge to how new product development contributes to customer retention in the industrial valve sector. Ethical considerations are also discussed.

3.2 Research Philosophy

The inquiry process of a researcher's research begins with philosophical assumptions about the nature of reality (ontology), how they know what is known (epistemology) and the inclusion of their values (axiology) and the process from which the research emerges (methodology) (Creswell & Poth, 2018). Table 3.2-1 presents an overview of philosophical assumptions and their implications. The philosophical assumptions underline the research strategy and the methods selected to realise the research strategy (Creswell, 2014).

Assumption	Questions	Characteristics	Examples
Ontological	What is the nature of reality?	Reality is multiple as seen through many views	The researcher reports different perspectives as themes to develop the findings
Epistemological	What counts as knowledge? How are knowledge claims justified? What is the relationship between the researcher and that being researched?	Subjective evidence is obtained from participants; the researcher attempts to reduce the distance between him or her and that being researched	The researcher uses quotes as evidence from the participants as well as collaborates, spends time in the field with participants and becomes an insider
Axiological	What is the role of values?	The researcher acknowledges that research is value laden and that biases are present in relation to their role in the research context	The researcher openly discusses values that shape the narrative and includes his or her own interpretation in conjunction with those of participants
Methodological	What is the process of research? What is the language of research?	The researcher uses inductive logic, studies the topic within the context, and uses an emerging design	The researcher works with particulars before generalisations, describes in detail the context of the research and continually revises questions based on experiences in the field

Table 3.2-1: Philosophical assumptions with implications (Creswell & Poth, 2018, p. 21)

Ontology is concerned with “what is” the nature of existence and the structure of reality (Crotty, 1998), and serves to challenge the assumptions researchers have about how the world works and their commitment to different viewpoints. Snape and Spencer (2003) defined ontology as the nature of the world and what we can know about it (Snape & Spencer, 2003). Bryman and Bell (2011) introduced the term “social ontology” and defined it as a philosophical

consideration in research which concerns the nature of social entities. Social entities can and should be considered objective entities that exist independently of social actors or, rather, they are social constructions in themselves built up from the perceptions, actions and interpretations of individuals in society (Bryman & Bell, 2011). In a framework, ontology would sit alongside epistemology, informing the theoretical perspective, because each theoretical perspective embodies a certain way of understanding what is (ontology) as well as a certain way of understanding what it means to know (epistemology) (Crotty, 1998, p. 10). Business and management researchers are typically drawn to two aspects of ontology: objectivism and subjectivism (Saunders et al., 2009). Objectivism represents the position that social entities, such as companies, exist in a reality external to and independent of social actors (Bryman & Bell, 2011). A theoretical position closely aligned to objectivism is positivism (Gray, 2014). This view places importance on the structural aspects of management, and assumes that management is consistent in all organisations (Saunders et al., 2009). This world view is also called postpositivist research, empirical science and postpositivism (Creswell, 2014).

Epistemology concerns the question of what is or should be regarded as acceptable knowledge in a field of research (Saunders et al., 2009; Bryman & Bell, 2011). Crotty (1998) defined epistemology as a way of looking at the world and making sense of it, where knowledge is involved and a certain understanding of what that knowledge entails.

Axiology deals with ethics, aesthetics and religion; it concerns scientific inquiry for no other reason than that it also concerns religion. A researcher should be aware of the roles that the values of a researcher play in all stages of the research process if the researcher wishes the research results to be credible (Creswell & Poth, 2018).

3.3 Research Paradigm

The adoption of the research paradigm is a key topic in this research on the relation between new product development and customer retention. The word paradigm means the philosophical way of a thing (Kuhn, 1970). A paradigm, the word originated from the Greek word *paradeigma*, is a cluster of beliefs and dictates which for researchers in a particular discipline influence what would be researched, how research should be conducted and how the result should be interpreted (Bryman & Bell, 2011). The term world view can be used (Creswell, 2014) instead of paradigms (Lincoln et al., 2011); epistemologies and ontologies (Crotty, 1998) or broadly conceived research methodologies (Neuman, 2014) describe the world view as a basic set of beliefs that guide action (Guba, 1990).

There is extensive uncertainty in the researcher community concerning the terms “research philosophy” and “research paradigm” (Easterby-Smith et al., 2015). Distinctions between terms such as ontology and epistemology are summarised in Table 3.3-1 in order to provide a useful summary.

	Positivism	Realism	Interpretivism	Pragmatism
Ontology: the researcher's view of the nature of reality or being	External, objective and independent of social actors	Is objective. Exists independently of human thoughts and beliefs or knowledge of their existence (realist), but is interpreted through social conditioning (critical realist)	Socially constructed, subjective, may change, multiple	External, multiple, view chosen to best enable answering of research questions
Epistemology: the researcher's view regarding what constitutes acceptable knowledge	Only observable phenomena can provide credible data, facts. Focus on causality and law like generalisations, reducing phenomena to simplest element	Observable phenomena provide credible data, facts. Insufficient data means inaccuracies in sensations (direct realism). Alternatively, phenomena create sensations which are open to misinterpretation (critical realism). Focus on explaining within a context or contexts	Subjective meanings and social phenomena. Focus on the details of situation, a reality behind these details, subjective meanings motivating actions	Either or both observable phenomena and subjective meanings can provide acceptable knowledge dependent upon the research question. Focus on practical applied research, integrating different perspectives to help interpret the data
Axiology: the researcher's view of the role of values in research	Research is undertaken in a value-free way, the researcher is independent of the data and maintains an objective stance	Research is value laden; the researcher is biased by world views, cultural experiences and upbringing. These will have an impact on the research	Research is value bound, the researcher is part of what is being researched, cannot be separated and so will be subjective	Values play a large role in interpreting results, the researcher adopting both objective and subjective points of view
Data collection techniques most often used	Highly structured, large samples, measurement, quantitative, but can use qualitative	Methods chosen must fit the subject matter, quantitative or qualitative	Small samples, in-depth investigations, qualitative	Mixed or multiple method designs, quantitative and qualitative

Table 3.3-1: Comparison of four research philosophies in management research (Saunders et al., 2009, p. 119)

The research will be performed within a constructivism paradigm often called interpretivism (Denzin & Lincoln, 2018). A constructivist approach to research is based on understanding the world of human experiences (Cohen et al., 2018); individuals seek to understand the world in which they live and work (Creswell & Poth, 2018). The world of experiences is constantly composed of human interactions with objects and other humans. In order to access and achieve an understanding about human perceptions, one of the principle requirements of the constructivist approach is the establishment of a reciprocal and communicational platform between the research project participants and the researcher in the construction of meaning (Mojtahed et al., 2014). Eventually, this would guide the establishment of a theory that is based on the experiences of the researcher and research participants (Mills et al., 2006).

The constructivist paradigm traditionally follows qualitative research methods, but quantitative methods may also be used in support of qualitative data (Mackenzie & Knipe, 2006). Since constructivist researchers tend to rely on participants' viewpoints about the subject under investigation, the vast majority of inductive research remains interview based and interpretivist in nature. Therefore the use of interviews as a data collection method in inductive research is justified by its affinity with daily life conversations and the centrality of interactions, exchanges and negotiation of meaning between two parties, which corresponds to constructivist approaches to research (Mojtahed et al., 2014).

The proposed research questions require an approach that is based on individual experiences to develop subjective meaning and meanings directed towards certain objects or things. This is related to the experiences of the researcher of this research who has more than 25 years of experience in the industrial valve sector. Accomplishment of the objectives of this research will rely on participants' views and participants being able to construct their own meaning and interpretation (Creswell & Poth, 2018).

There is a significant concern about how to assure and demonstrate the quality of constructionist designs, although researchers rarely use the term validity (Easterby-Smith et al., 2015). Based on this concern, the three dimensions of convincing are defined as authenticity, plausibility and criticality (Golden-Biddle & Locke, 1993). Authenticity involves convincing the reader that the researcher has a deep understanding of what was taking place in the organisation; plausibility requires the research to link into some on-going concern and interest beside other researchers' interest; and criticality reinforces readers' desire to question their taken for granted assumptions and thus offer something literally novel.

Easterby-Smith et al. (2015) argued that constructionist research should be believable and it should be achieved through methods and be transparent. The researcher should explain how he or she gained access to the particular organisation, what processes led to the selection of informants, how data were created and recorded, what procedures were used to summarise or collect it, how the data became transformed into tentative ideas and explanations and how the researcher felt about the research (Easterby-Smith et al., 2015).

3.4 Research Approach

Qualitative research is a research strategy that usually emphasises words rather than quantification in the collection and analysis of data. Quantitative research is based on a distinctive research strategy that emphasises quantification in the collection and analysis of data. The fundamental differences between qualitative and quantitative research strategies are summarised in Table 3.4-1.

Criteria	Qualitative	Quantitative
Principle orientation on the role of theory in relation to research	Inductive; generation of theory	Deductive; testing of theory
Epistemological orientation	Interpretivism	Natural science model, in particular positivism
Ontological orientation	Constructivism	Objectivism

Table 3.4-1: The fundamental differences between qualitative and quantitative research strategies (Bryman & Bell, 2011, p. 27)

Qualitative research from an epistemological position is described as interpretivist, which means that in contrast to the natural scientific model of quantitative research, the stress is on understanding the social world through an examination of the interpretations of that world by its participants. The ontological position of qualitative research can be described as constructionist, which implies that social properties are outcomes of the interactions between individuals, rather than of phenomena that are “out

there" and separate from those involved in their construction (Bryman & Bell, 2011).

The procedures of qualitative research, in other words its methodology, are characterised as inductive, emerging and constructed from researchers' experience in collecting and analysing the data (Creswell & Poth, 2018). A key feature is a striving to be as objective and neutral as possible in the collection, interpretation and presentation of qualitative data (Snape & Spencer, 2003). Knowledge is developed inductively through the crystallisation of verified data (Snape & Spencer, 2003). In cases where researchers are interested in understanding why something is happening, rather than being able to describe what is happening, the inductive research approach would be more valuable than a deductive research approach (Saunders et al., 2009). In an inductive approach, the focus is on data collection, following which the data are analysed to understand if any patterns emerge that suggest a relationship between the variables that enable a generalisation, relationships and even theories to be constructed (Gray, 2014). The inductive approach begins with observing the empirical world and then reflecting on what is taking place and moves towards thinking in increasingly more abstract ways (Neuman, 2014).

Deductive and inductive approaches are not mutually exclusive, for example, a researcher may turn data into a set of concepts, models or even theories through an inductive approach, which are tested through experimentation under a deductive approach (Gray, 2014). This research follows an inductive approach due its qualitative research methodology (Creswell & Poth, 2018).

The major differences between deductive and inductive approaches are summarised in Table 3.4-2.

Deductive approach	Inductive approach
• Scientific approach • Moving from theory to data • The need to explain causal relationship between variables • The collection of quantitative data • The application of controls to ensure validity of data • The operationalisation of concepts to ensure clarity of definition • A highly structured approach • Researcher independent from what is being researched • The necessity to select samples of sufficient size in order to generalise conclusion	• Gaining an understanding of the meanings humans attach to events • A close understanding of the research context • The collection of qualitative data • A more flexible structure to permit changes of research emphasis as the research progresses • A realisation that the researcher is part of the research process • Less concern with the need to generalise

Table 3.4-2: Major differences between deductive and inductive research approaches (Saunders et al., 2009, p. 127)

3.5 Research Strategy and Design

The research strategy describes the skills, assumptions, enactments and material practices that researchers use as methodological concepts when they move from a paradigm and a research design to the collection of empirical material (Denzin & Lincoln, 2018). However, there is no agreed structure on how to design qualitative research; nevertheless, the literature on qualitative research offers various suggestions for designing qualitative research and the process is very much shaped by the particular approach adopted by the researcher (Creswell & Poth, 2018).

The case study approach is strongly associated with qualitative research (Snape & Spencer, 2003); it is defined as an empirical inquiry that investigates a contemporary phenomenon in-depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident (Yin, 2003). A case study can be exploratory, descriptive or explanatory (Teegavarapu & Summers, 2008). The triangulation of data is recommended for a case study because it gives researchers the possibility of collecting the data using different approaches, such as survey, interview and experiments (Denzin & Lincoln, 2018).

Criteria for soundness	Case study tactics	Occurrence
Construct validity	• Use multiple sources of evidence • Establish chain of evidence • Let key informants review case study reports	Data collection Data collection Report generation
Internal validity	• Do pattern matching • Do explanation building • Address rival explanations • Use logic models	Data analysis Data analysis Data analysis Data analysis
External validity	• Use theory in single case studies • Use replication logic in multiple case studies	Research design Research design
Reliability	• Use case study protocol • Develop case study database	Data collection Data collection

Table 3.5-1: Soundness of case study (Yin, 2003, p. 34)

Any empirical research method has to satisfy certain criteria for soundness. Table 3.5-1 summarises the unique tactics of the case study method and how issues of soundness are addressed (Yin, 2003).

The case study research approach is adapted for this research on new product development and customer retention in the context of a specific industry. New product development and customer retention in the context of the industrial valve sector has not been extensively researched and no similar research has been published to date that supports understanding of new product development and customer retention in the context of the industrial valve sector. Therefore, this research, which proposes an in-depth understanding of the phenomenon, its context and the interaction between new product development and customer retention in the context of the industrial valve sector, is necessary. A case study approach will support an investigation of how new product development facilitates customer retention in the industrial valve business (Yin, 2003). The particular interest of this case study is to gain a rich understanding of the context of the research. A case study has considerable capability to produce answers to the research questions “why”, “what” and “how” (Saunders et al., 2009).

A case study is one of the prominent social research strategies that is criticised and stereotyped as being a method with weak rigour; however, it is used extensively in a wide variety of fields (Teegavarapu & Summers, 2008). Positivist researchers’ criticisms of the case study are that it lacks the rigour of natural scientific designs and there are difficulties in generalising the findings from specific cases (Yin, 2003). The case study creates massive amounts of

data where the researchers can use the data to support almost any interpretation they favour (Yin, 2003). In response to these criticisms, Yin (2003) suggested that all case studies should have a clear design prior to data collection, covering the main proposition or research questions, the unit of analysis, and links between data and proposition and procedures for interpretation of the data. Many researchers emphasise that they are interested in the detail of a single case and they do sometimes claim a degree of theoretical generalisability on the basis of it. Therefore, the goal of the case study should be to concentrate on the uniqueness of the case and develop a deep understanding of its complexity (Bryman & Bell, 2011). The case study in combination with a predominantly qualitative research approach tends to take an inductive approach to the relationship between theory and research (Bryman & Bell, 2011).

An intermediate approach to case study research was introduced by Eisenhardt, in particular, over the last 30 years (Eisenhardt, 1989; Eisenhardt & Graebner, 2007). This intermediate view was inspired by positivist and constructionist positions and has been adapted widely by researchers using case study methods (Easterby-Smith et al., 2015). Eisenhardt (1989) advised using research methods established at the onset of projects, while also encouraging researchers to adapt their approaches as the project develops. To derive the most powerful insights, she endorsed within case and across case analysis (Eisenhardt & Graebner, 2007). Eisenhardt and Graebner (2007) discussed building theory from case study-based research, stating:

a major reason for the popularity and relevance of theory building from case studies is that it is one of the best (if not the best) of the bridges from rich qualitative evidence to mainstream deductive research. Its emphasis on developing constructs, measures, and testable theoretical propositions makes inductive case research consistent with the emphasis on testable theory within mainstream deductive research. In fact, inductive and deductive logics are mirrors of one another, with inductive theory building from cases producing new theory from data and deductive theory testing completing the cycle by using data to test theory (p. 25).

The key features of the case study method informed by different epistemologies are summarised in Table 3.5-2.

	Positivist (Yin)	Positivist and Constructionist (Eisenhardt)	Constructionist (Stake)
Design	Prior	Flexible	Emergent
Sample	Up to 30	4 to 10	1 or more
Analysis	Cross-cases	Both	Within case
Theory	Testing	Generation	Action

Table 3.5-2: Key features of case study method informed by different epistemologies (Easterby-Smith et al., 2015, p. 265)

3.6 Time Horizon

This research is based on a qualitative case study in which semi-structured interviews were conducted with a selected group of people who have extensive experience in the industrial valve industry. The semi-structured interviews needed to be conducted within a planned time frame in order to execute the research. Typically, cross-sectional research is conducted when there are constraints of time or resources (Saunders et al., 2009). Furthermore, cross-sectional research measures units from a sample of the population at only one point in time. Cross-sectional research is the most predominantly and frequently used approach in qualitative business research with semi-structured interviews (Bryman & Bell, 2011). Bryman et al. (2011) argued that cross-sectional research allows researchers to collect a great amount of information in a short period of time on different variables. For this reason a cross-sectional research approach was utilised in this research in order to execute the research within a planned time period.

3.7 Sample Selection and Sample Size

The sample selection and the size of the sample are essential components that will affect the outcome of this research on new product development and customer retention in the industrial valve sector. The development of a sampling strategy is the first step in the preparation of data collection, which

underlines the selection of potential research participants and methods for data collection (Easterby-Smith et al., 2015).

The sampling strategy in this qualitative research will be based on purposeful sampling (Patton, 1990; Creswell & Poth, 2018), which means that researchers select individuals and places for the research as they can purposefully inform an understanding of the research problem and central phenomenon in the research (Creswell & Poth, 2018). Patton's (1990) purposeful sampling strategy is based on 16 different strategies for purposefully selecting information as summarised in Table 3.7-1.

No	Sampling strategy	Description
1	Extreme or deviant sampling	Examples with unusual conditions or extreme outcomes are selected, such as outstanding success, notable failures, crises, top of the class
2	Intensity sampling	Excellent (but not extreme) examples of the phenomenon are selected such as good researchers, poor, above average, below average
3	Maximum variation sampling	A number of heterogeneous samples are selected in order to find central themes
4	Homogeneous sampling	Similar examples are selected in order to gain an in-depth understanding of a certain subgroup
5	Typical case sampling	Typical examples for the case are selected; mainly with the help of experts or data from previous surveys
6	Stratified purposeful sampling	Selection of above-average, average and below-average examples
7	Critical case sampling	Examples are chosen that are particularly important in the scheme of things
8	Snowball or chain sampling	Asking a number of people about whom else to talk to about the case; looking for names that are repeatedly mentioned and choosing them as a sample

No	Sampling strategy	Description
9	Criterion sampling	Choosing the sample that meets some predetermined criterion of importance
10	Theory-based or operational construct sampling	People are chosen based on their potential representation of important theoretical constructs
11	Confirming and disconfirming cases	The evaluator explores emerging patterns and then looks for other examples which fit the already emerging patterns
12	Opportunistic sampling	Further samples are chosen during the actual data generation process
13	Purposeful random sampling	The sample is chosen randomly
14	Sampling politically important cases	A variation of the critical case sampling strategy involves selecting a politically sensitive site or unit of analysis
15	Convenience sampling	Sample selection based on the fastest and most convenient choice, which saves time, money and effort
16	Combination or mixed purposeful sampling	A combination of different sampling strategies based on needs and interests

Table 3.7-1: Purposeful sampling strategies (Patton, 1990, p. 226)

The logic and power of purposeful sampling lie in selecting information-rich cases for study in depth. Information-rich cases are those from which one can learn a great deal about issues of central importance to the purpose of the inquiry, thus the term purposeful sampling. Studying information-rich cases yields insights and in-depth understanding rather than empirical generalisations (Patton, 1990).

This research is based on combination or mixed purposeful sampling in order to get the best information through particular participants who are known to be able to provide important information. For this research, participants were selected:

1. on the basis of their experience of engineered products, innovation, new product development and customer retention in the industrial valve industry (homogeneous sampling).
2. on the basis of predetermined criteria (criterion sampling).
3. because other participants suggested some customers who might participate in the study (opportunistic sampling).

These sampling criteria were defined to ensure that the selected participants could provide information-richness (Patton, 1990). Furthermore, four inclusion and exclusion criteria were defined for the selection of interview participants as illustrated in Table 3.7-2.

Criteria	Inclusion	Exclusion
Experienced in industrial valve business	Minimum 5 years' working in industrial valve business	Less than 5 years' working in industrial valve business
Contractual obligation	Under full-time employment contract	Part-time contract
Location of people	Germany, Italy, China and USA	All other countries
Customers	Interviewees recommended customers to contact	All other customers

Table 3.7-2: Inclusion and exclusion criteria

First, only people who had experience in the industrial valve business were included. Typically, people in the hiring process were requested to have at least five years' experience in the industrial valve business and knowledge about industrial valve products, their applications and market dynamics. Based on this hiring selection process, people who had been newly hired and

had worked at least five years in the industrial valve business were included too. Second, only people who had a full-time employment contract were included. All others, such as those who had part-time, limited or consultancy-type contracts, were excluded. Third, based on the organisational structure of the company and its subsidiaries and where the people were located as a base, only the countries Germany, Italy, China and USA were included. China is the largest producer of industrial valves globally followed by USA, German and Italy (Freedonia, 2016; VDMA, 2016). Furthermore, most of the licensors are located in those countries (Kapp, 2019) so that the interview participants located in those countries could provide information-richness (Patton, 1990). Fourth, during the pilot interviews with three selected participants, two of them recommended the contact number of customers who had expertise on this topic. Only those recommended customers were selected and invited for interview.

Qualitative research typically focuses in depth on relatively small samples and even single cases (Patton, 1990). Nevertheless, Patton (1990) argued that there are no rules for sample size in qualitative research. Sample size depends on what needs to be known, the purpose of the research, what is at stake, what will be useful, what will have credibility, and what can be done within the available time and with the available resources (Patton, 1990, p. 184). In principle, the size of the sample and the depth of interviews affect whether researchers can claim immersion, because the deeper and broader each case, the smaller the sample size can be (Gilgun, 2014). Charmaz (2011) stated that numerous researchers have legitimised studies with small data. She argued that a researcher can finish collecting data when the

different categories become saturated. Categories are saturated when gathering fresh data no longer illuminates new theoretical insights or new properties of the core theoretical categories (Charmaz, 2011, p, 113). Thus, it is not possible to specify the total number of interviews beforehand; therefore, interviews need to proceed until saturation is reached.

The general tendency is to select a minimum sample size that is feasible with respect to the available resources and the level of accuracy demanded of the findings (Denscombe, 2010, p. 47). The literature regarding sample size and the number of participants refers to one or more participants (Saunders & Townsend, 2016). Participant numbers are considered to depend on the balance between participants and quality of responses to collect sufficient data (Alvesson & Ashcraft, 2012). Research investigating the number of participants required for research studies is limited (Saunders & Townsend, 2016). Within extant literature on interviews and participant selection, sampling guidance in the form of “expert voices” rarely states a precise number of participants (Baker & Edwards, 2012). An analysis of 798 articles, published between 2003 and 2013 in the top 10 academic journals, in terms of participant numbers for qualitative research within organisations and the workplace, concluded that in organisation and workplace research the norm was 15 to 60 participants, which was described as credible numbers for planning interview research (Saunders & Townsend, 2016).

One of the most important tasks in the research design phase is to identify appropriate participants; decisions regarding selection are based on the research questions, theoretical perspectives and evidence informing the

research (Easterby-Smith et al., 2015). Participants are selected on the basis of who can best inform about the research questions and enhance understanding of the phenomenon under research (Creswell & Poth, 2018). The sample size for this research was a total of 40 participants who worked in the industrial valve industry. The participants have experience with engineered valves in the industrial valve industry and worked in marketing and sales, engineering and the project department within four different locations of one organisation; the individuals were from Germany, which is the headquarters, Italy, China and USA (see Table 3.7-3 for location, gender, age, position and years of experience of participants). All invited participants were informed about the research topic and they confirmed their engagement in this research. The selected participants were:

1- senior and executive leaders who have experience in new product development processes, marketing and sales and in customer retention;
2- senior and executive leaders representing the customers, as recommended by interviewees; and
3- experts within the organisation who were selected based on predetermined criteria.

No	Location	Gender	**Age**	Position	Experience (years)
1	Germany	M	46	Sales and Marketing Director	15
2	Germany	M	57	R&D Director	25
3	Germany	M	53	Key Account Manager Petrochem I	23
4	Germany	M	40	Key Account Manager Petrochem II	10
5	Germany	M	35	Key Account Manager Oil and gas I	7

No	Location	Gender	**Age**	Position	Experience (years)
6	Germany	M	37	Key Account Manager Oil and gas II	6
7	Germany	M	49	Key Account Manager Steel and iron I	25
8	Germany	M	41	Key Account Manager Steel and iron II	12
9	Germany	M	33	Area Sales Manager I	7
10	Germany	M	46	Area Sales Manager II	22
11	Germany	M	34	Area Sales Manager III	9
12	Germany	M	56	R&D Manager Petrochem	31
13	Germany	M	42	R&D Manager Oil and gas	17
14	Germany	M	46	R&D Manager Steel and iron	19
15	Germany	M	38	Project Manager	8
16	USA	M	43	President Americas	15
17	USA	M	39	President Sales and Marketing	9
18	USA	M	51	Sales Manager Petrochem	14
19	USA	M	44	Sales Manager Oil and gas	19
20	USA	M	38	Sales Manager Steel and iron	7
21	USA	M	53	Engineering Manager	16
22	USA	M	35	Sales Engineer I	11
23	USA	M	33	Sales Engineer II	6
24	USA	M	37	Sales Engineer III	6
25	USA	M	44	Sales Engineer IV	7
26	USA	M	42	Sales Engineer V	9
27	USA	M	41	Sales Engineer VI	13
28	China	M	39	President Asia-Pacific (APAC)	9
29	China	M	41	President China	15
30	China	M	49	President Sales	17
31	China	M	43	Sales Manager Petrochem	16
32	China	M	51	Sales Manager Oil and gas	20
33	China	M	53	Sales Engineer I	25

No	Location	Gender	**Age**	Position	Experience (years)
34	China	M	32	Sales Engineer II	6
35	China	M	33	Sales Engineer III	6
36	USA	M	62	President Licensor	31
37	USA	M	58	Licensor Division President Petrochem	27
38	USA	M	46	Division President Oil and gas	19
39	China	M	52	Licensor Division President Petrochem	15
40	China	M	58	Licensor Division Manager	20

Table 3.7-3: Interview participants

The last five participants were from licensors that were nominated by the executives during the interview process in order to have their view on this research. These selection criteria were set up to ensure that the nominated participants would be in a position to provide information-richness (Patton, 1990).

3.8 Development of the Interview Questions

Qualitative interviews are directed conversation evolving around questions and answers about the research topic; interviews provide opportunities for mutual discovery, understanding, reflection and explanation, and they elucidate subjectively lived experiences and viewpoints. Therefore, interviews enable researchers to access information in context, and to learn about phenomena that are otherwise difficult or impossible to observe (Easterby-Smith et al., 2015, p. 390). The interview questions are at the heart of

interviewing (Majid et al., 2017) and the questions must be designed in such a way that respondents are able to provide a response without the restriction of lack of space. Open questions have no definitive response and lead to answers that are recorded in full. Open questions often begin with words such as “How”, “Why” and “What” (Gray, 2014, p. 361). The advantage of open questions is the potential for richness of responses, some of which may not have been anticipated by the researchers. Open questions may lead to interesting or unexpected responses; follow-up questions can be used (Saunders et al., 2009).

The development of the questions which will be used as a guideline during interviews is important to generate knowledge in order to address the research questions (Denzin & Lincoln, 2018) and to design a conceptual model in new product development and customer retention in the industrial valve industry. The following main areas were defined to develop open-ended questions: introduction, business environment, core competencies, new product development strategy, customer relationship, customer retention and conclusion. The developed open-ended interview questions are given in Appendix II.

3.9 Interview and Interview Procedure

Interviews are the primary data collection technique to obtain data in qualitative research (Saunders et al., 2009). The nature of the case study involves data collection and the researcher took the view that it was important to collect data from senior and executive leaders involved in new product

development and customer retention processes from a range of industrial valve companies. The use of interviews can support the validity and reliability of the data that are relevant to the research questions and objectives (Saunders et al., 2009). Even when the research questions and objectives are not formulated, interviews may help to formulate the research questions and objectives (Saunders et al., 2009). Constructivist researchers tend to rely on participants' viewpoints about the topics under investigation (Creswell, 2014); the vast majority of inductive research remains interview based and interpretivist in nature (Mojtahed et al., 2014).

Semi-structured interviews are the most common type of interview in human and social sciences today. In comparison to structured interviews, semi-structured interviews can make better use of the knowledge-producing potential of dialogues, allowing much more space where the interviewer has a greater chance of becoming aware of the knowledge-producing potential in the process itself rather than hiding behind a structured interview guide (Denzin & Lincoln, 2018). One definition of a qualitative research interview (in a generic form, but tending towards the semi-structured format) is: *"It is defined as an interview with the purpose of obtaining descriptions of the life world of the interviewee in order to interpret the meaning of the described phenomena"* (Kvale & Brinkmann, 2009, p. 24). It is essential to be aware of the benefits and the limitations of the different ways of conducting interviews, where structured interviews allow for a high degree of standardisation of questions and answers, and semi-structured and unstructured interview questions often generate a higher degree of confidences as the interviewees' replies can be

more personal in nature (Easterby-Smith et al., 2015). Different types of interviews are summarised in Table 3.9-1.

Interview Structure	Type of Interview	Guidance and preparation
Highly structured	Market-research interview	Detailed interview schedule, questions in a predefined order, some of them with a narrow selection of predefined answers
Semi-structured	Guided open interview	Topic guide, selection of topics or issues to be covered
Unstructured	Ethnographic interview	Individual questions stimulate an informal conversation; no interviews schedule or guide

Table 3.9-1: Types of interviews (Easterby-Smith et al., 2015, p. 405)

Highly structured interviews are often used to collect data for quantitative analysis; pre-prepared questionnaires and standardised questions are used, that is, the same questions are posted to all respondents (Gray, 2014, p. 437). The simplest form of such interviews is where there are short answers to questions, the interviewer simply ticks boxes, and no deep thought is required by either party (Easterby-Smith et al., 2015, p. 405).

Semi-structured interviews are based on a list of questions that can be addressed in a flexible manner (Easterby-Smith et al., 2015, p. 404). Semi-structured interviews are often used in qualitative analysis and open questions are used widely in semi-structured interviews (Saunders et al., 2009).

Unstructured interviews are interviews where questions are used to stimulate a conversation rather than to guide responses (Easterby-Smith et al., 2015, p. 404).

Semi-structured interviews will be applied in this research in order to generate knowledge in new product development and customer retention in the industrial valve industry.

Interviews should be conducted in accordance with a planned time schedule and should not be rushed (Gray, 2014). The length of interviews varies between researchers and between participants, although generally at least one hour is required (Legard et al., 2003). Based on this recommendation, the interviews conducted had a duration of between 50 and 90 minutes.

Predefined interviewees who met the selection criteria and who agreed to be part of this research were invited by email. The participants received two documents electronically, an invitation email (Appendix I) and the interview structure (Appendix II), as attached in the appendices. Interviews can be conducted face to face, by telephone or by video (Gray, 2014; Creswell, 2014). Interviews conducted via telephone or video conferencing have the advantage that it makes it possible to interview people who are far away or perhaps located in inaccessible or dangerous locations (Denzin & Lincoln, 2018). The interviewees for this research are located in different countries with different time zones; therefore, all the interviews were conducted via Microsoft Teams and Skype.

A total of 40 people were interviewed using Microsoft Teams and Skype within a three-month period, of these, 35 work in an industrial valve manufacturing company in executive management positions and team leader positions located in four different countries. The selected participants have been working with their company for 6 to 31 years (average 15 years) and the participants' ages were between 32 and 62. All selected participants are men since unfortunately women are still underrepresented in the industrial valve industry. The participants have extensive experience in the industrial valve business; they were informed of, and understood, the research problem and the central phenomenon of the research (Creswell & Poth, 2018). The interview sessions took in general 50 to 90 minutes and the interviews were recorded; following each interview the recorded information was transcribed. Based on the recommendations from some respondents during the interviews, the researcher contacted an additional five participants who represented the customers of the engineered valve manufacturer.

3.10 Pilot Testing

The purpose of pilot testing is to confirm the coverage and relevance of the content of the designed, preliminary questions, to identify the possible need to redesign questions and to test implementation of interview questions (Kallio et al., 2016). By testing the interview questions, it is possible to make changes and adjustments to interview questions and improve the quality of data collection (Kallio et al., 2016). Saunders et al. (2009) argued that pilot testing improves the validity and reliability of the data that will be collected. Preliminary analyses using the pilot test data can be undertaken to ensure

that the data collected will enable the researcher to answer the research questions (Saunders et al., 2009). Data collection during pilot testing might consist of one or two interviews so that the researcher can estimate the time needed to collect data (Creswell & Poth, 2018, p. 172). The pilot interviews do not need to be excluded from the data set unless very radical change of coverage occurs. The data collected will still contribute to the research findings even if the emphasis changes slightly (Arthur & Nazroo, 2003, p. 135).

The participants for the pilot study were selected based on three previously defined inclusion/exclusion criteria (Table 3.7-2): specifically, “experience in industrial valve business”, “contractual obligation” and “country”. These criteria were considered for the pilot study in order to guarantee that participants met the same criteria as the participants taking part in the main study. Details of the pilot test participants are given in Table 3.10-1.

No.	Location	Gender	**Age**	Position	Experience (years)
1	Germany	M	46	Area Sales Manager	22
2	USA	M	35	Sales Engineer	11
3	China	M	53	Sales Engineer	23

Table 3.10-1: Pilot test participants

The pilot study took place in April 2021 and participants had to run through the same process as was planned for the participants in the main study. The

purpose of this research was to interview information-rich individuals about new product development and customer retention.

The outcomes of the pilot test were:

- Pilot testing allowed the researcher to practise interviewing techniques and the transcription of the recorded data to be well prepared for the main interviews.
- The interview questions (Appendix II) were tested and one of the original interview questions was slightly modified from “How is a new product defined and how is it identified within the company?” to “What does new product mean for you and how is it identified within the company?”; the modification allowed respondents to be able to provide a response without restrictions on new product definition and it aided understanding of their experiences and opinions.
- During the pilot interviews two of the three participants mentioned the role of licensors as customers in new product development and customer retention. Based on that a fourth inclusion criterion was set up for the research as “customer” (Table 3.7-2).
- The original planned time for each interview was 60 minutes. During the pilot testing the conducted interviews had a duration of between 60 and 90 minutes, which allowed the researcher to estimate the time required to collect data from the main interviews.

3.11 Reliability and Validity

The core principles of qualitative research comprise reliability and validity (Neuman, 2014); reliability and validity are essential to establish the trustworthiness of qualitative research (Denzin & Lincoln, 2018). Although many critics are unwilling to approve the trustworthiness of qualitative research, frameworks underlying this approach have been in existence for decades (Shenton, 2004). Nonetheless, the purpose of qualitative research is to generate understanding; so, the evaluation concepts used in quantitative research need to be examined and translated (Stenbacka, 2001).

Basically, reliability considers the ability of measurement methods to generate the same research result over and over again (Stenbacka, 2001). However, this concept of reliability is misleading in qualitative research because qualitative research has its own quality based on its purpose of generating understanding of a social phenomenon (Stenbacka, 2001). Trustworthiness comprises the reliability and validity of qualitative research (Denzin & Lincoln, 2018). Trustworthiness is never an absolute proof, but by conviction one is constrained to accept the presented findings (Denzin & Lincoln, 2018). Seale (1999) claimed that trustworthiness is always negotiable and open ended, not being a matter of final proof whereby readers are compelled to accept an account. The trustworthiness of this research will be addressed as follows:

- The interviews were conducted using the method of non-forcing interviews with strategically well-chosen informants (Stenbacka, 2001).

- The research ethics used in data collection were based on insights into ethical review procedures that are in place in many universities (Easterby-Smith et al., 2015); this research was conducted in accordance with the guidelines of the University of Gloucestershire's *Research Degrees: A Handbook of Regulations and Procedures* as well as *Research Ethics: A Handbook of Principles and Procedures* (2008).
- Triangulation was used for the case study; triangulation makes case study research a hard form of research, although it has been traditionally considered a soft form of research (Yin, 2003).

Validity is one of the strengths of qualitative research and is based on determining whether the findings are accurate from the standpoint of the researcher and are really about what they appear to be about, and accurate from the standpoints of the participants and the readers (Creswell & Miller, 2000; Saunders et al., 2009). Rigour is referred to when determining the validity of qualitative research (Lincoln et al., 2011). The basic question of validity is whether the intended object of measurement is actually measured (Stenbacka, 2001).

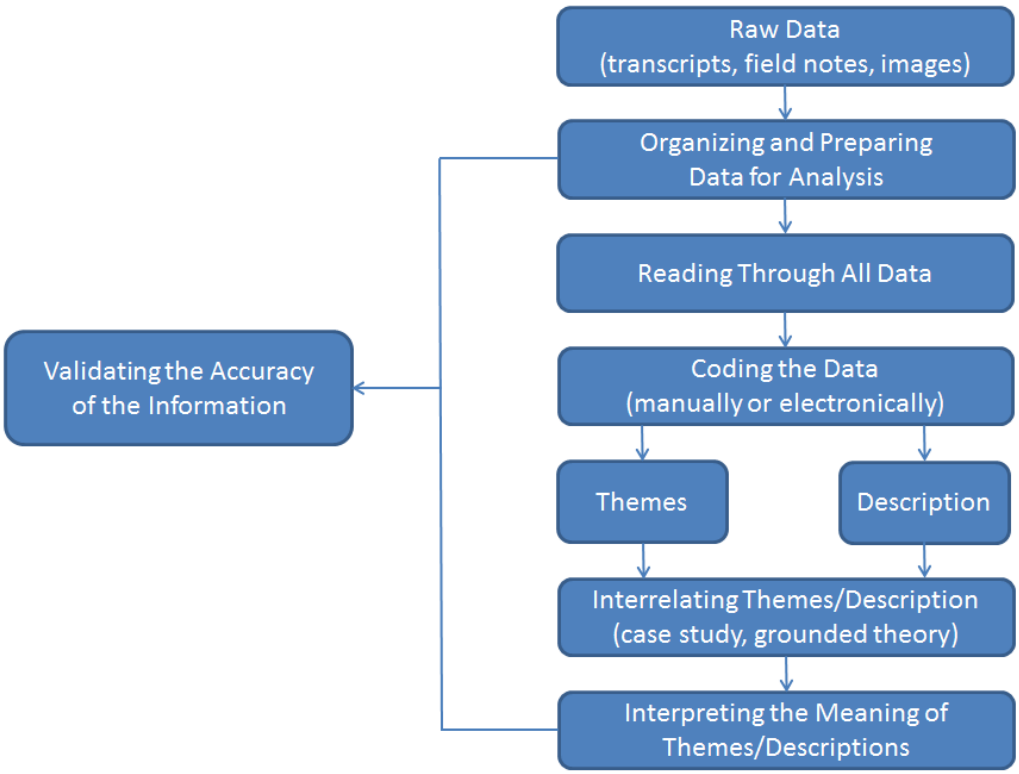


Figure 3.11-1: Data analysis in qualitative research (Creswell, 2014, p. 196)

Creswell (2014) argued that in qualitative research collected data are so dense and rich, not all of the information can be used. In qualitative research the data need to be aggregated in a small number of themes (Creswell, 2014; Ozuem et al., 2021). Typical data analysis in qualitative research is displayed in Figure 3.11-1. This figure proposes a linear, hierarchical approach building from the top to bottom. Before the data can be analysed, they have to be organised. Creswell (2014) argued that all the relevant data that have been collected should be formatted and labelled in a consistent way so that individual data fragments can easily be identified and retrieved. It is important to ensure that all data are stored in a way that prevents unauthorised access. Data preparation also involves writing up and organising field notes. Qualitative data collected as audio or video recordings are usually transcripted

into written text (Easterby-Smith et al., 2015). Following the organisation and preparation of the data, the data need to be read to reflect on their overall meaning (Creswell, 2014). Coding the data is the process of organising the data by bracketing chunks and writing a word that represents a category in the margins. It involves taking text data gathered during data collection, segmenting sentences into categories and labelling those categories with a term, which is often based on the actual language of the participants (Creswell, 2014, p. 197). The coding process enables descriptions to be generated, which provides detailed rendering of information about people, places or events in a setting. This analysis is usefull in designing detailed descriptions for case studies (Creswell, 2014). Following the coding process the findings of the analysis will be represented using narrative passages. The final step in data analysis is the interpretation of the findings (Creswell, 2014).

Generalisability or external validity in qualitative case studies is a concern, because how can the findings of single case studies be generalised to other cases (Bryman & Bell, 2011). Even the generalisability of the findings obtained from a small number of qualitative case studies is limited; however, many social scientists argue that generalisability is not the purpose of qualitative case study research (Crotty, 1998; Bryman & Bell, 2011). Qualitative case study research is perceived as a contribution to research or as an interpretation of a phenomenon; readers should weigh a researcher's interpretation, judge whether the findings have been soundly arrived at and whether they are plausible, and decide whether the research is of interest and applicable to their concerns (Crotty, 1998). Researchers who wish to generalise from qualitative research need to be aware of the limitations, which

are due to the limited units of analysis used in comparison to quantitative studies (Eisenhardt, 1989). Furthermore, qualitative research is as generalisable as quantitative research: what becomes useful in understanding this is a full and thorough knowledge of particular findings, and recognising them in new and foreign contexts. It is also important to acknowledge that knowledge is a form of generalisation too, not a scientific induction, but naturalistic (Stake, 1978). This research follows the concept of Yin (2009), who suggested that case studies are generalisable to theoretical propositions and not to populations. In this sense, the case study does not represent a sample, and in carrying out a case study the research goal is to generalise theories, not to enumerate statistical frequencies. In the current research, interviewees expressed their personal perceptions of the key drivers of new product development and how new product development facilitates customer retention in the industrial valve business. This means that the findings are analytically generalisable to the phenomenon within the setting in which the research was carried out.

In the context of research quality, the current research is in line with some ethical considerations, which are discussed in Section 3-12.

3.12 Ethical Considerations

Research ethics relates to questions about: how the research topic was formulated and clarified; the design of the research, including the methods used to gain access to data, collect data, and process and store the collected data; and the writing up of the research findings in a moral and accountable

way (Saunders et al., 2009). The integrity of the research should be protected through ensuring honesty and transparency in communicating about the research, and accuracy and lack of bias in the research result (Easterby-Smith et al., 2015, p. 356).

The research is based on ethical considerations in accordance with the guidelines of the University of Gloucestershire's *Research Degrees: A Handbook of Regulations and Procedures* as well as *Research Ethics: A Handbook of Principles and Procedures* (2008). The information obtained during in-depth interviews was used to understand the experiences, opinions and knowledge of participants with regard to how new product development facilitates customer retention in the industrial valve industry. The participants invited to participate in this research were selected based on predefined criteria. If the participants agreed to participate, they were informed about the nature, purpose and how the collected data would be stored, anonymised and used of the interview through a "participants informed consent form" that they needed to sign before the interview. The participants in this research were selected from the researcher's business and private environment; therefore, certain additional topics needed to be addressed in order to avoid any conflicts of interest and to meet the ethical standards of research studies more generally. In this regard, the current research addressed the following issues:

1- All invited participants were informed in advance about the aims and objectives of this research.

2- Participation in the research was entirely voluntary. Participants were free to refuse to answer any question or terminate the interview at any point

without any consequences. In cases of termination, all information pertaining to the participant was destroyed.

3- The interviews were characterised by mutual respect and trust. The dignity of the participants was respected.

4- The interviews were confidential and the identities of participants were anonymised.

5- Any quotations and/or examples used in research outputs (such as reports, conference papers, presentations, manuscripts) remained anonymous.

6- Where interviews were recorded and/or transcribed they were coded in order to protect the identity of respondents. All files are stored securely in accordance with the European Union's Data Protection Act.

7- The participants were provided with information about where the interviews were to be published.

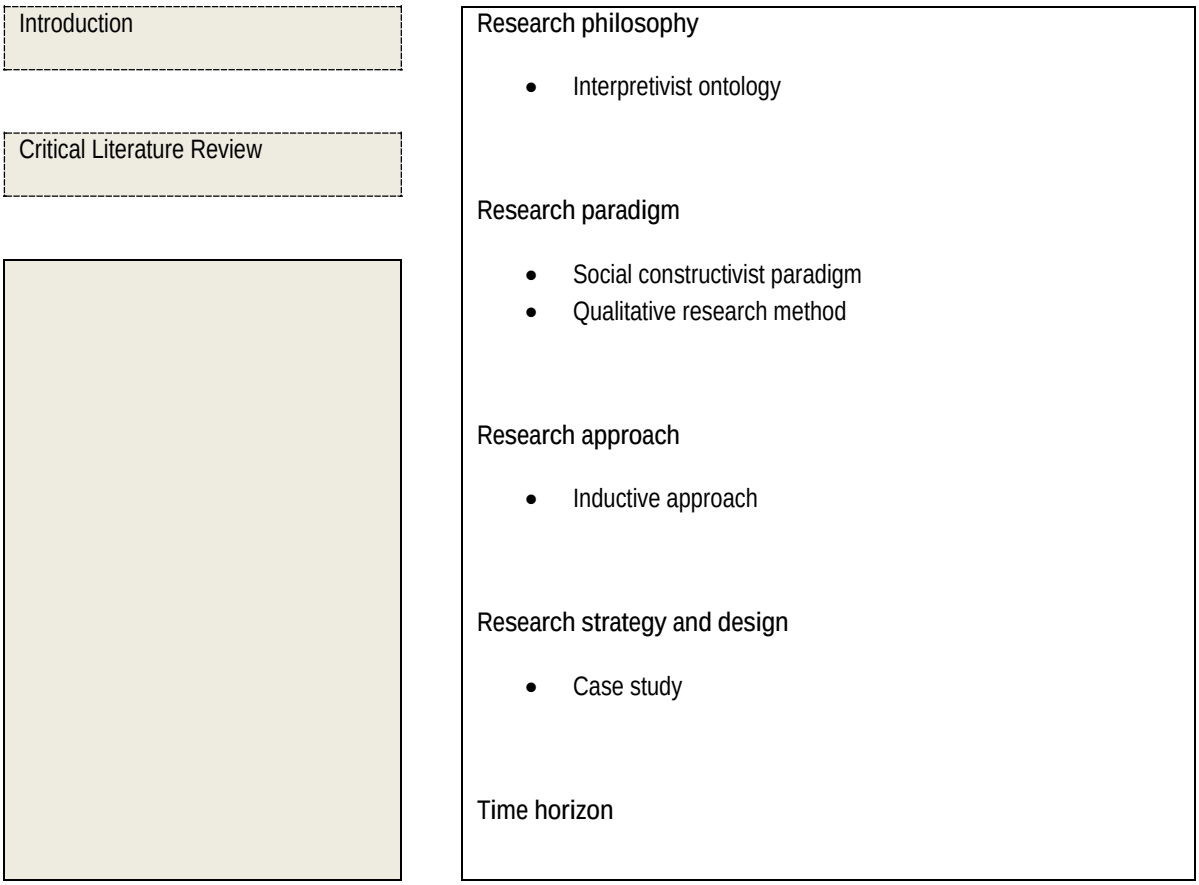
8- Participants were informed about the researcher's dual role as a researcher and interviewer.

9- The researcher maintained objectivity.

The researcher supplies some services to industrial valve companies, and does not have any financial interests in undertaking this research. In order to avoid any conflict of interest, a non-disclosure agreement (Appendix III) was signed between the researcher, participants and participants' organisations before the interviews were conducted.

3.13 Summary

This chapter describes the research methodology for this research. The chapter started with the selected paradigmatic perspective and continued by defending qualitative research as a suitable methodological approach. The case study approach was selected as a suitable research strategy. The chapter then offered some justification for the sample selection, sample size and data collection methods used. Finally, some ethical considerations were discussed. Figure 3.13-1 displays a summary of this research methodology chapter and the progress of the research.



Research Methodology

- Cross-sectional "snapshot"

Sample selection and sample size

- Mixed purposeful sampling and 40 interviewees

Development of the interview questions

- Open-ended questions were used to address the research questions and to aid in the design of the conceptual model

Interview and interview procedure

- Semi-structured interviews

Pilot testing

- Three participants
- Licensors as "customer" were included in the inclusion criteria

Reliability and validity

- Trustworthiness which comprises credibility, conformability, transferability and dependability

Ethical considerations

- University of Gloucestershire's *Research Degrees: A Handbook of Regulations and Procedures* as well as *Research Ethics: A Handbook of Principles and Procedures* (2008).
- Research integrity
- Creating knowledge

Analyses of Data

Conceptual Model

Conclusion and Recommendations

Figure 3.13-1: Summary of the chapter and progress of the research

4. ANALYSES OF DATA

4.1 Introduction

The previous chapter described the research methodology that regulates the direction of this research. The chapter justified why an interpretivist and social constructivist research approach can provide a comprehensive understanding of the key drivers of new product development and how new product development could facilitate customer retention in the industrial valve industry. Furthermore, it justified the choice of qualitative research and an embedded case study research strategy to collect participants' experiences and perspectives on new product development and customer retention in the industrial valve industry.

This chapter presents the result of the analyses of responses from the interviewees. This chapter provides answers to the research question,

What are the key drivers of new product development in the industrial valve sector?

and to the secondary research question,

How does new product development facilitate customer retention in the industrial valve business?

In addition this chapter provided answers to the following research questions related to the valve industry:

What are the key new product development processes and to what extent are customers part of this process?

How can co-creation processes integrate customer knowledge to improve new product development?

What are the key drivers of purchasing behaviour in terms of industrial valves, and what are the procurement and sales channels that must be identified to create new product development opportunities?

The current research elaborates four conclusive themes that describe perceptions among interview respondents of key drivers of new product development, and new product development and customer retention. The interpretation of the interview findings is oriented on the philosophical approach of social constructivism. Finally, the interview findings are discussed.

4.2 Rationale of Thematic Analytic Approach

The challenge of qualitative research is that in a short time period a large cumbersome database is generated (Bryman & Bell, 2011) and the analysis of qualitative data involves a demanding process (Yin, 2003). Thematic analysis is recognised as a foundational method for qualitative analysis due to its flexibility (Braun & Clarke, 2006). In this research, analyses of the collected data will be based on a thematic analysis approach (Boyatzis, 1998; Braun & Clarke, 2006). The analyses will start with the transcription of the recorded interviews and it will be conducted inductively. Based on a constructivist epistemology, an inductive thematic analysis approach is adapted to interpret the collected data (Boyatzis, 1998) in order to better understand what the key

drivers of new product development are and how new product development facilitates customer retention in the industrial valve industry, using the participants' own perceptions with context (Ozuem et al., 2015). Participants were asked to talk about their experiences on industrial market dynamics, new product development and its process, customer retention, co-creation on new product development and procurement channels in that industry. Semi-structured interviews were adopted in order to fully exploit the recounted vivid experiences and obtain the richest data. Open-ended questions were asked so that the participants could move from topic to topic, which provided a rich insight into experiences. Interview questions were designed based on both theoretical and experiential knowledge. The interview structure (Appendix II) helped to highlight that the research topics were covered and allowed the researcher to steer participants back on topic (Ozuem et al., 2015). Data analysis was conducted inductively, which means that the data were not aligned to an existing conceptual framework. Moreover, field research was conducted exclusively for the purpose of this research (Braun & Clarke, 2006). The themes identified bear little relationship to the questions that were asked during the interviews (Braun & Clarke, 2006). However, the themes were inextricably connected to the data themselves (Patton, 1990). Thus, the applied thematic approach for this research is data-driven (Boyatzis, 1998).

The guidelines on the data analytical process established by Braun and Clarke (2006) were followed. The aim was to become familiar with the data in order to interpret them accordingly during the interview process. Important and relevant information was highlighted during the interviews in order to discuss it with the subsequent participants. Because of this process, the interview

transcripts were reviewed and analysed following each interview. All transcribed interviews were summarised in an Excel file; names and other identifiable information were removed. The coding process was performed utilising Word and Excel; interesting and potentially important data related to the research questions were highlighted. After the 10th interview some initial codes generated. The interview transcripts were read several times paying specific attention to patterns that emerged from participants' responses (Ozuem et al., 2021). Commonly used words and sentences were analysed to find similarities, differences and patterns. This process allowed the grouping of words into appropriate themes (Braun & Clarke, 2006). The preliminary codes were then revised and grouped with the help of a thematic map. Thus 106 terms could be identified based on respondents' comments that seemed relevant to the research. In the next phase, themes were developed and reviewed so that the data within themes cohered together meaningfully, while ensuring there were clear and identifiable distinctions between themes (Braun & Clarke, 2006). A final version of a thematic map (Appendix IV) was generated after several reviews of the transcripts and identification of themes and codes. Finally, interpretations of respondents' perceptions of key drivers of new product development, and on new product development and customer retention generated four major themes:

1- customer intimacy

2- value

3- quality

4- customer service.

These themes represented the vivid perception of the empirical reality of new product development drivers, new product development and customer retention in the industrial valve industry. Hence, the presence of themes permits the generation of a testable, relevant and valid theory (Eisenhardt, 1989). All related literature was reviewed in order to investigate whether definitions and concepts exist which could help to describe each theme in detail, in the context of new product development drivers, new product development and customer retention in the industrial valve industry. This would strengthen the research quality of the empirical findings.

The four themes and their definitions, codes and key words are presented in Table 4.2-1. Sections 4.3 to 4.6 describe the four themes.

Themes	Definitions	Codes	Key words
Customer Intimacy	High level of mutual understanding, close and valuable relationship with the customers	Human relation	• Communication • Relationship • Networking • Understanding • Collaboration • Sharing (opinion & ideas, knowledge)
		Organisation	• Sectors • Knowledge • Co-creation • Time to market • CRM • KAM, Sales and Engineering • Training • Engineered product
		Strategy	• Growth • Profit • New product development • New product introduction • Market share • Marketing, conferences • Frame agreements • Competition • Customer focus • Market dynamics

Value	Customer's perceived preference for and evaluation of those products' attributes, attributes' performance, and consequences arising from use that facilitate (or block) achieving the customer's goals and purposes in use situations	Engineered valves	• Knowledge • Innovation • Performance • Quality • Reliability • Experience • Competitive advantage • Extreme conditions • Core competence • Selection for defined process
		Lifetime value	• Profit increase • Growth • Availability • Cost reduction • Premium price • Reputation • Retention • Collaboration agreement
		Operational excellence	• New product development process • Quality • Design, Engineering • Manufacturing technology • Testing • After market • Quick response
Quality	Degree to which a set of inherent characteristics of an object fulfils requirements	Design	• Functionality, safety • Problem solving • Capability • Reliability • Harsh conditions

		Conformance	• Contractual obligation • Performance • Price performance ratio • Technical specification • Design • Manufacturing • Testing • Time frame • Fulfilment
		Performance	• Perceive • Effective • Ability • Serviceability
Customer service	Providing service to the customer, before, during and after the purchase of the product	Knowledge	• Project business • Competition products • Expectations • Purchasing behaviour • Purchasing channels • Life cycle • Product selection • Market intelligence • Price strategy
		Processes	• Qualification • Approval • Customer specification • New product • Order execution • Organisational competence • Application engineering • Commissioning

		Voice of Customer	• EPC • Licensor • End user • Open communication • Listening • Customer satisfaction • Retention • Long-term agreements • After market, spare parts availability

Table 4.2-1: Themes representing new product development and customer retention findings in industrial valve industry. CRM customer relationship management; EPC engineering, procurement and construction; KAM Key Account Manager

4.3 Customer Intimacy

The definition of “Customer intimacy” has been described in this research as a close customer relationship, close communication, ability to understand a customer’s problems and be in a position to provide the expected solutions. In order to provide the expected solution, a high level of mutual understanding is an important element which is driven by a close and valued relationship with customers (Brock & Zhou, 2012). In this section, the role of customer intimacy in new product development is described.

The findings suggest that communication and collaboration with customers are important in new product development. One of the sales engineers with six years in the industrial valve business stated:

Communication and close collaboration with the customers are the basis for understanding their needs and expectations better and earlier than the competition [eeem]; so we can provide them with appropriate solutions. In most cases the solutions are newly developed engineered products.

Understanding customers’ needs and requirements is crucial to provide the right solutions to fulfil the customers’ expectations and/or to solve their problems. Understanding what customers want is one of the building blocks of customer intimacy. The components of customer intimacy such as trust, close communication, collaboration, customer knowledge and commitment (Osei, 2017) help understanding of the customers’ needs and requirements in order to provide the right solutions.

The business president of the Americas region, who has worked for 15 years in the industrial valve business, reflected on his experiences of customer intimacy as follows:

We re-organised our sales and engineering sector-wise to strengthen our customer intimacy. This is a part of our growth strategy. Well, the new organisation focused on capturing and gathering customer knowledge. Our highly skilled engineers analyse the collected material and implement it in engineered valve design. This helps to supply appropriate valves for critical applications.

This respondent who works in the industrial valve business, manufacturing engineered valves and equipment, gained a strong understanding of organisational development focused on capturing customer knowledge. Thus, he can be considered an expert. Customer knowledge in this context is defined as innovative knowledge of the flow-related processes and applications where the customers are operating. A trustful relationship with customers will help to capture knowledge of customers' flow-related processes and applications. Since industrial valve companies are focused on providing engineered valve solutions in critical applications (Weaver, 2004), collecting and understanding customers' flow-related knowledge in-depth are the basis of new product development. The profitable growth of industrial valve manufacturer's is linked to the generation of ideas for developing new products (Minor et al., 2017) and solving customers' flow-related problems. In co-creation in new product development, the customer is fully involved in the industrial valve manufacturer's new product development process and together they can generate more ideas for developing new products.

Similarly, the business president in China who has worked for more than 11 years in the industrial valve business stated:

The sales is organised and the sales team trained [eeemm] in order to increase customer relationship and communication. We implemented KAMs in sales organisation. Their main responsibility is expanding relationships with customers. The sales managers cover three main regions: Americas, EMEA and APAC. They lead sales activities and sales engineers. The sales engineers are located around the world. Sales engineers are responsible for generating sales leads. Also, for understanding customers' needs and expectations.

Close relationship and communication refers to customer intimacy in which manufacturers and customers take value from their relationship and communication (Buttle & Maklan, 2019). To drive profitable growth with new products, the organisation of industrial valve manufacturers needs to perform well in understanding customers' needs and expectations. Internal communication within an organisation is as important as its external communication with customers in addressing customers' expectations. Therefore, the collected knowledge of customers should be shared effectively within an organisation to develop the right solution for the customers.

The business president of Asia-Pacific (APAC) who has nine years of experience in the engineered valve business commented on strategy as:

Well, customer intimacy is important to growth strategy.

He continued:

Hmmm, customers are part of the new product development process and it is very important to have close collaboration and to utilise synergies with them.

Customer intimacy plays an important role in industrial valve manufacturers' growth strategy, which creates profitable new product development opportunities. Customer intimacy positively impacts relationship commitment level, behavioural loyalty and repurchase intentions (Brock & Zhou, 2012). In co-creation, customers are part of the new product development process and work closely with industrial valve manufacturers on the development of products for defined applications. Trust, open communication and knowledge sharing between customers and manufacturers are mandatory for the successful development of new products. Many respondents similarly mentioned the importance of close communication and collaboration with customers and utilisation of their knowledge in a new product development process.

The area sales manager in APAC region who has worked in the industrial valve business for more than nine years commented on the importance of customer intimacy and the strategy for new product development:

New products are fundamentally important for us. They represent one of the key pillars of our growth strategy. A large portion of our sales are generated from new products. [Hmmm] The xx% [significant] profit increase comes from new products. Based on our strategy, we will intensify our customer relationship to sign long-term frame agreements. This will drive us to gain more market share in the flow control business.

This industrial valve manufacturer's growth strategy for new products is based mainly on intensifying the customer relationship and on signing frame agreements to secure repeat orders for longer periods. A long-term frame agreement with customers is the result of a valuable relationship based on new product development which fulfils customers' expectations. This will lead to gaining more market share and to a significant increase in profit.

A sales manager in the oil and gas field who has worked in the industrial valve business for 20 years, reflected on the strategy of new product development and customer intimacy as follows:

Definitely, developing new products is vital. The strategy of the company on new product development is based on strong collaboration with the licensors and end users. A multilevel relationship with licensors and customers is important to understand customers' problems and needs.

Our capabilities on new product development and on shorter time to market, as expected, are crucial elements to increase customer intimacy. These will lead to a powerful collaboration with the customer, to address their problems and to deliver a timely solution for their long-term success.

This respondent, based on his experience in the industrial valve business, can be considered an expert on industrial valve business. New product development capability, time to market and increasing customer intimacy are crucial factors for solving customers flow-related problems in an expected time frame. In order to solve customers' flow-related problems, an industrial valve manufacturer has to identify the problem before providing a solution to the customers. To identify the right solutions, the manufacturer has to communicate and to collaborate closely with the customers as well as with the

licensors who have the process knowledge. If the provided solution leads to customers' long-term success, then customers have a strong interest in maintaining a long-term relationship with the manufacturer who solved their problems in a timely manner. The licensors will also have a strong interest in maintaining a long-term relationship with the industrial valve manufacturer since it solved the existing problems in their licenced process.

The Key Account Manager (KAM) responsible for the petrochemical business, who has worked in the industrial valve business since 2000, similarly stated:
New products are essential in terms of: to be one step ahead of our competition, to drive sales and profit growth, and to strengthen the customer relationship. New products provide technological and competitive advantages. The benefits of gaining competitive advantage by introducing new products are: revenue and profit increase, product development, productivity, operational efficiency and customer retention (Perryman, 2014).

One of the sales engineers, who has been engaged in the industrial valve industry for more than 13 years, stated:
We participate in sector- and application-based conferences. Many of our existing customers, potential customers and licensors participate too. During conferences we establish networks with selected people from licensors and customers. We share knowledge, ideas and opinions with them [yeah] on market dynamics and on new product development potential in critical applications. We present papers [important!] on how we identified customers' problems and how we solved them by providing engineered valves. This is

well appreciated by the participants and creates a close relationship with the decision makers in that sector.

Participation in sector- and application-related conferences supports the creation of a relationship with the decision makers from potential customers and from the licensors. Presenting success stories on how existing problems were identified and solved based on a close customer relationship and their participation strengthens the relationship with decision makers.

A KAM in the oil and gas business who has worked seven years in the industrial valve business commented:

CRM is one of the important tools in order to be successful in the industrial valve business. We have [hmmm] a self-made Excel tool in place. We collect project-related information, such as name of the licensor, name and the location of the end user, all involved EPC companies, size of the project, contact names and decision makers as well potential competitors and their project-related strengths and weaknesses. Unfortunately, the Excel tool does not address all the issues to follow the opportunities fully. For this reason we started to implement professional CRM software. I am sure that utilisation of the new software will support our business growth better than Excel, for example on relationship management, on sales leads and opportunities, on AFM opportunities.

One of the tools used to increase customer intimacy is CRM. In professional CRM software all the necessary customer-related information is stored, such as decision makers, potential competitors, customers' behaviour and customers' historical problems and provided solutions. CRM plays an important role in new product development performance to generate value to

customers (Zhang et al., 2021). CRM helps industrial valve manufacturers manage and analyse customer interactions and determine customers' needs and requirements.

A sales engineer who has been engaged in the industrial valve business for more than 11 years indicated:

New product introductions help to increase sales. We planned and introduced five new products in 2019. With new product introductions we strengthen our relationships with licensors and with end users.

This interviewee has 11 years' experience in the industrial valve business and he has a close relationship with customers. Thus he can be considered competent in the industrial valve business. At stronger levels of customer intimacy the exchange of sensitive and confidential information increases and the relationship is strengthened (Osei, 2017).

4.4 Value

In this research, value is considered to be customer value. Customer value is defined as the trade-off between benefits and sacrifices perceived by the customer in a manufacturer's supply (Coletta et al., 2021, p. 17). Customer value is the customer's perception of the worth of the manufacturer's product and/or service. The attributes of worth are defined by Coletta et al. (2021) in relation to customer value as follows (p. 19):

- Net benefit; it represents the trade-off between benefits and sacrifices. Sacrifices are measured as money, time, effort.

- Service-related; it represents the quality of the service provided.
- Relationship-related; it represents the quality of the relationship between the customer and manufacturer as strength of relationships, trust, commitment.
- Customer satisfaction; it measures the satisfaction with the relationship.
- Knowledge sharing; it represents the communication quality, information exchange, perceived learning effects.

The business president sales and marketing Americas who has worked for nine years in the industrial valve business stated in relation to customer value:
Basically our core competences are developing, designing and manufacturing high quality and reliable engineered valves and equipment. Actually, we as an innovative company developing sophisticated products, create added value for our customers. Our strength is developing new products that work in extreme conditions, such as in extreme temperatures and pressure, in a very short time in close collaboration with our customers. The time to market of the new products varies between 24 and 48 weeks. Further, we provide full after service around the world to respond to our customers in a short time.
I asked what kind of “added value” and he replied:
Yeah, it is a good question actually. [Hmm] Added value to our customers means providing a solution and solving their problems. In most cases we exceed their expectations with our high performance organisation! [laugh]. We provide solutions, new or upgraded engineered products, so our customers can be successful in their business. For example, reduction of their production cost to be competitive, reduction of unplanned shutdown times related to valves, reduction of maintenance cost, lowest energy consumption and

emissions, and quick response on any service-related cases on 24/7 basis, to make them successful in their business.

Confronted with demanding and well-informed customers, stiff global competition and unstable economies, delivering added value to customers is more critical now than at any time in the past. Added value is defined as additional features of a product or service in order to increase the value to customers (Hooley et al., 2020). An industrial valve manufacturer needs to provide added value, such as by enabling their customers to increase their productivity, to reduce their production cost and to monitor the condition of their valves through digital monitoring access. Understanding customers' problems during the product offering and product development process will support the creation of added value for the customers. When customers face flow-related problems in their plants, there is an impact on customers' plant performance which creates economic loss for the customers. Customers want flow-related problems to be solved immediately. Therefore, time to market plays an essential role in the new product development process in order to solve customers' problems in a shorter time period to reduce customers' losses.

One of the sales engineers, who has worked in the industrial valve business for six years, similarly stated:

Our knowledge and experience on processes, on engineered valve selection for the defined application, on new product development, on design and engineering, on manufacturing technologies, on final inspection and testing, on installation and on commissioning provides added value to our customers.

For example, increasing the product lifetime of the valves and equipment installed in critical applications compared to the market followers.

The resources of industrial valve manufacturers, such as knowledge of processes where customers face process-related problems and organisational capability on product development and production, contribute to creating value for customers. The lifetime of engineered valves for critical applications covers the period from when the engineered valves are installed in a specific plant until the time they have to be replaced with another solution. Providing increased lifetime on engineered valves also contributes to creating value for customers and should be considered a competitive advantage.

The business president of the APAC region who has nine years' experience in the industrial valve business stated:

We are very well known for providing engineered products for critical applications. Most licensors recognise us as a trusted partner [confident voice] because we provide them with value and make them successful. Our close collaboration with licensors and our track record on new product introductions are very important. They help us to qualify our products for new projects.

The researcher asked the respondent to clarify what trusted partner means, the respondent explained:

Trusted partner means to be part of a customer's organisation as a solution provider. We are fully integrated into our customer's organisation, starting from their research and development of new products and processes to their long-term business growth strategies. We have signed long-term technology agreements with most licensors as trusted partner and as preferred partner.

Many respondents expressed value creation for customers similarly. Trusted partners in terms of the relationship between the customer and manufacturer are viewed by the customer as part of their organisation (Matthews & Schenk, 2018). In this case, the manufacturer is in a position to use its knowledge of the customer in its product development and production process. A trusted partner relationship is characterised by trust, open communication and the sharing of confidential information (Osei, 2017). Collaboration and co-creation on new product development with trusted partners leads to a long-term relationship and customer retention.

An R&D director who has worked for 25 years in the industrial valve industry defined a new product as follows:

We define a new product in our company as follows:

1. *new to the specific application,*
2. *an existing product but installed in a new application,*
3. *cost reduction through value analyses and value engineering,*
4- *maximum three years in the market,*
5- *modifications to an existing product, such as a new design feature on the valves and/or on the control equipment, including digitalisation.*

Modifications, also called upgrades, to an existing product become necessary due to technological changes to a process and/or because of process-related new legislation. Upgrades are not limited to the manufacturer's products; any of the competition's products are also potential opportunities for upgrades for industrial valve manufacturers. The time limitation of three years on new product definition in the market applies to existing products in new

applications, without consideration of how long the existing product has been in the market.

The business president Americas with 15 years of experience in the industrial valve business commented:

The reason behind new product development is creating additional value not only for our customers but also for our company. This can be done either by increasing the sales volume and/or increasing profitability. The sales volume can be increased either by exploiting the customer's existing potential or by exploiting the product's existing potential. The customer potential includes acquiring new customers and retaining existing customers. Exploiting the potential of a new product could be a product overhaul which enables the penetration of additional markets in flow applications. Increasing the value with higher profitability involves either a reduction of costs or increasing the customer's willingness to pay premium or a combination of both.

New products also create value for industrial valve manufacturers themselves, such as knowledge accumulation, profit increase, customer retention, acquiring new customers, gaining of market share and sustainable business growth. Furthermore, new products help to increase the brand value of industrial valve manufacturers.

An area sales manager Americas explained one of his experiences in this context as follows:

I was involved in a project before [excited voice]. One leading company in that sector was searching for a solution in their engine testing facility. The engine needs to be tested for a certain time simulating the real case. After completion

of the test, the flow of cryogenic fuel needs to be stopped by isolation valves. If the flow continues or leaks through the closed valves, then the engine will be damaged. Well, this would cause the company more than half a billion dollars of loss. The isolation valves need to remain tightly shut off following completion of the test. We have been recognised in cryogenic applications with our cryogenic valves. We have a broad install basis around the world, such as liquid nitrogen, oxygen at minus 320°F (−196°C) in air separation business, and in liquid helium at a very extreme temperature of minus 454°F (−270°C and 4 Kelvin) in a nuclear particle testing facility in Europe. I contacted the customer and organised an initial meeting. With the participation of our R&D director, we presented our product range in cryogenic applications including the flexible seat design from ambient temperature to extreme low temperatures, which allows strong tightness in closed position. In addition, we introduced the vacuum jacketed body design to avoid any icing effect on external surfaces. Following the presentation, the customer's programme manager decided to visit our facility in Germany. During his visit, he also visited our manufacturing location. We performed a cold shock test in our cryogenic testing facility, which simulates the real case in cryogenic process. During the test, he said that we were the first company he had seen that provided such an innovative test, simulating the real case in cryogenic temperatures. By the way, after witnessing the cold shock test, the customer included our cryogenic test procedure in their valve specification. In addition we successfully completed the pre-qualification process. Now, we have been approved to provide a proposal for the engineered cryogenic isolation valves for the engine testing facility. The fuel on engine testing was specified as a mixture of liquid oxygen −320°F (−196°C) and liquid hydrogen −425°F

(−254°C); by the way, the temperatures were given at design conditions, "hey those are very cold applications!" [laugh]. The valves on each medium need to be closed after completion of 90 seconds test, within 0.5 seconds, very quick. When the valves in each line are closed, they have to remain tight. In that condition the valves in the upstream side of the pipeline face the extreme cryogenic temperatures and the valves in the downstream side of the pipeline face ambient temperature. In case of any leakage through the valves the engine will be damaged. This will have a huge financial impact on the customer as well as a loss of our reputation for their upcoming projects. The temperature cycle from ambient down to cryogenic in a very short time period creates tremendous thermal stress. The selected materials and the design of the isolation valves have to withstand this thermal cycle. Finally, we received the order from the customer to develop and supply the engineered cryogenic isolation valves in collaboration with them. When we presented the order for the approval to our divisional president, who supported us during the pre-qualification process, he commented, "wooww, the price of each valve is the price of a unique luxury car and the gross margins are nearly close to triple digits". Following successful completion of the delivery and commissioning, we received several additional orders from the same customer. This reference created additional business with another customer in Europe.

The respondent described his experience in the industrial valve business where they supplied engineered valves to secure the functionality of an engine during and after a test procedure in extreme temperature conditions. In this example, the key drivers of new product development are: providing a solution to customers for new product development for a next generation engine to simulate the real condition, to generate sales and profit, to build a long-term

relationship with a blue chip customer and to generate further business in this field with other customers. Providing innovative solutions to customers' critical problems builds trust and generates competitive advantages. Trust is one of the essential elements of customer retention as described in this example. In terms of social exchange, both parties benefited from the relationship and even the price of the products was not in focus in the first instance.

The sales president responsible for the Chinese market who has been employed for more than 17 years in several industrial valve manufacturers stated, as has been stated similarly before:

New product development is our DNA [laugh]. New products generate additional value for our customers. Sometimes, customers are not in a position to find a solution from available products in the market. Companies providing a solution to a customer will be the winner, will be the winner [he repeated this statement five times]. Of course, we will make money on that journey.

New product development capability and providing a solution to customers' problems not only creates value for customers but also for industrial valve manufacturers. Customer intimacy, value, quality and customer service are important elements in identifying customers' problems in their plant and in providing valuable solutions.

A petrochemical R&D manager who has been engaged in the industrial valve industry for more than 31 years referred to creating value for customers as follows:

We focused on new product development based on customers' requirements. We have been collecting data about the performance of our products and information on the competition's installed products. In addition, our maintenance and after sales team are monitoring the maintenance intervals and spare parts consumption. They are analysing the collected data from valve control panels together with our engineering team. This enables us to improve our products' performance and provide added value to our customers. For instance, in ethylene plants the end users have to perform maintenance after every five years of operations on installed equipment. But, due to the higher demand on plant output and stronger competition landscape, one of the ethylene plant owners requested us to extend the interval to seven years. We reviewed the design of the installed transfer and decoking valves with their process and maintenance engineers. Together we identified an upgrade opportunity for the installed valves. It is very important to say that if a valve fails before the maintenance interval, then the plant owner will lose around one million euro per day. This is a typical loss on unplanned shutdown of ethylene plants. We upgraded the design of installed valves in collaboration with the owner's team. The licensor of the plant was fully involved as well. During the operation we monitored the conditions of the upgraded valves. The valves now operate on extended maintenance intervals without any interruptions.

Close collaboration with customers on new product development in which customers actively contribute to product development is called co-creation (Mandolfo et al., 2020). In co-creation, customers and an industrial valve manufacturer have a defined common target to deliver a solution or product for an existing problem. In this example, the provided solution to the

customer's problem creates added value for the customer in terms of increased productivity and increased competitiveness.

An R&D manager in iron and steel working in the industrial valve industry referred to creating value in a similar way as follows:

Our upgraded blast furnace valve, designed for a critical application in a steel melting blast furnace, was a remarkable accomplishment. All of our customers in this sector were interested in installing the new generation blast furnace valve. Indeed, most of them installed it. This product generated tremendous revenue and profit increase but also created value for our customers, like low operational cost including less maintenance and less spare parts usage.

A longer lifetime of products leads to customer retention and to higher profit of manufacturers (Buttle & Maklan, 2019). Lifetime value in engineered valves is defined as the value which the installed engineered valves generate during their lifetime. The lifetime value of engineered valves is linked to the operational costs during their lifetime. If engineered valves need to be maintained more often than usual, then the related operational costs will be higher than planned; consequently, the lifetime value will be lower. In unplanned maintenance of engineered valves in a plant, the plant has to be shut down. In an unplanned shutdown of a plant, the economic loss of the plant is significantly higher than the cost of the engineered valve itself. For this reason, customers select reliable engineered valves to avoid any unplanned shutdown and economic loss.

Identifying the key drivers to new product development to create value in the industrial valve industry was reviewed with the interviewees. An R&D director

who has worked for 25 years in the industrial valve industry stated in that context:

The main key drivers of new product development are based on our own market intelligence and on identifying customer problems. Our own market intelligence source is the information from sales, marketing, customers and licensors. Further, we have a database containing all process descriptions where our application engineers review the processes for new product development potential. In addition, customer requirements for specific applications are the basis of new product development. Moreover, the competitions' products or product range might be a driver for new product development. Sub-suppliers' new products could also be a driver of new product development based on their new products, such as materials, controls, automation. Digitalisation should be considered one of the latest key drivers of new product development. Communication and networking with key people, working with the licensor and end user, help better understanding of the market dynamics and potential new products development.

Market and process knowledge are essential to identifying the customers' flow-related problems; therefore, multilevel communication and relationships with well-chosen people from customers, potential customers, licensors and EPC companies need to be intensified. Networking with customers and sharing ideas and knowledge on a specific process will help a manufacturer to understand the flow-related challenges, to identify problems and to provide solutions.

A KAM who has worked for seven years in the industrial valve industry made similar comments about customer participation in new product development and he added:

New international and national standards can be drivers of new product development.

He continued:

A new product development process can be project-wise. In this case the customers have already placed an order for developing and manufacturing the new product. But, it can also emerge from our own internal gate process for our own internal new product development projects. In any case, the majority of new product development processes are based on customer projects. In some cases the process could be the combination of our own gate and customer project. For example, we decided to develop a new product for the delayed coker process in a refinery. Based on our market intelligence, we noted that one of the leading licensors in this field was not comfortable with the existing solution. We started the development process based on our own market intelligence with internal gate product development process. We communicated our intention to the licensor. The licensor was very interested in our intention and we agreed to collaborate on the new product development. During the development process, we had an opportunity together with the licensor to install the product in a delayed coker application. We presented the solution together with the licensor to the end user, who was very satisfied with our approaches. The end user placed an order even though the product was under development [proudly]. With that, the gate product development process turned into a customer product development process. The end user and the licensor participated actively in the development

process and shared their knowledge with our engineering team. Typically, before we start to collaborate with licensors, we sign a collaboration agreement. In this agreement the framework and conditions of the collaboration are defined. These types of agreements strengthen our relationship with the licensors. This put us in a position to develop new products for their upcoming new processes. The new product for the coker application was a great success.

New product development processes in engineered valves are dominated by customer projects instead of gate processes or a combination of both. The new product development process is not as rigid as Cooper (2017) described; it is flexible with a focus on utilisation of the customer's knowledge and experience. A customer's and licensor's knowledge and their participation in the development process are mandatory for a successful new product development.

A sales manager of oil and gas who has been engaged in the industrial valve industry for 19 years commented on entering new markets and customer satisfaction:

We introduced a newly developed top-entry quarter-turn cryogenic valve for an LNG receiving plant, "the design temperature is −164°C", to replace the ball valves. After successful installation at the first LNG plant, we received many inquiries from across the world for projected new plants. The LNG application was a new application for us. Indeed, the cryogenic version of the quarter-turn torque seated valve was developed in collaboration with one of our customers, a leading company in that sector. Ball valves are heavier than quarter-turn valves and require larger actuation. Quarter-turn valves with the torque seated

design are very compact and require smaller actuation compared to ball valves. The end user is in a position to build an LNG receiving plant that is much more compact, like less piping supports, less construction materials and at less cost than before. Now, the quarter-turn torque seated cryogenic valves have become very popular. We are generating a significant portion of our sales, actually xx% of our total revenue, from the newly developed top-entry quarter-turn cryogenic valves. Our experiences in the cryogenic field open additional business fields for us: liquefied nitrogen, hydrogen and in helium. Finally, we were in a position to increase the number of applications with this new product, which includes the space industry. Nevertheless, to provide value to the customer you have to be in a position to understand their flow-related processes and the actual problems they face. More than 200 processes served by 35 licensors are available in our databank. Our application engineers review these processes in detail based on these inputs as well as from our sales team. The target is to identify the best solution [laugh].

Substitution is one of the driving forces of industrial competition according to Porter (1980). Substitute products that deserve the most attention are those that are subject to trends improving their price–performance trade off with the industry's product or are produced by industries earning high profits (Porter, 1980, p. 24). Substitutes in product development increase competition in the industrial valve industry and lead to price and performance improvement. In this example, the existing product was heavier and the actuation was larger. The newly developed product replaced the existing product because it was much lighter, more compact and the required actuator is much smaller. The overall cost and performance of the new product were much more attractive

for the customer than the existing product. Therefore, substitution can be considered a new product development driver.

4.5 Quality

The definition of quality according to International Organization for Standardization (ISO) 9000 is the "*degree to which a set of inherent characteristics of an object fulfils requirements*" (European Standard, 2015, p. 18). Garvin (1988) argued that quality should be seen from different perspectives and he segmented quality into five categories (Garvin, 1988, p. 40):

1- Transcendent definitions. Transcendent definitions are personal and cannot be defined precisely. They are perpetual but go beyond measurement and proper description. They are related to concepts such as beauty.

2- Product-based definitions. Quality is seen as a precise and measurable variable. The foundations for measurement are objective attributes of the product.

3- User-based definitions. Quality is a means for customer satisfaction, how the product fulfils the customer's expectations. This makes these definitions individual and partly subjective.

4- Manufacturing-based definitions. Quality is seen as conformance to design requirements and specifications.

5- Value-based definitions. These definitions define quality in relation to costs. Quality is seen as providing good value in relation to cost.

In terms of quality and engineered products, a president of one of the licensors who has 31 years of experience in the engineered equipment and process licensing business stated:

A newly developed engineered product or equipment is an outcome which fulfils defined needs; needs they haven't fulfilled before or in a different way, such as less effective. New engineered valves are judged mostly on their quality instead of brand and price. New engineered products in this industry are mostly related to the enhancement of the customer's abilities.

This respondent who has 31 years of experience working in the engineered equipment and process licencing business can be considered an expert. New engineered valves are judged on their quality and they need to fulfil all specified quality requirements. The quality requirements of new engineered valves are:

- Conformance with engineered valve design specifications.
- Performance of and fulfilment of specified functions.
- Operational excellence in order and manufacturing processes.
- Reliability of the engineered valve during the specified timeline.
- Durability and lifespan of the engineered valves in harsh conditions.
- Serviceability of the engineered valves.
- End users' perception of the engineered valves.
- Low operational costs and no unexpected plant shutdown caused by the new engineered valves.

One of the KAMs, who has spent more than six years working in the industrial valve business, commented:

A purchase order contract with our customers obliged us to deliver the specified engineered products, as specified and with defined quality. Also within the agreed time frame.

Customer satisfaction is linked to the quality of the engineered valves. In cases in which the defined quality requirements of the engineered valves are in line with the specifications, customer satisfaction will be higher. The quality requirements of engineered valves are typically specified in engineered valve specifications. The valve specification covers: the type of the medium, inlet and outlet pressure, temperature, valve size, pressure rating, valve type, valve body material, type of actuator, function of valve such as on/off; control; emergency close/open, leakage rates, inspection and test requirements. Furthermore, any additional equipment related with the actuation is listed in the valve specification. However, the valve specification covers only valve-related design features. Process-related information is also relevant in the selection of the valve design features. For instance, in a process where medium segregation is required to secure the adjacent equipment, a double block and bleed sealing system is required. This process-related information has to combine with the engineered valve specification to fulfil the quality requirements of engineered valves.

A sales president in China who has worked in the industrial valve business for 12 years stated:

Customer expectations are getting very tough: low pricing, at highest quality and shortest delivery time. In contrast, we face increased demand to solve customers' flow-related issues and problems. Usually, we are requested to follow the customer's tough specifications and meet their requirements:

reliable functionality and capable to withstand harsh conditions, justifying the outcome by intensive testing and quality requirements in design, manufacturing and testing phases are some examples.

A KAM similarly commented:

We are fulfilling the customers' expectations on quality and on performance with an optimum price performance ratio.

Customer satisfaction needs to be viewed from the customer's perspective; a customer's expectations have to be understood and the proposed solution has to focus on the satisfaction of the customer. Customer satisfaction has a positive impact on trust. Customers are willing to pay a higher price for the engineered valve solutions produced by a trusted supplier. However, in an environment with stiff competition, EPC companies in particular are searching for low-cost solutions. In such cases, some of the quality requirements for engineered valves are cannibalised in order to save costs. For instance, the low operational cost of engineered valves is not a quality criterion for EPC companies. EPC companies focus on the execution of the plant; following a successful start-up and performance acceptance test, the plant will be transferred to the end user. The end user is responsible for operating the plant and a low operational cost is an important quality criterion for the end user. In such cases, pre-qualification with the licensors and end users will help consideration of which quality criteria are important to licensors and end users in the engineered valve specification. When quality requirements are included in the specification of licensors and end users, the EPC companies have to consider the criteria at the procurement stage.

A sales engineer who has worked in the industrial valve business more than six years commented:

The customers' main focuses are receiving high-quality reliable products, full after sales service capability and low operational costs. Our strong reference lists give a good overview of our performance and meeting the quality requirements on critical applications. Most of our customers see us as a reliable partner.

Reference lists about proven performance in critical applications are evidence of the performance of a reliable industrial valve manufacturer. New and/or potential customers are interested in an industrial valve manufacturer's performance track record.

Another sales engineer who has worked for six years in the industrial valve business similarly stated:

We have significant competitive advantages. We are perceived as a trusted partner by our customers, where we provide additional value for their long-term success. Most of our competitors are recognised as qualified vendors by customers. In fact, they lack a proven track record on close collaboration with licensors and on technical expertise. This is mainly to drive the competition on project business to compare the pricing and added value between the trusted partner and qualified vendors. End users look for quality, availability and reliability in the first instance. Further, customers audit the financial capability of engineered valve manufacturers. They like to make sure valve manufacturers are in a position to execute large-scale projects as well to drive the new product development process. Most customers qualify manufacturers

on their financial capabilities. They are confident that this is related with the performance of the manufacturer.

Providing value to customers for their long-term success creates competitive advantage, which leads to becoming a trusted partner of customers. Some competitors are classified as qualified vendors; however, due to a lack of technical expertise, proven references and close collaboration with licensors, they are ranked lower than a trusted partner. To become a trusted partner of licensors creates a competitive position. In any case, the proposal of qualified vendors will be considered to review the performance of the trusted partners. Quality, availability and reliability are significant factors for selecting the right engineered valve manufacturer, where financial strength also becomes important in the execution of large-scale orders. Financial strength is one of the tangible resources of an organisation to gain a competitive advantage (Grimm, 2005; Mamoun, 2012).

An area sales manager who has worked for 22 years in the industrial valve business stated:

One of our customers, end user, has to replace valves originally installed by the competition. They failed shortly after the commissioning of the plant. The end user told us that the competition's product was selected by EPC during the construction phase. Originally, we proposed to the EPC too, however, our proposal was more expensive than the competition's. Now the installed valves do not perform well. We reviewed the process together with the end user and came to the conclusion that the originally installed valves cannot perform. The design of the valves shows lack of knowledge of product selection for that very abrasive and corrosive process. We reviewed our originally proposed design

details with the licensor and end user. Our proposal was based on a solution which was developed before for a similar abrasive and corrosive process. We selected a resistance material and we upgraded the seat design according to advice from the licensor. We manufactured one of the upgraded engineered valves and delivered it for a test at the end user's site. The test procedure was specified by the licensor on that application as agreed. Following a successful test result we received the order from the end user to replace all the originally installed valves. There was one additional request from the end user that we had to fulfil, the newly developed engineered valve should be delivered within 20 weeks instead of 36 weeks as we proposed. You know, because of a lack of knowledge on product selection, this action cost the licensor and end user a lot of money; of course, including the premium for acceleration of the production capacities! The licensor adapted the valve specification according to what we supplied for future projects.

Process knowledge and the selection of engineered valves for critical processes are key elements in solving customers' flow-related problems. A lack of knowledge of flow-related processes can cause extra financial costs. Furthermore, this could lead to loss of reputation for the involved parties.

A sales manager responsible for petrochemical business who has served in the industrial valve business for 14 years stated:

Product differentiation is an important factor creating competitive advantage. Building up product differentiation is to offer improved quality that enables the customer to create additional value. This cannot be achieved by purchasing other products.

Fulfilling the quality criteria of licensors and end users creates additional value for them. In engineered valves, product differentiation (Kotler et al., 2019) is required to win new customers and market share. Typically, customers who are satisfied with their current engineered valve supplier will not want to change supplier unless the new supplier offers significantly higher benefits than their existing supplier.

An R&D director described his experience of the connection between customer value and customer retention as follows:

One of our customers in the nuclear power industry faced a serious issue. The financial position of the qualified and contracted industrial valve supplier was not good enough and they filed for bankruptcy. The supplier informed them they could not fulfil the contractual obligations for several projects in APAC region any longer. The ordered valves were specified for critical application within the nuclear power plant. Actually, we had never been in the nuclear power plant business before. For this reason we never followed any business opportunities in that field. During a call from our joint venture company, we were informed about the situation. We decided to visit the customer for a meeting. The customer is a consortium of a several companies; we presented our company and the product offerings for critical applications. Following the meeting we received specifications to prepare and submit a technical and commercial proposal. During the meeting we learned that we have to perform a valve performance test to qualify. We reviewed the received specifications and the test procedure with our engineering team, including with nuclear plant experts. Finally, we decided to submit our proposal. Our proposed design had three main advantages against the previously qualified supplier products.

First, robust design where the valve will be in operation at a specified earthquake level. Second, low operation torque requirements, which enabled use of smaller actuation than previously. And third, material source, we proposed plate material rather than casting material, which is a robust design and has a two-week lead time instead of six months. We also underlined our strong financial capabilities to handle such large projects as confirmed by our stakeholders. We presented our technical and commercial proposal to the customer. In this case the customer is the contractor but influenced by the licensor, by end user, by local authorities and by third-party inspectors. The independent third party represents the interests of all involved parties in that project. They will fully witness the manufacturing process and testing process at the manufacturer's and their suppliers' locations. During the proposal review meeting, we agreed to simulate two different sizes of valves representing 30 years' operations based on the customer's qualification process. The test procedure was very challenging. We had to test the functionally of the valves by cycling, followed by seat test in ambient and in elevated temperatures. The test took 96 hours without any interruptions [phuff]. We successfully passed the demanding test process. Finally, we received the order to deliver the newly developed engineered valves. The first batch of valves were delivered [sounding proud], including the sub-supplier qualification, design certification by an independent engineering consultant qualified by licensor, manufacturing and final tests witnessed by the third party contracted by the end user and completion of demanding final documentation within 6 months. The second batch of valves were delivered 3 months later. This was based on great collaborative work with all involved parties, including our sub-suppliers, without any compromises on very hard specifications.

Following, we received, based on the frame agreement that was signed during the execution of the first order, many additional orders to supply xx nuclear power plants. The provided engineered valve is now included in the main specification of the licensor. Actually [sounding very proud], this is one example from many others that we have been involved in, solving customers' problems.

This respondent gave an example (during his explanation he sounded very proud about what was achieved) from his experience in the industrial valve industry related to customer relationship and solving their problem. The pre-qualification process of a new supplier that provides products in critical applications is a challenging process for the supplier (Kapp, 2019). Customers like to make sure that the new supplier is in a position to fulfil the quality requirements and their expectations. Typically, customers who are satisfied with their existing supplier do not want to change their existing supplier unless there is a potential risk associated with the existing supplier's business and performance. The pre-qualification process includes a product performance test based on customers' specifications. The product performance test process is usually a complex and time-consuming process and the supplier has to invest in the costs of this test process. Since the test results play a significant role in supplier acceptance and non-acceptance, the supplier has to be well prepared to complete a successful pre-qualification process and the specified product performance test. If the supplier fails the pre-qualification process, then customers will not use that supplier in their future projects and re-starting a pre-qualification process with the same customer is nearly impossible.

A R&D director who has worked for 25 years in the industrial valve industry talked about new product development processes as follows:

We have four different processes on new product development: 1, gate process; 2, short gate process; 3, project based; and 4, mixed, gate and project-based new product development processes. On all four processes the new product development process begins with a market overview, market size, five years' sales and profit forecast, the benefits of the new product and ROI calculation. Customers are involved in gate processes; however, the new developed product could be sold after successful completion to all customers. On project-based new product development the customer already placed the order and the customer is part of the development process. Nearly 80% of our new product development processes are project-based processes, the remaining are gate and short gate processes and mixed between the gate and project-based new product development process.

This respondent has been working in the industrial valve industry for 25 years and can be deemed an expert in the industrial valve industry. On project-based new product development the failure rate of new products is very low. It is in the common interest of the customer and the industrial valve manufacturer to successfully complete the new product development process in order to solve the customer's flow-related problems. Therefore, the failure rate on a project-based new product development process is significantly lower than the failure rate on a Stage-Gate process, which Cooper (2017) stated was in the range of 25 to 45%.

4.6 Customer Service

Customer service is defined as providing service to the customer, before, during and after the purchase of the product (Matthews & Schenk, 2018, p. 42). This research reviewed customer retention under customer service because establishing a long-term relationship and customer service are important elements of customer retention (Venetis & Ghauri, 2004). In this research, customer service is categorised as sales, procurement, order execution and after-market (AFM) service.

Business opportunities were categorised by a sales engineer who has worked in the industrial valve business for nine years, as follows.

Within targeted markets, we categorise projects as:

1. *New construction, where the plant will be built completely new, also called greenfield project.*
2. *Upgrade, where the end user modernises an existing plant or increases the capacity of an existing plant, also called brownfield project.*
3. *After market and service, where we provide spare parts, and in-house and field service for our install basis. We also provide service for the competition's products in critical applications.*
4. *In addition we provide technical consultancy and training on engineered valves and their applications in different flow-related processes.*

Customer service in the industrial valve business begins with the acquisition of the projects and continues after the delivery of the engineered valves. Therefore, customer service should be considered in three stages (Matthews

& Schenk, 2018). The first stage, is the pre-order phase, where the customer and industrial valve manufacturer exchange information about the customer's identified flow-related problems and the provided solutions. The pre-qualification process and the submission of technical and commercial proposals are part of customer service in the pre-order phase. Second, is the order execution phase, where the customers and industrial valve manufacturer collaborate on design, engineering, procurement, manufacturing, testing and logistics of the produced engineered valves. The third phase is the follow-on phase, where the industrial valve manufacturer provides after sales service and maintenance and follows the performance of the delivered engineered valves. All three phases are equally important for customer satisfaction and customer retention.

A sales and marketing director who has worked in the industrial valve business for 15 years classified customers in the industrial valve business as follows:

The customer is the organisation who is ordering and paying the bill on engineered products. We are obliged to manufacture and deliver specified engineered products to them. They are EPC companies or end users. The difference between them is: an EPC company builds the plant on behalf of the end user, whereas an end user builds the plant themself for their own purpose. The procurement behaviour of both of them differs: an EPC company looks for a low-cost solution, whereas the end user looks for a long-term solution where the life cycle cost of the product is more important. Licensors are not our direct customers; however, they play an important role. They qualify and approve our company's capability for specific processes. For this

reason, the qualification of our products and organisational competence by licensors are essential. Only after qualification and approval by licensor can we approach potential customers, especially on midstream and downstream projects.

The EPC company is the key player in the execution of a project for the end user. The type of contractual agreement between the EPC company and the end user will affect the industrial valve company in terms of doing business with the EPC company. In a lump sum type of agreement (Kapp, 2019), the EPC company has to execute the project for a fixed price based on an agreed specification. The end user has to approve any deviations to the specification, such as material, design and/or supplier, before the execution. In lump sum projects, the industrial valve manufacturer should be approved for the project and should be listed in an approved supplier list prior to the EPC company being awarded execution of the project. Since end users are very restrictive regarding approval for any deviations, it is very difficult to approve any additional industrial valve manufacturers during the project execution stage. In a reimbursable type of agreement (Kapp, 2019), the EPC company has the right, within defined tolerances, to execute deviations without the approval of the end user. In this case, an industrial valve manufacturer has opportunities to qualify its products during the execution of the project. In both types, lump sum and reimbursable agreements, the EPC company's procurement target is to search for a low-cost solution where the products fulfil the applicable specifications.

A R&D manager responsible for the oil and gas business who has worked for 17 years in the industrial valve business stated:

We need to understand the customer's challenges and problems on their flow-related processes. Open communication with the customers and listening to them are very important, to identify their problems. We collect all necessary information from the customer and analyse the issues with our application engineers to create a proper solution. For example, in a refinery on isomerisation process where the reactors need to be isolated, a customer was searching for a solution for this demanding application. We approached the customer through our sales network and analysed the process with the customer, licensor and with our application engineers. All the required design features were reviewed. We worked out a solution which needed to be developed further. Following our presentation of the solution to the customer and licensor, they accepted the solution. Actually, we were able to demonstrate that the provided solution would fulfil the process requirements. After installation we monitored the performance of the newly developed engineered valves. The customer was very satisfied with our performance and provided services during the order execution and on commissioning of the plant; so, that customer published a case study including our provided product details and services for that application.

Open communication and listening to customers and licensors are essential to understanding their problems and needs. Therefore, to have the knowledge to be able to provide the correct solution to the customers' flow related problems is crucial for an industrial valve manufacturer.

A KAM responsible for the petrochemical business and working for 23 years in several industrial valve companies commented on purchasing channels in the context of new product development:

The purchasing channels of our engineered products are complex. When a new project is announced, the time from the announcement until receiving inquiries for engineered valves takes between two and five years. During that time, we have to make sure to communicate closely with all involved parties on this project, such as the licensor, EPC company and end user, and project management consultant if they are involved. [Hmm] The purchasing process on industrial valve business starts with the licensors and ends with the end user. The decision power for the selection of the engineered valves is mainly dominated by the licensors. In any project, the valve suppliers need to be "actually have to be" qualified by the licensors before the purchasing process begins. Sometimes, EPC companies or end users invite non-qualified suppliers in order to create competition between qualified and non-qualified suppliers. Suppliers qualified by licensors could have a higher price, because of the following three reasons:

- *First, the qualification process with the licensors for the specific process takes time and costs money and needs to be invested before receiving any inquiries.*
- *Second, the qualified products and manufacturers are listed as key equipment on licensor process where the licensors only grant performance of their processes if qualified equipment is used.*
- *Third, based on the collaboration agreement with the licensors, if the qualified supplier wins the bid, actually this happens in most cases, the supplier agrees to pay 3 to 5% of the project sales price as an incentive for the licensors. This is also why we don't have any sales agents or re-sellers since licensors promote our products based on mutual interests.*

This respondent with his experience in the industrial valve industry can be considered proficient in this field. The procurement process of engineered valves typically has three main steps. The first step is the qualification process at licensors and end users. The product selection process and production capability of industrial valve manufacturers need to satisfy the licensors and the end users. The qualified industrial valve manufacturers will be added to the project-specific approved supplier list. The second step is the bidding process where industrial valve manufacturers are invited to submit their proposals for the specified products. Usually, most of the qualified industrial valve manufacturers have a frame agreement with the end users so that the proposals will be based on the existing frame agreement. The third step is the execution of the order. The industrial valve manufacturers have to deliver the specified products under agreed contractual conditions.

An engineering manager with 16 years in the industrial valve business stated in relation to customer's order execution:

The customers and licensors are part of the order execution process, such as on pre-engineering, engineering and on approval of the design. Following the design freeze, we can start with the purchasing of the material. Afterwards, the manufacturing of the engineered valves will start. The manufacturing process and the final test as specified are controlled by the customers and documented in ITP. Since we are proceeding in that way the definition of the product is engineered products and it is important to say they cannot be copied easily.

The licensors and end users are fully involved during the order execution. Design verification and approval, manufacturing process, quality control and

defining the acceptance criteria, and final test and acceptance are the areas where the licensors and end users are involved. Jointly with industrial valve manufacturers, licensors and end users develop an Inspection and Test Plan (ITP) that describes the steps, the involvement and acceptance criteria of licensors and end users.

A sales manager with 12 years of experience in the industrial valve business similarly stated:

Most of our products that we deliver to the customer could be defined as new products since all engineered valves are designed according to customer specifications. We have collaboration, technology and frame agreements in place with the end users and licensors. Those agreements define our role as manufacturer of engineered valves, delivering the latest technological solutions for their future projects.

Most of the engineered valves designed for specific applications are new products, since they have new design features to fulfil the process-specific requirements. The products are designed according to the customer's specifications and there are frame agreements in place with the end users and licensors. The frame agreements allow delivery for the customer's future projects using the latest technology.

One of the sales engineers, who has six years of experience in the industrial valve business, commented on the expectation of customer service:

We are facing an increased number of requests from our customers. They have problems with the originally installed valves. The problems are mainly performance related; like higher leakage rate than specified due to the higher

wear of the valve seat, the function of the valve fails where the drive shaft stacks due to less clearance between the shafts and bearing in elevated temperatures and on temperature cycles. The valve blocks due to polymerisation of the media where the valve needs to be heated to a certain temperature with the heating jacket to avoid any polymerisation of the media, the valve has strong vibration during the opening and closing where the actuation of the valve is not able to operate the valve due to less torque/force output than required. All of these problems occur due to lack of process and application knowledge, lack of valve type and actuation selection for the application, design error and lack of testing capabilities. In addition, the price pressure mainly driven by the EPC companies results in poor selection of valve in critical applications, if it is not specified properly by licensors. Nevertheless, problems at the plant during its operation causes more costs since the plant must be decommissioned many times because of the low performance of installed valves. In those cases our technical experts support the customers on selection of the proper valves for the application.

Lack of process knowledge in the selection of the right solutions and budget limitations at the purchasing stage of the engineered valves are the factors that cause high costs to the end users. An unplanned plant shutdown due to the upgrade or replacement of the original installed valves will create additional loss for the end users. Therefore, the operational costs of engineered valves in a plant are one of the important factors in the selection of engineered valves.

One of the KAMs in the petrochemical business stated:

I am convinced that customer retention is related to customer intimacy. When we help to solve the customer's problems and keep them happy [laugh], we have already won their respect. Customer retention means that the customer will contact us at any time when they have any problems to be solved and on their future projects. In addition, if we solve a customer's problems and they are satisfied, then they promote our capabilities.

There is a connection between customer retention and customer intimacy and many respondents mentioned this in a similar way. Understanding a customer's flow-related problems through customer intimacy and solving their flow-related problems with a newly developed engineered valve lead to customer retention.

A project manager who has worked for eight years in the industrial valve business commented:

The way of driving customer retention is fulfilment of contractual obligations in terms of quality, on time delivery and on agreed price. Typically, we sign frame agreements with our satisfied customers, on our performance, where all order- and product-related terms and conditions are defined.

Industrial valve manufacturers and end users of installed engineered valves face stiff competition; therefore, industrial valve manufacturers have to create value for their customers. By creating value for their customers, industrial valve manufacturers are in a position to gain competitive advantages. Creating value for customers will also help industrial valve manufacturers retain customers, since their customers benefit from the solutions they provide.

One of the sales engineers with seven years' experience in the industrial valve business stated in terms of retention:

The success factors on customer retention have two dimensions: one, that the customer will contact us at any time when they have any new projects where flow-related equipment is required and they face problems that need to be solved; two, the customer will start to promote our capability for providing solutions in critical applications in order to win new customers.

Customer retention will also generate value to the industrial valve manufacturer, in forms of engagement, such as repeat orders from the same customer and customer promotion and marketing of the capability of the industrial valve manufacturer. The customer promotion will lead to the winning of new customers and it will increase the brand value of the industrial valve manufacturer.

4.7 Discussion of Factual Findings

This section furnishes a detailed description of the major themes that came out of the research. It discusses the drivers of new product development, new product development process, co-creation, purchasing behaviours and channels, and customer retention in relation to four themes: customer intimacy, value, quality and customer service. As the interviews indicate, new products are important to increase competitive advantage. New products are vital for sales and profit growth. These outcomes are supported by the literature on new products (Brown & Eisenhardt, 1995; Tabassum & Ozuem, 2019).

The current research considers key drivers of new product development, and new product development and customer retention, for engineered products in the industrial valve industry; interviews indicated that human relations are essential to new product development. Open communication with customers leads to the capture of their needs and expectations. A sales and marketing director stated:

You need to know your customers better than they know themselves.

This statement underlines the importance of multilevel communications with the customer in the industrial valve business. A sales and marketing director described the main areas of targeted communication:

The upcoming projects and locations, planned key investments, are we listed as preferred supplier, if not how will the pre-qualification process be performed, new product development opportunities, what are the key flow-related problems, our performance level compared with competition's performance level, opportunities on maintenance including the competition's products, who are their main competitors, are the main areas which we are communicating about with our existing and potential customers.

Close communication with customers and customer intimacy will lead to understanding the customers' behaviours, such as on future investments, on selection of processes and on selection process of suppliers. Customers' previous experiences and problems will help understanding of customers' expectations.

The drivers for new product development in the industrial valve industry indicated in interviews are supported by the literature. Nevertheless, one factor was repeated by respondents several times during the interviews:

identifying and solving customers' problems are the main drivers for new product development. An engineering manager in this context stated:

Most of our new products were developed to solve customers' flow-related problems in critical applications.

Business president Americas added:

On solving a customer's flow-related problems with a new product we also seek additional opportunities with that newly developed product for similar applications.

There are additional interests beyond solving customer problems; they are mainly company's growth, sales and profit increase and gaining market share as indicated by other respondents.

The key drivers of new product development in the industrial valve industry are listed in Table 4.7-1 based on the results from the interviews.

Key drivers of new product development	**Source of inputs for new product development**
Customer requirements	Market intelligence, sales organisation
Customer problems	Information from sales, marketing
Customers' new process development	Process database
Increasing life cycle	Collecting data about the performance of products
Substitution of existing solution	Maintenance and after sales team input
Competition	Participating in application-driven conferences and sharing opinions and ideas
Technological advantages	Sector-based and application-based
Digitalisation	
Company strategy	
Sub-suppliers' new products	

Key drivers of new product development	Source of inputs for new product development
New international and national standards and legislation	conferences Voice of customers

Table 4.7-1: Findings on key drivers and sources of new product development in the industrial valve business

Sharing knowledge, opinions and ideas during regular communication with the customer can generate opportunities for new product development. Customers' new process development, where they require new products for flow controls, may create new product development opportunities. The interviews indicate that product life cycle extension in critical applications is also a driver for new product development. This finding contradicts the literature, where one of the four main drivers of new product development was the shortening of a product's life cycle (Trott, 2017; Cooper, 2017; Ulrich et al., 2020).

The interviews indicate that new product development leads to customer retention. Several examples showed that solving a customer's problems with a new product generated additional business, such as new orders and signing frame and technological development agreements, with the same customer. Figure 4.7-1 shows how new product development can generate customer retention based on the defined themes of customer intimacy, value, quality and customer service of this research.

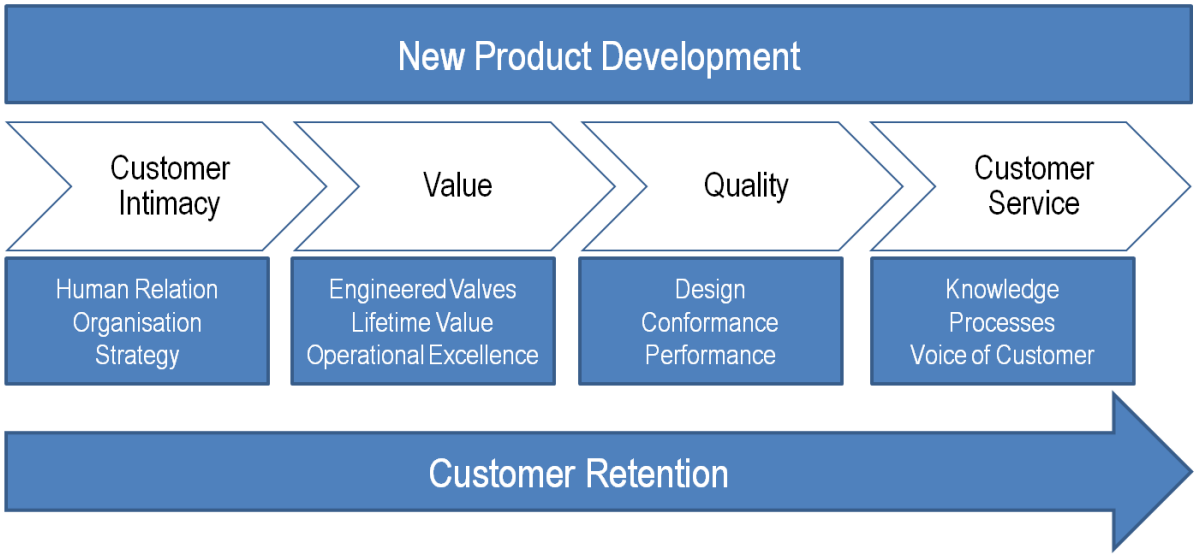


Figure 4.7-1: New product development and customer retention

The interviews indicate that most new product development processes are based on projects in the industrial valve business. The customer places orders to solve their identified problems where most of the provided solutions are based on new products. Figure 4.7-2 shows a project-based new product development process. The customer is fully involved during the new product development process and their involvement in project-based new product development is essential for a successful result. Customer knowledge and historical experience of the processes in the installed equipment are key elements in a project-based new product development process.

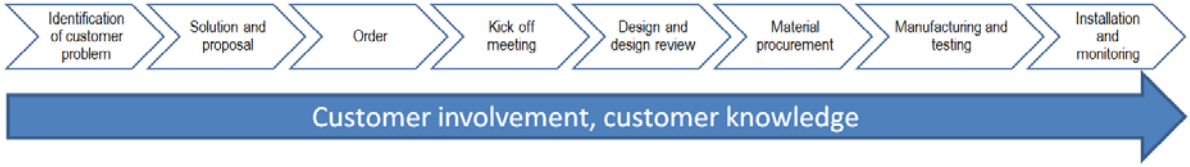


Figure 4.7-2: Typical project-based new product development process

One of the outcomes of this research is the role of influencers in the industrial valve industry. Licensors typically do not procure any equipment or build any of the plant (Kapp, 2019). Licensors who own flow-related processes may dictate which product should be installed on a specific process. Licensors qualify products and manufacturers for a specific process to make sure that the process will perform in accordance with specifications. The role and position of licensors are illustrated in Figure 4.7-3.

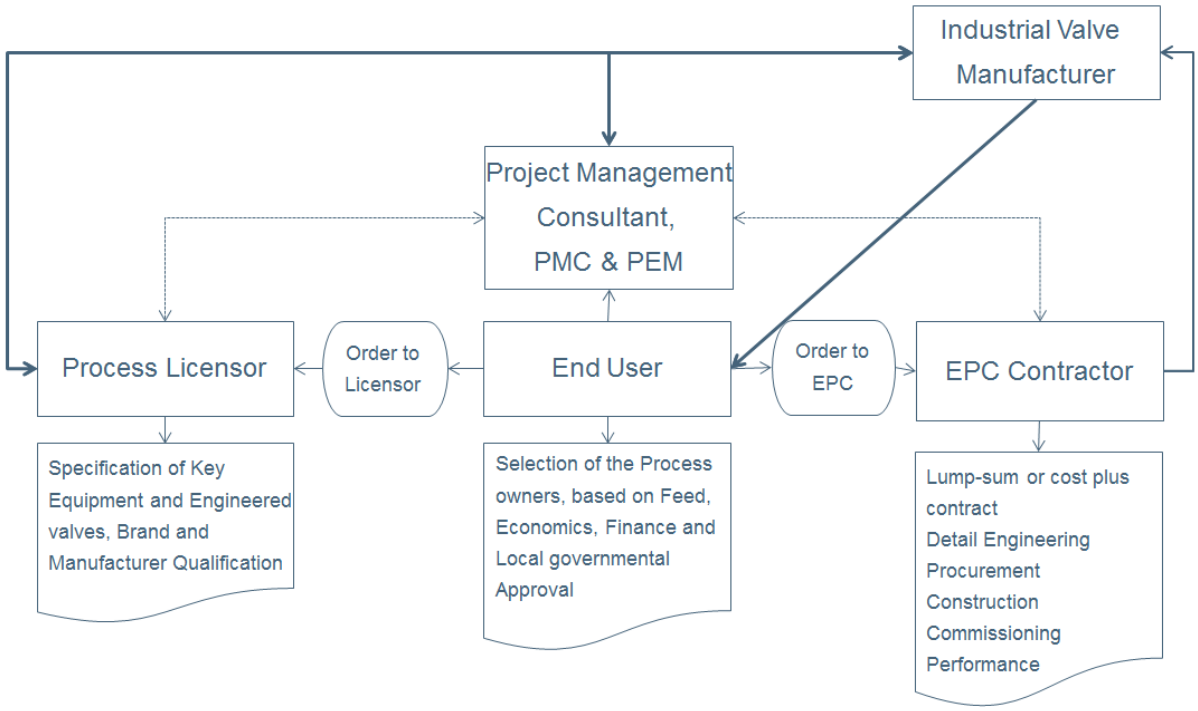


Figure 4.7-3: Process licensor influence on product selection. EPC engineering, procurement and construction; FEED front-end engineering design; PEM project engineering management; PMC project management consultancy

Typically, a process licensor provides the appropriate process under a licence agreement to the end user. The PEM is involved in process selection together with the end user. After selection of the process licensor, the main

specifications for key equipment will be completed. Based on a licensor's specifications and end user's requirements, the selected EPC company will build the plant. Industrial valve manufacturers need to start communication with the licensor, the end user, the PEM as well as the EPC companies in advance in order to be listed on the approved vendor list. When an industrial valve manufacturer misses an opportunity to be listed on a specific project approved supplier list, there is very limited opportunity to be listed after the EPC company receives the order from the end user. Only in some cases when the EPC company is contracted on a cost-plus (reimbursable) basis to build the plant is an industrial valve manufacturer in a position to be listed in agreement with the end user and licensor.

Licensors are also involved in the qualification of the potential equipment suppliers and their product range. Knowledge of the processes and experience in that field are important factors to attain qualification. A KAM described the pre-qualification process as follows:

In a liquefaction of natural gas (LNG) plant, deep knowledge of cryogenics and cryogenic processes is very important. In this process, engineered valves control and shut down the cryogenic fluid at −164°C. The typical qualification process of engineered valve manufacturers in oil and gas, power, nuclear and petrochemical industries contains the following steps:

- *Pre-screening including financial performance.*
- *Visit and audit at manufacturer sites, related to health and safety, design, manufacturing, testing and quality assurance.*
- *Typical product test related to the application.*
- *Compliance process.*

- *Pre-qualification as approved supplier.*
- *Qualification for specific projects and applications.*
- *Technical evaluation.*
- *Commercial and technical non-binding proposal.*
- *Listing on projects and applications.*
- *Definition of the partnership level.*
- *Long-term contract with licensor.*

Interviews indicate that the qualification processes are costly and time consuming. However, after suppliers have been qualified by licensors they are in a position to propose for on-going and future projects. Qualified suppliers have the opportunity to extend their relationship with licensors, such as signing technology agreements, to be part of the licensors' new process development process. Collaboration with licensors is based on mutual interests as indicated by respondents. In the case that a qualified supplier wins the business to supply the specified product, they pay 3 to 5% of the project sales price as an incentive to the licensor based on an earlier signed collaboration agreement with the licensor. On the other hand, licensors promote the supplier's products as qualified key equipment for their projects. Most industrial valve manufacturers do not have any independent sales agents. They are in direct contact with the licensors and with the end users, which has the advantage of gaining them understanding of the customer's problems and needs better than independent sales agents.

The purchasing channels play an important role in identifying new product development opportunities. A sales manager described the procurement channels as:

We have direct contact with our customers thanks to our global sales organisation. We know their procurement behaviours and their procurement processes. The main procurement processes that we face are: e-commerce, e-auction, tender and individual inquiry. We, as manufacturers of engineered valves, are involved mainly in tenders and individual inquiry processes. In addition, we have signed frame agreements with several customers where the product is in general specified, and the lead time and the commercial terms and conditions are defined.

The respondent stated that e-commerce and e-auction are not the main procurement processes they are involved in as a manufacturer of engineered valves. Those processes are mainly for standard products and for commodity valves, which are suitable because the products and their performance are standardised. The product specifications of engineered valves are developed during the tender and inquiry process. This could generate new product development opportunities. Table 4.7-2 shows which procurement channels can create new product development opportunities.

Purchasing Channel	**Description**	**Added Value on New Product Development**
E-Commerce	Commodity and standard valves with a defined specification could be ordered via e-commerce. The valve specifications are firm and cannot be changed during the e-commerce process	The added value is very limited, the valve manufacturer will develop some features on valves to improve the performance without knowing the benefit of their investment
E-Auction	Similar to e-commerce, the valve specifications are prepared before an invitation to an e-auction so that	The added value is very limited after the specifications are published in an e-auction portal.

Purchasing Channel	Description	Added Value on New Product Development
	there is no room to change the specifications	However, there is a good opportunity to influence the valve specification with a newly developed design feature during the preparation phase of the valve specification prior to e-auction
Tender	Customer publishes the basic data, such as scope of supply for the valves, and the specifications for the application. For the tender, invited valve suppliers will review and complete the specification to submit their technical and commercial proposals	The added value potential is good, the valve manufacturer will add to the technical proposal newly developed features where the benefits will be explained to the customer
Inquiry	The customer submits an inquiry for the requested valves including the drafted technical specification prepared by the customer for the required valves. The drafted specification describes the customer's flow-related problems	The added value potential is great, since the valve manufacturer has the opportunity to improve the specifications prepared by the customer to provide added value with the new products

Table 4.7-2: Effects of purchasing channels on new product development

4.8 Summary

Figure 4.8-1 shows the progression of this research after the analyses of data.

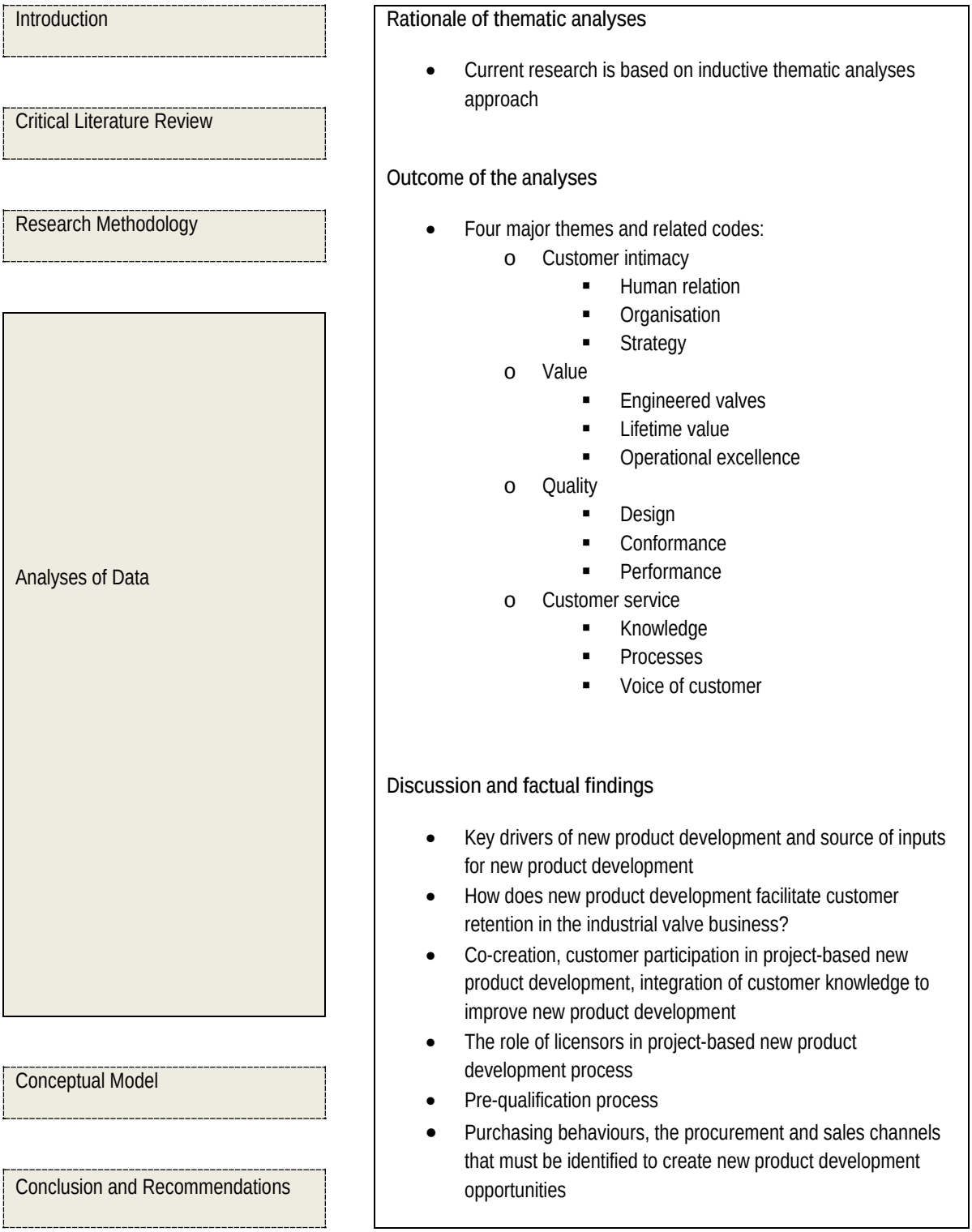


Figure 4.8-1: Summary of the chapter and progress of the research

This chapter has presented an analysis and discussion of research findings. First, it introduced inductive thematic analysis as a suitable data analytical approach. Then, it identified four major themes representing interviewees' perceptions of key drivers of new product development, and of new product development and customer retention. Furthermore, it addressed the additional research questions:

What are the key new product development processes and to what extent are customers part of this process?

How can co-creation processes integrate customer knowledge to improve new product development?

What are the key drivers of purchasing behaviour in terms of industrial valves, and what are the procurement and sales channels that must be identified to create new product development opportunities?

In the next chapter, the theoretical concepts that emerged from this research will be developed.

5. CONCEPTUAL MODEL

5.1 Introduction

The critical literature review (Chapter 2) set the foundation for this research about the taxonomy of new products and customer retention. Chapter 3 reasoned about how the social constructivist paradigm can provide an understanding of how new product development facilitates customer retention in the industrial valve business. The emergent themes presented in Chapter 4 explored and defended the epistemic choices for a new conceptualisation of new product development and customer retention in the industrial valve industry.

This chapter contains a presentation of key findings from the literature about key drivers of new product development, and new product development and customer retention. Furthermore, the factual findings from field research are summarised and a conceptual model is presented.

5.2 Existing Theory and Research

As described in the rationale for the research (Section 1.5), new product development has been widely investigated for standard and consumer products, which can be developed independently without customers' involvement. However, this conceptualisation does not take account of

engineered products or customer involvement and co-creation for new engineered product development. In the industrial valve industry, the customer decides to use a non-existent product and becomes part of a new engineered product development process. In this case, it is essential that the customer selects the right manufacturer that is capable of new engineered product development. Therefore, customers carry out an intensive pre-qualification process with potential manufacturers to determine their new product development capabilities. As the interviews indicated, the financial capability of the manufacturers is also part of the pre-qualification.

The findings from the interviews on key drivers of new product development and the source of inputs for new product development in the industrial valve industry are displayed in Table 4.7-1. Identifying and solving a customers' problems (as described in Section 4.7) was mentioned by several participants as one of the main drivers of new product development.

A significant proportion of the research on new product development processes focuses on structured approaches (Goulding, 1983; Cooper, 1983, 2017; Cooper & Kleinschmidt, 1993; Brethauer, 2002; Trott, 2017). Various structured processes and methods have been analysed and the advantages of those methods have been widely described in the literature (Cooper, 1983, 2017; Goulding, 1983; Kahn, 2013; Trott, 2017). Nevertheless, Oostra (2001) argued that a lot of energy has been put into generalisation of the new product development process; however, practitioners do not gain much from this knowledge. In addition, a majority of new product development processes do not include processes to identify customers' problems, needs and

expectations. The findings indicate that new product development of engineered products is driven by identifying and solving customers' problems. None of the new product development processes described within the literature considered solving customers' problems, starting from identifying the problem and finishing with delivering the new product. Customers' contract qualified engineered product manufacturers to develop a product that is a project-based new product development in order to solve their problems. Therefore, the project-based new product development process in the industrial valve business differs from the structural new product development processes described within the literature.

Stage and activity-based new product development processes dominate the literature. The Stage-Gate process specifies a series of key steps and each step has to be fully completed and aligned with the project specification before the next step starts (Cooper, 2017). The Spiral process considers the voice of customers to integrate customers' expectations into the new product design. An iterative validation with customers leads to fast prototyping (Cooper, 2008, 2017; Trott, 2017; Ulrich et al., 2020). The Network process is based on the accumulation of knowledge across an organisation with external inputs on new product development (Trott, 2017). A comparison of new product development processes described within the literature is summarised in Table 2.3-3. The main distinction of a project-based new product development process is customer participation in the entire new product development process. Furthermore, the developed product will be used to solve the customer's problems without any new product launch activities. The differences between

project-based and Stage-Gate new product development processes are summarised in Table 5.2-1.

Criteria	Project-based NPD process	Stage-Gate® NPD process
NPD initiation	Identification of customer problem	Idea generation
Scoping	Technical solution and proposal	Market and technical assessment
Business scope	Purchase order for NPD	Build business case
New product evolution	Kick-off meeting, design and design review and design approval	Development
Proving	Manufacturing and testing	Testing and validation
Final step	Installation and monitoring	Launch and marketing process

Table 5.2-1: Differences between project-based and Stage-Gate® new product development processes. NPD new product development

Project-based new product development starts with the identification of the customer's flow-related problems. A root cause analysis and open communication with customers and licensors support identifying the best solution to their problems. However, many solutions never address the root cause, as it can often be undiscoverable. Therefore, it is important to incorporate customers' and licensors' knowledge and experiences in the proposed solution in order to address real problems. In addition, sub-suppliers' knowledge is important in creating knowledge in collaboration with licensors and end users. In the next step, an industrial valve manufacturer usually provides a technical solution and a commercial proposal to the customer. Potential solutions, as interviewees indicated, are mostly a new

product. The potential solutions will be reviewed based on some design attributes with the customer and licensor prior to issuing the purchase order for developing the new product. The purchase order describes the role of the customer and licensor as well as sub-suppliers, and where they will participate during the development process, starting from design until the installation of the product. Their knowledge and experience will be incorporated in the new engineered valve design. During the kick-off meeting, application-related information, like flow and function of the engineered valves, is reviewed with all the involved parties. The end user's application-related knowledge, the licensor's process-related knowledge and the industrial valve manufacturer's product-related knowledge will be combined in a technical specification. At the end of the kick-off meeting the technical specification of the engineered valve will be finalised and the testing procedure will be completed. Followed the completion of detail design, the end user and licensor will review the design. After acceptance of the design and a design freeze, and the purchasing of the required material at sub-suppliers, the manufacturing process will start. The testing procedure of the newly developed engineered valve is also part of the project-based new product development process. Usually, the end user and licensor in collaboration with the industrial valve manufacturer describe the final testing procedure, including the acceptance criteria. The manufacturer of the engineered valve has to implement the required testing setup based on the described test procedure. The scope of the final test includes real application conditions, such as temperature, pressure, medium, number of cycles and cycle time, tightness through the seat and through the shaft sealing to atmosphere. The test process is important since developed new products are tested on their functional performance (based on the specification) at the

industrial valve manufacturer's testing facility and the real testing of new products is done at the customer's install basis. The final test at the industrial valve manufacturer's testing facility will be witnessed by the end user and by the licensor. The successful completion of the final test is the first indicator of compliance with the technical specification of the newly developed engineered valve. Finally, the newly developed engineered valve will be installed in the customer's plant. After commissioning of the plant, the performance of the newly developed engineered valve will be monitored.

Battor and Battor (2010) argued that the failure rate of new products is very high and nearly 50% of new products introduced each year fail. Ernst et al. (2011) suggested utilisation of CRM, which can provide customer orientation and customer knowledge during the new product development process, to reduce the risk in new product development and support a successful new product introduction. The interviews indicate that customer involvement during new product development is crucial for a successful new product introduction. This outcome (utilisation of customer knowledge) is supported by the literature (Battor & Battor, 2010; Ernst et al., 2011). The interviews indicate that customers fully participate in the new product development process due to their interest in solving their flow-related problems. In the case of the failure of a newly developed engineered valve, there will be significant damage to customers and to the engineered product manufacturers, such as loss of profit, loss of reputation and loss of future business. To avoid failure of a new product introduction to solve a customer's problems, customers select an industrial valve manufacturer carefully, performing a comprehensive pre-qualification audit, which is repeated periodically. Customers are only

interested in working with industrial valve manufacturers that have successfully completed a pre-qualification audit and are able to present solid references for successfully solving a customer's problems before. Furthermore, customers are involved in the design, manufacturing and testing to make sure that the developed product will solve their flow-related problems. Customer interaction on a project-based new product development process is illustrated in Figure 4.7-2. A successful new product introduction will lead to customer retention as the interviews indicate.

In general, the definition of the new product given in this thesis is supported by the literature. However, one of the outcomes of the interviews about the definition of a new product is the duration of new product development. Cooper (2017) argued that new product development took at least 50 person days (p. 25). The interviews indicate that new product development time and time to market need to be shorter in terms of gaining competitive advantage. No minimum new product development time was explicitly defined during the interviews; however, limiting the minimum duration of time for new product development could result in losing competitive advantage.

The role of the licensors in new product development was described during the interviews. The licensors have unique knowledge of the technology of specific processes (Kapp, 2019). The role of the licensors is to define technologies and the main system design in order to guarantee the output, reliability and efficiency of the process to the end users, as indicated in the interviews. New product development processes and co-creation are described in the literature with a focus on consumer products and their

consumers (Krishnan & Ulrich, 2001; Oostra, 2001). Licensors have an important role even though they are not the customers of industrial valve manufacturers. Licensors like to make sure that the developed product fulfils the process-related requirements because they are responsible for the performance of the processes. For this reason they do not play the same role as influencers in new product introductions of consumer products (Maden, 2018). However, they have to make sure that the equipment that is going to be installed in the process will meet the required performance. As the interviews indicated, licensors are involved in the pre-qualification process and review the organisational capabilities of the companies providing new engineered product development.

5.3 Experiential Knowledge and Exploratory Research

As the empirical findings indicate, identifying and solving customers' flow-related problems is one of the key drivers of new product development in the industrial valve industry. Identifying and solving customers' problems in collaboration with the customers is defined as co-creation (Prahalad & Ramaswamy, 2004).

The current research acknowledges Platzer's (2004) framework where providing new product development capability with identified technological advantages, production techniques and continuous improvements to quality are essential factors for engineered product manufacturers to increase their reputation and customer retention. However, the findings of this research also add to this knowledge. The current research identifies four major themes in

project-based new product development process that describe how new product development facilitates customer retention in the industrial valve industry, as illustrated in Figure 5.3-1.

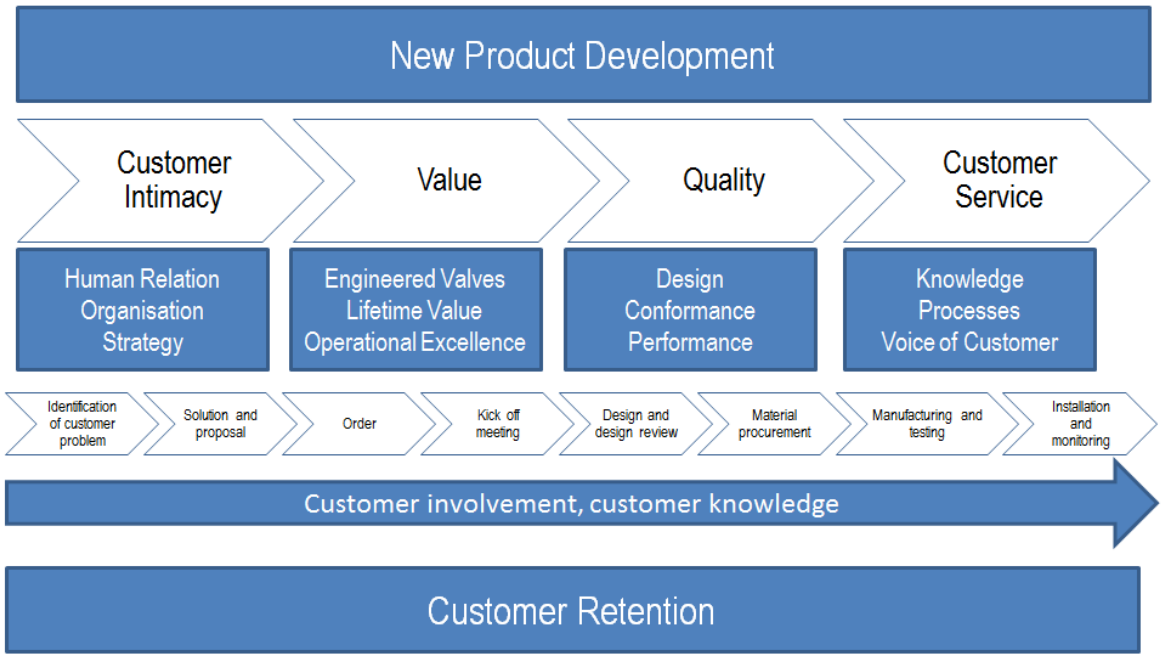


Figure 5.3-1: New product development and customer retention

Customer intimacy is related to human relations, organisation and the strategy of the manufacturers in the industrial valve sector. In human relations, communication with the customer and licensors as well as with related parties, such as stakeholders, suppliers and business partners, is important. Open communication is crucial to understanding the needs and the problems of the customers. Collaboration and sharing knowledge with the involved parties create value for customers. Organisations need to support actions related to customer intimacy. The sales organisation is focused on sectors where the company has their core competencies. A shorter time-to-market capability for new product introductions will drive a competitive position. CRM plays an important role in capturing the knowledge of the customers of engineered

products. Customer intimacy will drive companies' strategies on growth and profit. Participation in focused conferences will strengthen customer intimacy. Signed frame agreements with customers are evidence of the retention of customers.

Regarding the customer value of engineered valves, knowledge and innovation in that sector are important. Knowledge of defined processes in extreme conditions is essential to creating value for customers. The lifetime value will generate a premium price for engineered valves as interviews indicated. Operational excellence on new product development process and successful solutions that solve the customers' problems will reinforce customer retention.

The quality of function and safety in the problem solving of customers' flow-related problems and the process-related knowledge and design of the product play essential roles. The manufacturing processes and the testing of the newly developed product ensure the fulfilment of customers' expectations.

On customer service, knowledge of project-based new product development and understanding customers' needs and expectations are key elements in the success of a project-based new product development process. The voice of the customers and listening to the customers about their expectations drive the retention of customers and the signing of long-term agreements.

These four themes (customer intimacy, value, quality and customer service) together with the project-based new product development process and

customers' involvement facilitate customer retention. In a project-based new product development process, customer intimacy plays an important role in identifying customers' flow-related problems. Customers' process-related knowledge will support industrial valve manufacturers' capabilities to propose a solution. In project-based new product development project execution, the four themes of customer intimacy, value, quality and customer service play an important role in solving customers' flow-related problems. Customers and licensors participate in the project-based new product development process in order to complete the new product development successfully. Finally, successful completion of the new product development facilitates customer retention.

5.4 Conceptual Model

This research conceptualises a model of how new product development facilitates customer retention in the industrial valve industry as illustrated in Figure 5.4-1.

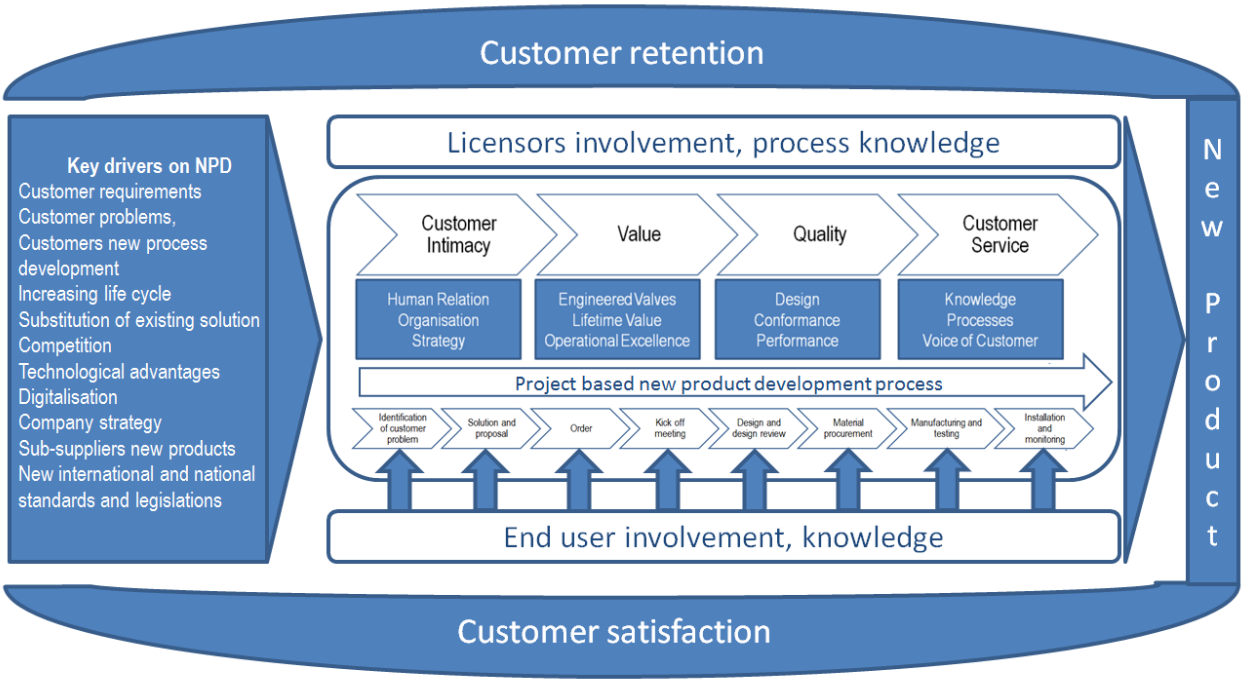
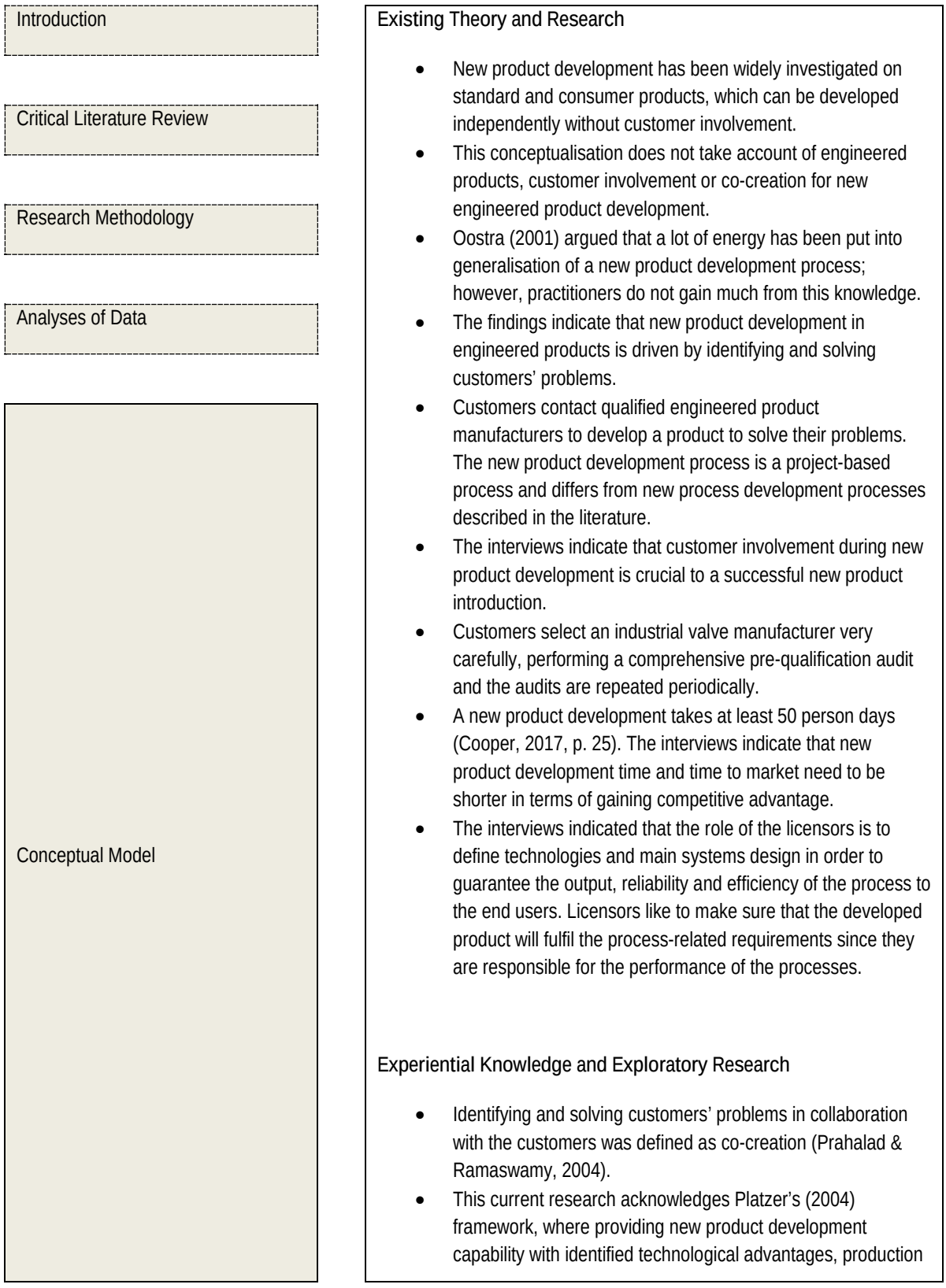


Figure 5.4-1: A new product development and customer retention model in the industrial valve business. NPD new product development

Customer retention is related to how satisfied the customers are with the solution provided by industrial valve manufacturers. Industrial valve manufacturers that correctly address the problems of their customers are in a position to retain customers. In any case, the implementation of the customers' (end users and licensors) knowledge and their experiences are fundamental to providing the right solution to customers' problems. The end users and licensors participate in the project-based new product development process. Providing solutions to customers' problems was defined as a key driver of new product development in the interviews. A new product development process is project based and end users and licensors are fully involved in a project-based new product development process. The four major themes are part of the project-based new product development process.

5.5 Summary

Figure 5.5-1 shows the progression of this research up to this point and the development of the conceptual framework.



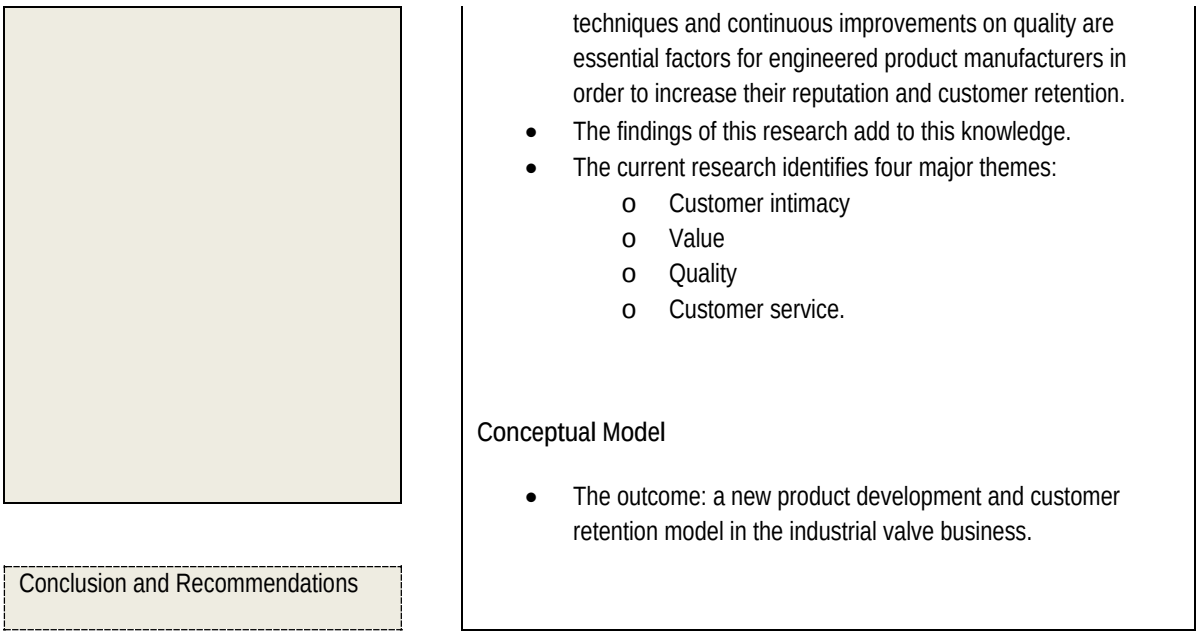


Figure 5.5-1: Summary of the chapter and progress of the research

Chapter 5 has presented an insight into existing theory about key drivers of new product development, and new product development and customer retention. It has synthesised the findings and has produced an original conceptual framework. Furthermore, it presents the exploratory research outcomes from empirical research. Finally, it presents a conceptual model of the current research: a new product development and customer retention model in the industrial valve business.

6. CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

The previous chapter presented the contribution of this research to extant knowledge about the key drivers of new product development and how new products can facilitate customer retention in the industrial valve business. This contribution was based on existing conceptual theories and new empirical findings. Thus, this research conceptualised a new product development and customer retention model in the industrial valve business as shown in Figure 5.4-1.

This chapter presents the conclusion to the current research. It discusses the contribution of this research to theory and to practice and it proposes some managerial implications. This chapter addresses the limitations of the research and how researchers can expand the scope of key drivers of new product development, and new product development and customer retention concepts in future research projects.

6.2 Conclusion

This research is concerned with understanding the key drivers of new product development, and new product development and customer retention in the industrial valve industry. This research examined the aims and objectives as

described in Section 1.3. The aims and objectives related to the outcome of this research are summarised as follows:

1- **Critically review existing conceptual models and theoretical issues relating to new product development and customer retention in the industrial valve industry.**

   Most literature on new product development focuses on standard, consumable products that can be developed without customer involvement (Oostra, 2001; Trott, 2017). In terms of industrial products, Platzer (2004) argued that providing new product development capability combined with technological advantages, production processes and continuous improvements on quality are important elements for manufacturers to increase their reputation and customer retention. A majority of industrial valve manufacturers focus on solving customers' flow- and process-related problems instead of only selling valves (Micheli et al., 2016b). Solving customers' problems drives a stronger relationship with the customer (Weaver, 2004). Nevertheless, there is limited research available in the field of new product development in industrial products and its effect on customer retention (Barczak, 2012; Preikschas et al., 2014). Field research indicates that new product development on engineered valves facilitates customer retention in the industrial valve business because the new products solve the customers' problems and address their needs (Sections 4.3 to 4.7).

2- Critically evaluate the importance of new product development to customer retention in the industrial valve industry.

The focus on new product development has increased in recent decades since industry has realised the value of the introduction of new products to the marketplace (Goulding, 1983; Bhattacharya et al., 1998; Bhuiyan, 2011; Trott, 2017). New products are important for businesses to survive, to compete and to drive organic growth and they strengthen the customer relationship (Trott, 2017). Brown and Eisenhardt (1995) argued that new product development is a potential source of competitive advantage for many companies. Industrial valve manufacturers operate in an increasingly competitive environment due to the recent global recession, which was driven by unstable oil prices, weak economic growth and political instability, and finally the coronavirus pandemic and Russia-Ukraine war. Industrial valve manufacturers realise the importance of new product development and have acknowledged that the number of new products introduced have increased their competitive advantage in the last decade (Brancaleoni, 2014). The interviews indicate that new product development leads to customer retention. Several examples of solving customers' problems (as described in Sections 4.3 to 4.6) showed that newly developed products generated additional business with the same customer. Figure 4.7-1 illustrates new product development and customer retention in the industrial valve business based on defined themes: customer intimacy, value, quality and customer service. Based on the findings of this research, new product development is the basis of customer retention in the industrial valve industry.

3- Identify the key success factors of new product development and customer retention in the industrial valve industry.

The key success factors of new product development in the industrial valve industry are summarised as follows:

a- Understanding customers' needs is an important factor for successful new product development (Sethi, 2000; von Hippel, 2001; Battor & Battor, 2010). The importance of understanding customers' needs for successful new product development was stated in the field research (Sections 4.3 to 4.6).

b- Successful new product development is related to how closely the developed product meets the customers' specification and requirements. (Cooper, 2017). The product specification should remain unchanged during the production stage for successful new product development (Kapp, 2019), which is part of the project-based new product development process described in Sections 4.5 and 4.7.

c- A successful new product meets the customers' expectations better than the competition's with a higher product quality and lower cost (Cooper, 2017), which is in line with the field research as described in Sections 4.4 and 4.5.

d- New products solve customers' problems in a more innovative way (Krishnan & Ulrich, 2001; Khan, 2006; Cooper, 2017; Kapp, 2019) than the competition's products (Sections 4.3 to 4.6). Solving customers' problems in an innovative way was also stated as a success factor for new product development in the industrial valve business during the field research (Sections 4.3 to 4.6).

e- Effectiveness (Cooper & Kleinschmidt, 1993), a focus on sharp and early new product definition (Cooper, 2017) and project-specific new product development, which is focused on solving customers' problems, were identified as success factors during the field research (Sections 4.5 and 4.7) and support theory.

f- Right timing on time to market (Bhattacharya et al., 1998), the speed of new product development (Bacon et al., 1994) and shorter time to market that is also earlier than the competition's, were repeated several times as success factors during the interviews (Sections 4.3 to 4.6).

g- Successful new product development depends on the quality of the product development process and execution of the planned actions (Cooper, 2017) in the context of the Stage-Gate new product development process. This also applies to project-based new product development on engineered valves (Sections 4.5, 4.6 and 5.2).

h- Successful new products deliver unique and real benefits to the users which are not available from competitors' products (Cooper, 2017). The examples described in Chapter 4, such as substitution of an inefficient product with an efficient product and testing newly developed engineered valves in real conditions, are defined as key success factors of new products and generate competitive advantage.

i- Technological synergies between the new product development team and dedicated resources, highly skilled project team (Cooper, 2017) and the competences of managing knowledge on new product development (Cabrera & Cabrera, 2005) are important for successful new product development. The field service outcome showed that highly skilled

employees and utilisation of synergies with customers are important to successful new product development (Section 4.3).

j- New product market attractiveness with a higher growth rate and higher profitability (Cooper, 2017) provide sustainable competitive advantage (Trott, 2017). Interviews indicated higher growth rate and higher profitability on new products (Sections 4.3 and 4.4).

k- Lower total life cycle cost on new product to the customer (Kapp, 2019), which was confirmed during the interviews (Section 4.6).

l- Close customer interaction (Athaide & Klink, 2009; Sofianti et al., 2010) with utilisation of CRM (Ernst et al., 2011). The interviews indicated that customer intimacy and utilisation of a professional CRM were success factors of new product development (Section 4.3).

m- Customers' participation, co-creation (Prahalad & Ramaswamy, 2004; Sofianti et al., 2010) and consideration of their knowledge and creating knowledge during the new product development process (Sections 4.3 to 4.6).

n- Four themes were identified in field research: customer intimacy, value, quality and customer service (Section 4.2).

o- Company organisation and leadership involvement are crucial to successful new product development (Cooper, 1990, 2017). The interviews indicated that a high-performance organisation and leadership are the basics for successful new product development (Section 4.4).

The key success factors for customer retention are summarised as follows:

a- Solving the customers' problems (Sections 4.4 and 4.5) and creating value for the customer's business (Section 4.4).

b- Co-creation and customer participation on project-based new product development process, customer intimacy (Sections 4.3 and 4.7).

c- Providing new product development capability with identified technological advantages, production techniques and continuous improvement on quality (Platzer, 2004) and this conceptualisation is supported by field research (Sections 4.3 to 4.7).

d- Utilisation of a professional CRM tool (Crosby & Johnson, 2005; Frow & Payne, 2009; Dayan & Arnolds, 2012) and this was confirmed by a respondent during the interviews (Section 4.3).

e- Identified four themes from field research in the context of successful new product development and customer retention: customer intimacy, value, quality and customer service (Section 4.2).

4- Recommend how new product development can be used to retain customers in the industrial valve industry.

This research conceptualises how new product development facilitates customer retention in the industrial valve industry. Based on the research findings, a new product development and customer retention model is conceptualised as illustrated in Figure 5.4-1. Customers are fully involved in the new product development process in project-based new product development on engineered valves in the industrial valve business. The customers have an interest in the newly developed product because they

want it to solve their flow-related problems and fulfil their needs. In the case of any failure of newly developed engineered valves there will be significant damages to customers and to engineered valves manufacturers, such as loss of profit, loss of reputation and loss of future business.

In this research, the research questions (as stated in Section 1.4) were addressed as follows.

The primary research question is: What are the key drivers of new product development in the industrial valve sector?

The drivers for new product development in the industrial valve business as interviews indicate are supported by the literature. However, one of the key drivers of new product development – solving customer problems – was repeated several times during the interviews. Identifying and solving customer problems are main drivers of new product development as respondents stated. The key drivers of new product development in the industrial valve business revealed by the interviews are listed in Table 4.7-1.

The secondary research question is: How does new product development facilitate customer retention in the industrial valve business?

The conceptualisation of how new product development facilitates customer retention in the industrial valve business is illustrated in Figure 5.4-1. The new product development and customer retention model is based on customer intimacy, value, quality and customer service and on a project-based new product development process with involvement and knowledge sharing of end users and licensors. Customer retention is related to customers' satisfaction

with the provided solution and the value it creates for them. The result of the interviews indicated in many examples that new products facilitate customer retention.

Third research question: What are the key new product development processes and to what extent are customers part of this process?

The key new product development processes are based on the project-based new product development process in the industrial valve business. Project-based new product development begins with the identification of the customer's flow-related problems. It is important to incorporate customer knowledge and experience in the proposed solution to address real problems. Therefore, as interviews indicate, the customer takes an active part in project-based new product development process (Figure 5.3-1).

Fourth research question: How can co-creation processes integrate customer knowledge to improve new product development?

In the industrial valve business the new product development process for engineered valves is based mainly on a project-based new product development process. The customers are actively involved in the project-based new product development process since they have an interest in solving their own problems with the new developed product.

Fifth research question: What are the key drivers of purchasing behaviour in terms of industrial valves, and what are the procurement and sales channels that must be identified to create new product development opportunities?

Micheli et al. (2016a) argued that industrial valve procurement in the oil and gas industry, and in other flow-related industries, is an important activity in terms of purchasing reliable and high-quality industrial valves, which results in a flawless commissioning of the plant. The purchasing process for an engineered product is more effective with fewer manufacturers providing the right products rather than more manufacturers (Walker & Hampson, 2003; Jacoby, 2012). Regarding concerns about competitiveness due to limited number of engineered product manufacturers, several types of agreements were introduced by licensors, end users and EPCs (Walker & Hampson, 2003). R&D, licencing and frame agreements are the most common agreements in the industrial valve business. The purchasing behaviours of industrial valve manufacturers are illustrated in Table 1.2-1. Kapp (2019) stated that relying on past purchasing behaviours is not good practice. For this reason, a continuous review of customers' behaviour is important to capture any changes in their purchasing behaviour (Kapp, 2019). Most industrial valve manufacturers focus on identifying and solving customers' problems instead of selling their products (Micheli et al., 2016b).

Purchasing channels play an important role in identifying new product development opportunities as interviews indicated and there are four main procurement processes: e-commerce, e-auction, tender and individual inquiry. The product specifications of engineered valves are developed during the tender and inquiry type of procurement processes which can generate new product development opportunities. Table 4.7-2 displays different procurement channels and their new product development opportunities.

The interviews indicated that the sales organisation is organised sector-wise to strengthen customer intimacy. A KAM's responsibility is to expand the relationship with customers. The main responsibility of sales managers is leading sales engineers and sales activities; sales managers cover three main regions: America; Europe, Middle East and Africa (EMEA); and APAC. Sales engineers are responsible for generating sales leads and for understanding customers' needs and expectations; they are located around the world. Open and direct communication with the customer leads to understanding their needs and expectations. A direct approach to a customer and the identification of their problems generates new product development opportunities. Licensors do not buy any products; however, they select the best suitable products and manufacturers for their processes. Because of that, customers, in this case the end users and EPC companies, follow licensors' instructions on the selection of the manufacturers and the products. However, manufacturers have to be previously qualified by licensors and by end users.

6.3 Contribution to Theory

The overall aim of this research was to develop a conceptual model to detail how new product development could facilitate customer retention in the industrial valve industry. Platzer (2004) argued that to increase their reputation and customer retention, engineered product manufacturers need to provide new product development capability with defined technological advantages, state-of-the-art production techniques and continuous improvements on quality. Nevertheless, there is limited research available in the field of new product development in industrial products and its effect on customer retention (Barczak, 2012; Preikschas et al., 2014). Furthermore, most of the existing literature on new product development focuses on consumer products (Oostra, 2001; Trott, 2017).

This research investigates the lived experiences and perspectives of individuals in the context of new product development and customer retention in the industrial valve industry. Therefore, this research is based on a social constructivist epistemology (Creswell & Poth, 2018). In social constructivism, researchers develop the subjective meaning of their experiences (Creswell & Poth, 2018). This is the first research to provide empirical knowledge on new product development and customer retention from a social constructivist position in the context of the industrial valve industry. This research made several contributions as follows.

First, as a result of the field research the key drivers of new product development in the industrial valve business were identified as illustrated in Table 4.7-1. Solving customers problems was found to be one of the key drivers of new product development in the industrial valve industry.

Second, the interviews indicated that new product development leads to customer retention. Several examples were given in which solving a customer's problems with a new product generated additional business, such as new orders and signing frame and technological development agreements with the same customer. Figure 4.7-1 shows how new product development can generate customer retention based on the defined themes of customer intimacy, value, quality and customer service as per the findings of this research.

Third, a significant proportion of the existing research on new product development processes focuses on structured approaches (Goulding, 1983; Cooper, 1983, 2017; Cooper & Kleinschmidt, 1993; Brethauer, 2002; Trott, 2017). Various structured processes and methods have been analysed and the advantages of these methods have been widely described in the literature (Cooper, 1983, 2017; Goulding, 1983; Kahn, 2013; Trott, 2017). Nevertheless, Oostra (2001) argued that a lot of energy has been put into generalisation of new product development processes; however, practitioners do not gain much from this knowledge. In addition, a majority of new product development processes do not include processes to identify customers' problems, needs and expectations. The findings indicated that new product development in engineered products is driven by identifying and solving customers' problems.

None of the new product development processes described in the literature considered solving a customer's problems, starting from identifying the problem through to delivering the new product. Customers contract qualified engineered product manufacturers to develop new products, which is a project-based new product development process, in order to solve their problems. The project-based new product development process of the industrial valve sector differs from the structural new product development processes described in the literature. A project-based new product development process is illustrated in Figure 4.7-2.

Fourth, this research conceptualises a model of how new product development facilitates customer retention in the industrial valve industry. A new product development and customer retention model is illustrated in Figure 5.4-1. Consequently, the current research offers an additional explanation of key drivers of new product development, and new product development and customer retention, in the industrial valve industry as a contribution to the extant literature in these fields.

6.4 Managerial Implications

This research sets out a number of managerial implications.

First, operational excellence is one of the attributes that creates value for customers. An organisation should be in a position to deliver the expected solutions on time, on quality and on budget to the customers. Execution of new product development where the customer is part of the development

process is important and business leaders in the industrial valve manufacturers sector need to implement and execute a Lean culture within their organisations. Business processes should support collaboration across disciplines. On project-based new product development process a project task force (team) needs to be established and the project team should be led by an experienced project manager. The project manager has to be involved in all process steps on a project-based new product development process as illustrated in Figure 4.7-2, and build the task force with the right people on the right tasks. A dedicated project execution plan prepared with the customer will support execution of the project and communication with involved people. Since the customer participates in all project steps on new product development and there is open communication on progress, quick responses to customer requests and comments with regular meetings will simplify project execution. One of the important elements of successful project-based new product development is that all project members understand the customer's needs and expectations of the new product. The interviews indicated that end users and licensors carry out an intensive pre-qualification process and investigate the capability of the industrial valve manufacturer on new product development and its process. This pre-qualification process should not be underestimated since end users and licensors will accept or reject the industrial valve manufacturer based on the pre-qualification process findings. A well-prepared capability presentation and well-organised manufacturing and testing area will support the pre-qualification process.

Second, sales engineers play a significant role in the identification of the customer's problems, needs and expectations. Human relations is one of the

important attributes of building customer intimacy. Good communication skills and a technical background in the applications where the industrial valves are going to be installed are the basic requirements for sales engineers. They have to be able to build relationships and network with customers from different disciplines, such as technicians, buyers, after sales team, management and senior management, in order to understand the customer's behaviours and needs. Furthermore, they should be able to identify business opportunities based on the customer's needs before the competition does. In terms of a new product development opportunity, sales engineers need to communicate with engineering to prepare a new product development business case with engineering. The sales engineers have to be in a position to present the technical solution that solves the customer's problem. For this reason, sales engineers need to be developed to T-shaped competency (Bierema, 2019) to identify the customer's problem and provide a solution. The vertical bar of the T contains deep knowledge on customer's flow-related processes, on industrial and engineered valves and equipment, on selection of the right valves for the questioned processes, on competition landscape, on advantages over the competition and on existing solutions. The horizontal bar of the T comprises soft skills such as communication, listening, networking, building relationships, critical thinking, curiosity, understanding and teamwork which are crucial to human relations. These competencies allow sales engineers to powerfully connect and engage in inquiry, collaboration and problem solving (Bierema, 2019, p. 69). Becoming a T-shaped sales engineer is a development process and industrial valve business leaders need to plan, to support and to invest in this development process.

Third, knowledge management occupies an important role in the industrial valve business and in the project-based new product development process. Sharing knowledge within an organisation will support the sustainable success of the business. The business leader of an industrial valve company needs to make sure that a knowledge management system is implemented within the organisation. Documentation of knowledge and displaying it via intranet will support the sharing of knowledge within the organisation. Since knowledge is an evolutionary process, the gained core knowledge should be protected. A succession plan should be in place to avoid loss of knowledge caused by employee withdrawal. Furthermore, the protection of knowledge should be described within the business continuity plan.

Fourth, customer service; the voice of customers is crucial to understand how customers rate an organisation's problem solving, project execution and received new products' performance. In the industrial valve business, customer retention is related to customer satisfaction. For this reason, the customer satisfaction level needs to be measured. The feedback of customers is valuable information on the continuous improvement process. How customers' feedback is handled should be communicated to the customers. After project execution and installation of a new developed product, a well-prepared questionnaire will help understanding of a customer's view of identification and solving of their problems, of project execution and of after sales service. Any critical comments from the customer need to be addressed: How will those critical issues be handled in the future? An action plan with a deadline for actions should be presented to the customer which will help increase customer satisfaction.

Fifth, leadership is one of the important elements of successful new product development and customer retention in the industrial valve industry. The world is continuing to change drastically, which requires transformational, effective leaders. Transformational leaders work with their teams to generate creative solutions for complex problems (Bass et al., 2003). The skills needed for transformational leaders are conveying an attractive vision to the organisation, communication to achieve company goals, support for new product development, autonomy, encouragement, recognition and resilience. Transformational leaders need to intensify new product development within their organisation and they need to promote creative ideas (Bass et al., 2003). The skills needed for effective leadership are communication, science, thinking and reasoning, macro-level thinking and reasoning, networking, problem solving and self-discipline all to be rethought and rebuilt for the twenty-first century (Sowcik et al., 2015). For this reason, tomorrow's leaders need to understand changes in the industrial valve industry and its related and connected businesses with a focus on how the changes will affect their organisations. Solving customers' flow-related problems was found to be one of the key drivers of new product development. Industrial valve companies should be in a position to understand customers' problems and needs in order to provide appropriate solutions. The leaders of industrial valve companies need to establish a high-performance organisation with a target to identify customer problems and to generate solutions, such as new products, within the expected lead time. Sowcik et al. (2015) argued that valuable leadership should (p. 20):

- be focused and targeted,

- be original and imaginative,
- provide economic, personal and cultural payoffs,
- offer enrichment and learning, and
- include localisation detail to account for unique cultural and logistic context.

6.5 Limitations and Areas for Future Research

This research adopted a qualitative research paradigm utilising an inductive approach and an embedded case study research strategy. The social constructivist stance justified the researcher's case study approach. Further, the careful selection of information-rich interview participants ensured the rigour of this research. Therefore, the research is able to theoretically generalise on the drivers of new product development and how new product development facilitates customer retention in the industrial valve sector.

In terms of future research, the scope of this research was restricted to investigation of the industrial valve industry. It would be interesting to investigate across engineered products, including rotating equipment such as pumps and turbines. In addition, research could be extended towards industry settings other than flow-related industries.

This research contributed to knowledge on new product development and customer retention. The conceptualised model of new product development and customer retention provides four major themes. Furthermore, it considers a project-based new product development process where customers are involved in the process. Future research might identify other determinants

important to customer participation in a new product development process to enrich the proposed model.

There is limited research available in the field of new product development in the industrial market and its effect on customer retention (Barczak, 2012; Preikschas et al., 2014). This research investigated new product development and customer retention in the industrial valve industry. There is further research potential on the impact of new product development on customer retention in industries other than the industrial valve industry.

In addition, there is no clear or standard definition of competitive advantage (Ma, 2000). Because of the lack of a definition of competitive advantage, there is a need for further academic research in strategic management.

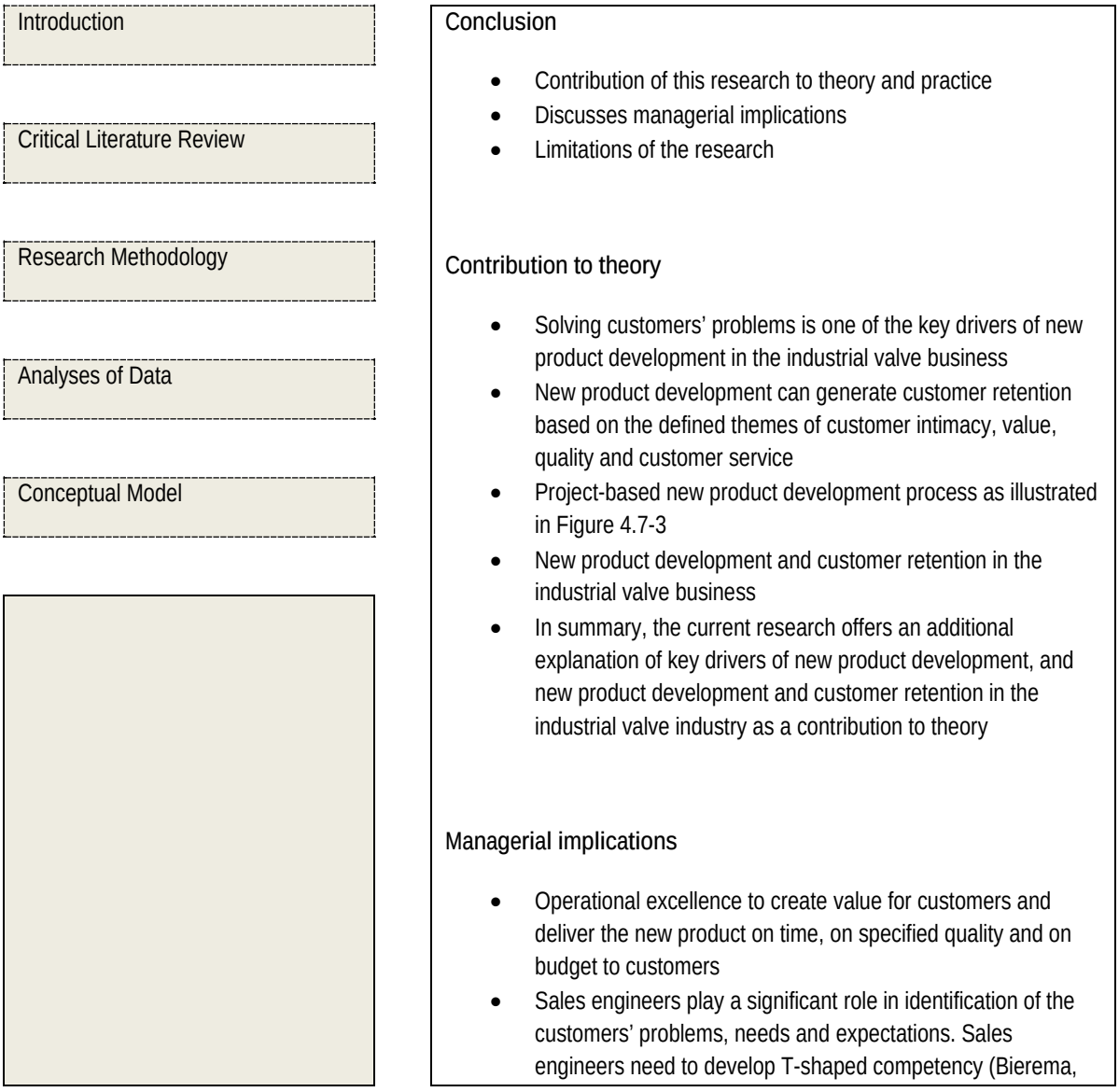
The potential influence of CRM on new product development has been neglected (Athaide & Klink, 2009; Battor & Battor, 2010; Ernst et al., 2011). However, CRM can provide valuable information from customers and about their impact on new product development as indicated in the interviews. Development of a conceptualisation of the influence of CRM on new product development would be an area for further research.

There is limited research available that explores the value of social exchange in collaborations to develop successful products (Knudsen, 2007). The capability of collaborative partners in new product development and willingness to exchange their knowledge in product development are important

to successful collaborative product development. This phenomenon could be a potential area for further research.

6.6 Summary

Figure 6.6-1 shows the final progression of this Doctor of Business Administration thesis following the development of the Conclusion and recommendations chapter.



Conclusion and Recommendations	2019) • Knowledge management occupies an important role in the industrial valve business and in project-based new product development • On customer service, the voice of the customer is crucial. What is the customer's rating of the received solution and service? • Leadership is one of the important elements of successful new product development and customer retention in the industrial valve business and requires transformational and effective leaders Limitations and areas for future research • The research adapted a qualitative research paradigm utilising an inductive approach and embedded case study research strategy • The careful selection of information-rich interview participants ensured the rigour of this research • This research was restricted to an investigation of the industrial valve industry. Could expand across engineered products and extend to other industries • Other determinants important to customer participation in new product development process to enrich the proposed model • New product development in different industries and its effect on customer retention • Strategic management due to lack of definition of competitive advantage • Potential influence of CRM on new product development • Exploring the value of social exchange in collaborations to develop successful product

Figure 6.6-1: Summary of the chapter and progress of the research. CRM customer relationship management

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APPENDICES

Appendix I: Letter for participants, invitation

Email invitation

Date

Title and name of respondent

Participating in an interview

Dear respondent name,

I am participating in Doctoral Business Administration study at the University of Gloucestershire in the UK. The topic I am researching is “an empirical investigation of new product development and customer retention in the valve industry”.

You have been selected as an expert in this field and I would like to invite you to a 60-minute interview via Teams. The interview will be conducted based on the attached interview structure, which will serve as a guideline, and I would like to hear your valuable views on this topic. I must emphasise that your participation is entirely voluntary and it is up to you to decide whether or not you wish to take part in this research. Participants are free to refuse to answer any question or terminate the interview at any point.

Let me assure you that all the information you provide will be dealt with anonymously and confidentially so participants cannot be identified individually from the data, and that the information you provide will only be used for the purposes of this research. I will ensure that the data collected from you and others are stored electronically and will be password protected.

Any quotations and examples used in research outputs will remain anonymous.

Should you have any queries, please contact me by email and/or on my mobile.

I am grateful for your kindness and thank you for your generous help in my postgraduate research.

Kind regards

Metin

Appendix II: Interview structure

- Welcome, opening speech and guidance
- How long have you worked with the company?
- Major changes in the industrial valve sector in the last five years
- Major changes in the company in the last five years
- What is the company's core business and how does it work?
- What do product and engineered product mean for you and what are the differences?
- What is the company's strategy on new product development?
- What does new product mean for you and how is it identified within the company?
- What are the key drivers of new product development and how does the new product development process work?
- Why is a new product important and what are the benefits of a new product?
- Could you describe the purchasing channel and how the purchasing channel drives new product development?
- How is the customer involved in new product development process?
- What kind of CRM is in place and how does it work?
- Could you please define customer; What does customer mean to you?
- How do you describe your customers' expectations?
- How does the sales process work?
- How is sales organised?
- Why should the customer buy the company's product?
- What are the competitive advantages?

- What does customer retention mean for you and what are you doing to retain the customer?
- What is the company's strategy on retaining the customer?
- What are the success factors for retaining the customer?
- What is the relationship between new products and retaining the customer?
- May I contact one of your best customers to have their views on this topic?
- Do you have any further comments?
- Conclusion and thanks for your participation and for providing valuable information.

Appendix III: Non-Disclosure Agreement

The following non-disclosure agreement template represents the agreements which were signed between the researcher, participants and participants' organisations. However, the original signed non-disclosure agreements varied depending on the country where the agreement was signed.

NON-DISCLOSURE AGREEMENT

THIS NON-DISCLOSURE AGREEMENT is effective from the date of last signature given below and is made **BETWEEN:**

(1) **Company Name**, (Company) a company registered in [City/Country] under company number [number on Register of Company] whose registered office is at [Address]; and

(2) **Name of the Interview Participant,** (Interview Participant) who is employed at the Company; and

(3) **Name of the Researcher**, (Researcher) who is employed at the Company and conducting part-time Doctor of Business Administration (DBA) study at University of Gloucestershire in Cheltenham in UK.

PREAMBLE

(A) The Researcher wishes to interview the Interview Participants as part of his DBA study. During the interview process they may exchange Confidential Information.

(B) To protect such Confidential Information, the Company, Interview Participant and Researcher wish to make clear the terms and conditions on which that Confidential Information is disclosed.

TERMS AND CONDITIONS

1. Confidential Information Defined. As used herein, "Confidential Information" means all oral and written information provided by Interview Participants and by Company to Researcher including but not limited to know-how, customers data, contract terms, business plans, analyses, commercial, technical, product design, specifications, drawings, notes or other documents that contain or otherwise reflect such Confidential Information.

2. Limitations on Use. Researcher may use and reproduce the Confidential Information only for the purposes set forth in this Agreement and shall not disclose such Confidential Information to any third party without the prior written approval of Company. Researcher shall take precautions that are at least as protective of the Company´s information as those that protect his own information to prevent the unauthorized disclosure or use of such Confidential Information, but in no event less than a reasonable degree of care.

3. Exclusions. The restrictions on the use or disclosure of Confidential Information set forth in this Agreement shall not apply to any Confidential Information that: (i) is or becomes generally

available to the public through no fault or omission of Researcher; (ii) was in the Researcher's possession on a non-confidential basis prior to it being furnished by Company as shown by Researcher's written records; (iii) becomes available to Researcher on a non-confidential basis from a third party with the legal right to do so; (iv) has been independently developed by Researcher without the use of the Confidential Information as evidenced by written documentation; or (v) Researcher is legally compelled to disclose by subpoena or other legal process; provided, however, that Researcher shall provide Company with prompt written notice of any such subpoena or legal process so as to enable the Company to seek a protective order or other appropriate remedy.

4. Limited Internal Disclosure. Researcher shall maintain control over the Confidential Information and shall limit its distribution only to employees, directors and officers who are directly involved in evaluating the Interview process and results, who have a legitimate need to know all or part of the Confidential Information, and who agree to be bound by the terms of this Agreement.

5. Competitive Advantage. The Researcher will not use the Confidential Information in any way that would (i) be detrimental to the Company, (ii) be competitive with the Company's products or services, or (iii) threaten harm or injury to the Company's reputation or ability to conduct business.

6. Term. This Agreement shall begin on the Effective Date and end on the earlier of: (i) the date on which Researcher returns or destroys all of the Confidential Information to the Company as set forth under Section 7 or (ii) five (5) years from the Effective Date, unless such period is extended by the Company in writing.

7. Return or Destruction of Material. All Confidential Information shall remain the property of Company and shall be returned or destroyed upon (i) Company's written request; (ii) Researcher's written determination that it no longer has a need for such Confidential Information; or (iii) expiration of this Agreement; whichever occurs first. At the request of Company, Researcher shall verify in writing that all Confidential Information has been returned or destroyed and no copies of same have been made.

8. Survival. Researcher's obligations under this Agreement shall survive expiration of the Agreement for a period of seven (7) years.

9. No Transfer/No Warranty. No license to Researcher, under any trademark, patent, copyright, or any other intellectual property right, is either granted or implied by the conveying of Confidential Information to the Researcher. None of the Confidential Information that may be disclosed or exchanged by the Company to the Researcher shall constitute any representation, warranty, assurance, guarantee, or inducement of any kind by the Company.

10. Severability. If any provision of this Agreement shall be held by a court of competent jurisdiction to be illegal, invalid or unenforceable, the remaining provisions shall remain in full force and effect.

11. Waiver. No waiver by either Party of any term or condition of this Agreement, no matter how long continuing or how often repeated, shall be deemed a waiver of any subsequent act or omission, nor shall any delay or omission on the part of either Party to insist upon compliance

with any term or condition of this Agreement be deemed a waiver of such term or conditions. All waivers must be in writing and signed by the Party granting such waiver.

12. Equitable Relief. The Parties acknowledge and agree that any use or disclosure of the Confidential Information by Researcher in violation of this Agreement may be harmful to Company and to Interview Participants. In the event of any such breach of this Agreement, Company shall be entitled to equitable relief, including injunctive relief and specific performance, as a remedy for any such breach (which shall not be the exclusive remedy for breach of this Agreement).

13. Governing Law/Venue. This Agreement shall be governed by the laws of the [Name of the Country]. Any judicial proceeding brought against either Party regarding any dispute arising out of this Agreement or any matter related hereto shall be brought in the courts [Name of the Location].

14. Entire Agreement. This Agreement constitutes the entire understanding between the Parties hereto and supersedes all previous communications, representations and understandings, oral or written, between the Parties with respect to the subject matter of this Agreement.

15. Amendments. No amendment or modification of this Agreement shall be valid or binding on the Parties unless made in writing and signed by each Party.

IN WITNESS WHEREOF this Agreement is executed as follows:

Company

Name

Position

Signature

Date

Interview Participant

Name

Position

Signature

Date

Appendix IV: Coding Map Overview

Themes	Codes	Key Words	Respondent Number	Category	Number of respondents each category
Customer intimacy	Humans Relation	Communication	24 29 28		1 2 3
		Relationship	24 29 11 4 27 5 22		1 2 3 4 5 6 7 8 9 10
		Networking	27		8
		Understanding (Customer problems, needs and expectations)	24 29		1 2
		Collaboration	28 32		3 4
		Sharing opinion & ideas	27		8
	Organisation	Sector	24 16 27		1 2 8
		Knowledge	16		2
		co-creation	28		3
		Time to Market	32		4
		CRM	5		9
		KAM, Sales and Engineering Organisation	16 29		2 3
		Training	29		3
		Engineered Product	24 16 27		1 2 8
	Strategy	Growth	28 11 4 5 22		3 4 6 7 9 10
		Profit			6 7 9 10
		New Product Introduction	22		10
		New Product development	28 11 32 4 27		3 4 5 6 7 8 9 10
		Market Share	11		4
		Marketing, Conference	27		8
		Frame agreement	11		4
		Competition	4 5		5 9
		Customer focus	24 16 29 28 11 32 4 27 5 22		1 2 3 4 5 6 7 8 9 10
		Market dynamics	27		8
Value proposition	Engineered Valve	Knowledge	16		2 6 7 9 10
		Innovation			1 6 7 9 10
		Performance			8 9
		High quality			1
		Reliable			1
		Strength			1
		Trust			3 6
		References, track records			3 6 7 9 10
		Experience			3 7 9 10
		Competitive Advantages			3 7 9 10
		Extreme condition			1 9
		Core competence			1 3 9
		drivers on New product development			1 9 11 12
		Sophisticated			1
		Engineered valve selection			3 7
		Severe and critical applications			3 7 9
		Digitalisation			4 11
	Lifetime value	Profit Increase	11 4		3 4 6 7 9 10
		Growth	11		3 4 6 7 9 10
		Availability			1 2 6 7 9 10
		Cost reduction			1 4 6 9
		Premium Price			4 6 9 10
		Reputation			6 9 10
		Retention			6 9 10 11
		Technology Agreement			3 11
	Operational Excellence	NPD Process			1 11
		Quality			1 6 7 9 10
		Design, Engineering			1 2 6 7 9 10 11
		Manufacturing Technologies			1 2 11
		Testing			2 7 9 11
		AFM			1 6 9
		Quick Response			1 9
Quality	Design	(Safety), Functionality			6 7 8 9 10
		Problem Solving			1 6 7 9 10
		Capability			7 10
		Reliability			1 6 7 8 9 10
		harsh conditions			6 7 10
	Conformance	Contractual obligation			6
		Performance			6 8 9 10
		Price performance ratio			8
		Specification, defined needs			6 7 10
		Design			6 7 10
		Manufacturing			7 10
		Testing			7 10
		Time Frame			6 9
		Fulfilment			6 7 8 9 10
	Performance	Perceived			6 8
		Effective			6
		Ability			6 7 10
		Serviceability			8
Customer Service	Knowledge	Project categorisation, Projects			12
		Competition produces			12
		Expectations			12
		Purchasing Behaviour			12
		Purchasing channels			3 12
		Flow related Processes			12 13
		Life cycle cost			12
		Product selection			3 13
		Market intelligence			3 12
		Price strategy			3 12
	Processes	Qualification			3 12
		Approval			3 12
		Order execution			3 13
		Design			3 13
		Manufacturing			3 13
		Testing			3 13
		Organisational competence			12
		Application Engineering			13
		Commissioning			13
		New Product			13
		Customer Specification			13
	VOC	EPC			3 12
		Licensor			3 12
		End User			3 12
		Open communication			13
		Listening			13
		Customer satisfaction			13
		Decision power			3
		Licensor Incentive agreement			3
		Agreements			13
		Retention			13
		AFM, Service			12
		Spare Parts			12