CHALMERS

Entering New Territory

Adapting the NPD process for Diversification in the Chemical Industry

Master of Science Thesis
in the Management and Economics of Innovation Programme

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Abstract

ChemCo is a specialty chemicals producer that during the past five years has experienced a stagnating sales growth as well as declining margins due to Asian competition. Especially newly developed products are suffering from poor sales performance. The purpose of the thesis is to identify the sources of this poor performance and also suggest how the new product development process can be improved to increase sales performance of diversification projects. Six products that were developed using ChemCo's new product development process were examined in the study. The findings suggest that the sources of the poor sales performance are ChemCo's new product development process' inability to reduce market uncertainty, lack of marketing efforts, and project delays causing comparisons between projected sales and actual sales to be skewed. The thesis also suggests a modified product development process to use in projects where market uncertainty is high. The process consists of four steps, which are the classification of a project, the evaluation of the new product's targeted segments, the mapping of the product's business model, and the monetary valuation of the targeted segments.

Keywords: new product development, diversification, chemical industry, customer development

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"Everybody has a plan until they get punched in the face."

- Mike Tyson

Olof Wändahl

Gothenburg, August 2015

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Introduction

The chemical industry is huge. According to Cefic (2014), world chemical sales in 2013 amounted to €3156 billion. The majority of these sales are attributable to Asian companies with €1811 billion, while the share of sales of European companies is €630 billion. The industry has grown 9 % annually for the past 10 years, mainly in emerging markets such as China who today alone accounts for 33 % of world chemical sales. Ten years ago, China's share was only 9 %, which says something about the explosive growth in production that has taken place there. While the chemical industry in other parts of the world has also experienced an overall growth, there is now considerable competition from low cost producers in China.

Manufacturers in the process industry, of which the chemical industry is a sub industry, are critically dependent on capacity utilization to cover the costs of expensive production facilities (Pennings & Natter, 2001). Since the chemical industry growth has driven massive investments in new production capacity in China, the new excessive capacity in comparison to market demand in combination with the need to maximize capacity utilization has increased the already high cost competition significantly.

As implied by the race to higher capacity utilization and expensive production facilities, economies of scale are highly influential on the chemical industry (Lieberman, 1987). With large investments in production equipment, a chemical producer faces high switching costs when the input material is not a commodity in addition to not being compatible with existing production equipment. Further, the customer of a chemical producer must also accept any changes to the product qualities, which also applies to the customer's customer, all the way down the value chain to the end consumer. These features result in one conservative industry part where suppliers seldom are switched out, and new products are harder to establish on the market the farther back in the value chain a supplier is situated. The other part of the industry is one using commodity chemicals for production, where suppliers are often switched out since they are chosen primarily on who can offer the cheapest product presently.

There are three classes of commercial chemicals. Othmer et al. (1996) mention commodity- and specialty chemicals. Commodity chemicals are distinguished by their large production quantities and are generally almost identical regardless of supplier, and are therefore easily interchangeable between different suppliers. Specialty chemicals consist of a variety of chemical substances that are formulated in a way that gives the specialty chemical unique properties. In contrast to commodity chemicals, the unique properties of specialty chemicals enable a chemical producer to differentiate its offer than what would have been possible had it only produced commodity chemicals. Because of these unique properties, it is often difficult to switch between two different suppliers of a specialty chemical. Pollak (2011) describes the final class called fine chemicals. Fine chemicals are similar to commodity chemicals except they are only produced in small quantities to strict specification. The typical example of fine chemicals is pharmaceuticals.

The subject firm to the research in this report is referred to as ChemCo. ChemCo describes themselves as a world leader within specialty chemicals and has an annual turnover in excess of €1 billion. During the last five years, ChemCo has experienced a stagnating sales growth as well as declining margins, mainly due to competition from Asia according to ChemCo's management. Further, new product development projects, from here on NPD projects, intended to spur company growth seldom seem to live up to the sales expectations outlined in the business plan. If the main reasons for poor sales performance for new products can be located, ChemCo hopes to be able to devise corrective actions so that the new products will actually contribute to ChemCo's growth.

In 2014, ChemCo launched a formalized NPD process based on the Stage-Gate model usually attributed to Dr. Robert G. Cooper of the McMaster University. The intent of the new process was to secure that NPD projects adhered to a best-practice process since there was no former process that integrated the different functions of the company participating in NPD projects. However, a problem was identified similar to the issue of applying the Stage-Gate model on radical innovations described by Bers et al. (2012) where it was questioned if projects that were classified as diversification activities should undergo the same process as other types of projects. Diversification is defined by Ansoff (1957) as a simultaneous departure from the present product line and market structure. The term diversification project hence refers to a project to develop a product separated from the present product line in addition to targeting new markets. ChemCo decided to investigate the potential mismatch between the NPD process and diversification projects, since the NPD process was developed for an environment where the uncertainty is lower than in a diversification setting, resulting in this thesis.

Purpose

The purpose of this thesis is twofold. The first purpose is to identify the underlying problems causing the poor sales performance of new products. When the causes are known, one may seek a solution to the problem, which leads to the second purpose that is to determine how the new product development process may be improved to facilitate increased customer adoption and sales performance of diversification projects.

Research Questions

Based on the two purposes outlined above, the following research questions are stated:

1. What are the sources of poor sales performance of new products?

2. How can the new product development process be improved to increase customer adoption and sales performance of diversification projects?

Literature

The literature section is divided into three parts. It begins by introducing the concept of diversification, proceeds to new product development, and finally ends with describing some business model tools.

Diversification

In the introductory section, diversification was defined using Ansoff's (1957) definition as a simultaneous departure from the present product line and market structure, depicted in the lower right of Figure 1. There are however other definitions that could be applicable for the purpose of this thesis. A well-defined theoretic construct is proposed by Gort (1962) who defines diversification in terms of the heterogeneity of output and how many markets are served by the same output. Products then serve different markets if their cross-elasticity of demand is low, in addition to requiring different resources of production. While Gort's definition may be useful for theory building, its practical usefulness in the context of this thesis is low. A less strict definition is used by Ramanujam and Varadarajan (1989, p.525), who define diversification as "the entry of a firm or business unit into new lines of activity, either by processes of internal business development or acquisition". Internal business development and acquisition refers to the two existing pure modes of diversification by which the diversification is carried out (Lamont & Anderson, 1985). In addition, there exist hybrid modes of diversification, of which the joint venture is an example (Raff, Ryan & Stähler, 2009). Ramanujam and Varadarajan's definition is similar to that of Ansoff's, but since Ansoff's definition focuses on internal product development as a means of diversification rather than acquisitions, it better serves the needs of this thesis. Hence, for the purpose of this paper, Ansoff's definition will be used.

	Current Products	New Products
Current Markets	*Market Penetration*	*Product Development*
New Markets	*Market Development*	*Diversification*

Figure 1. The Ansoff matrix, adapted from Ansoff (1957).

Diversification for ChemCo is to be interpreted as a looser form of diversification than the how the term is usually thought of. The reason for this is the ambiguity in what constitutes a new market. If chemicals is to be considered a market, ChemCo does not engage in diversification. However, ChemCo does not have knowledge of the entire chemical market, but parts of it, why the definition of market must be more granular to be useful when working with Ansoff's (1957) definition of diversification. This also has the implication that some projects that would be classified as product diversification with the usual interpretation of diversification instead will be classified as diversification. To exemplify, a new specialty chemical used in packaging may intuitively sound like product diversification since it is just another new chemical, but to ChemCo the packaging market is unknown, and therefore the project should be classified as diversification.

Motives for Diversification

The previous section addressed what diversification is, but not why firms seek to diversify. Diversifying into new markets is a risky endeavor that often ends up in great losses to the diversifying firm (Biggadike, 1979). Research conducted on firms in the 1970s suggests that entry into new markets with new products on average requires eight years before they yield profit, and ten to twelve years before their returns are on pair with mature businesses, so there should exist powerful incentives for firms to engage in diversification. A range of motives for firms to pursue diversification is mentioned in the literature (Reed & Luffman, 1986; Devlin, 1991; Detrie & Ramanantsoa, 1986). Reed and Luffman (1986) use the most structured approach to group these motives into the following three categories. First, the motives relating to capacity and resource utilization are categorized as use of resources. As the name implies, motives in this category aims to make efficient use of resources that are already at the firm's disposal. Examples include utilization of byproducts that may contain value, exploitation of existing brand name and market position, or specific knowledge that can be used in applications in other products or markets. The second category contains motives that are related to the growth of the firm. Growth motives in diversification can be of both offensive and defensive nature. Offensive ones aim to increase future profits while defensive ones aim to stabilize earnings and spread market risk. An example of a motive in this category is to counter saturation in existing markets. The third and final category is motives relating to adapting to customer needs. Motives in this category are common when a firm's current offering cannot, at least not by itself, satisfy either a single or a group of important clients, or satisfy the requirements of diversified dealers. Figure 2 shows the complete set of motives associated with each category.

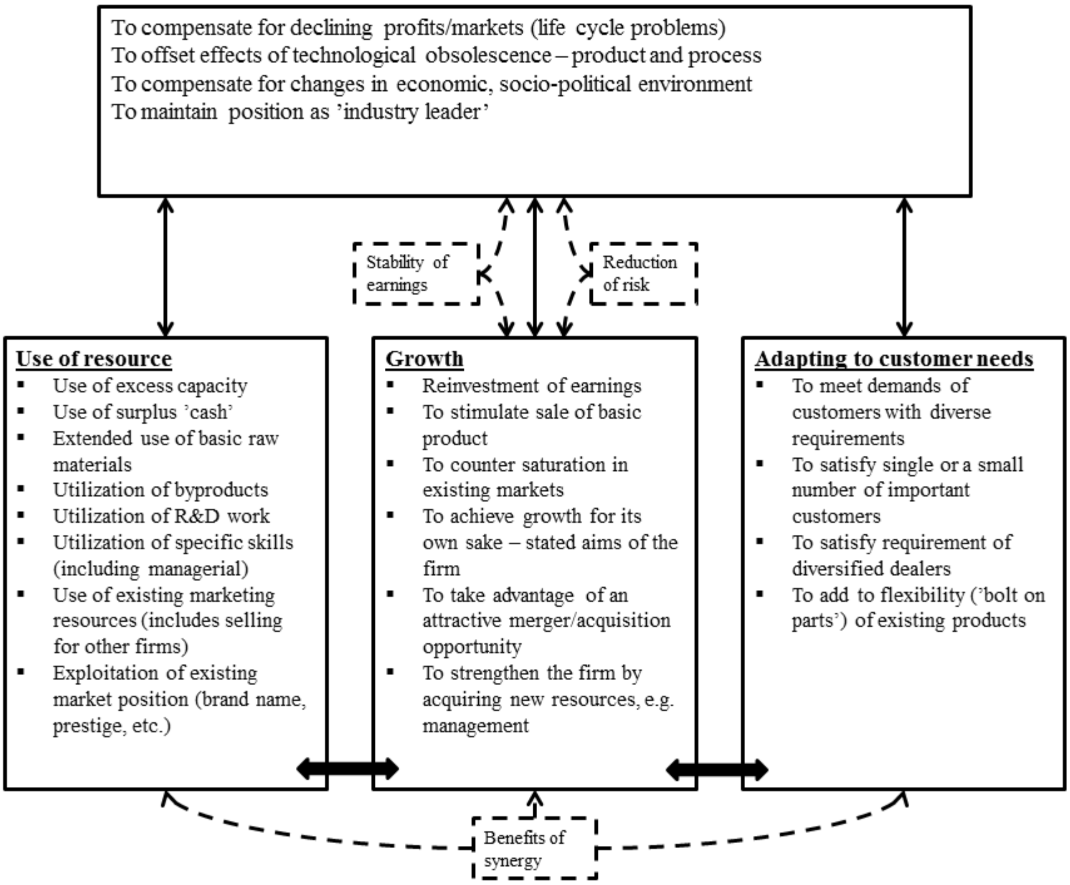

Figure 2. The basis for and benefits of diversification, adapted from Reed and Luffman (1986).

In ChemCo's case, the motives for diversification are both to increase the use of resources and growth. Specialty chemicals most often require a commodity chemical for their production. The commodity chemical can either be bought at market price or be produced in-house. Chemical companies always strive to justify the investment to produce the commodity chemical in-house since it will provide them with a significant cost advantage against the companies who buy the commodity chemical at market price. The issue with building a new plant is that the minimum capacity needed for proper scale efficiencies is often much larger than the amounts of commodity chemical needed for making the specialty chemical. Therefore, one of ChemCo's motives is to increase use of resources by increasing the capacity utilization of current plants and make extended use of basic materials. ChemCo's motive for growth is a stated aim in ChemCo's company vision, and a way to maximize company value before the impending IPO or selling of the ChemCo.

New Product Development

New product development is the activity that a company exercises in hope of creating products superior to existing alternatives, which in turn will improve their competitive position on the market (Annacchino, 2003). The activity is multidisciplinary and project based to its nature, why it often requires the cooperation of different company functions in addition to being time constrained. The activity of developing new products is subject to uncertainty (Stockstrom & Herstatt, 2008). The amount of uncertainty of a new product development project depends on where the product places itself in the Ansoff matrix. In one case, the project intends to extend the product line but sell it to the same market, which Ansoff (1957) terms Product Development. This type of project is subject to moderate uncertainty since the market environment is known. In another case, the project intends to both extend the product line and sell it to a market not previously targeted by the company, which Ansoff terms Diversification. This type of project is subject to high uncertainty since the market environment is unknown. Beside the response of the market, the innovation process of the new product itself may be subject to technical uncertainty. It is therefore in most manufacturing companies' best interest to seek a structured way to manage and reduce uncertainty in new product development activities.

The Stage-Gate Model

The most commonly used process for managing new product development when the market is known, Product Development as defined by Ansoff (1957), is the Stage-Gate model outlined by Cooper (1983). The basics of the model are trivial to grasp since it only consists of two different kinds of elements. The first element is the stage where some type of activity is taking place, e.g. R&D to develop a technical functionality or market research to assess customer demand. A stage always has a deliverable, which is used as input to the gate, the second element. The gate consists of a set of criteria, and the deliverable from the preceding stage is then measured against the criteria of the gate in order to determine if the project should be allowed to proceed to the next stage, or if it should be killed. Figure 3 shows an example of the model as proposed by Cooper (1990).

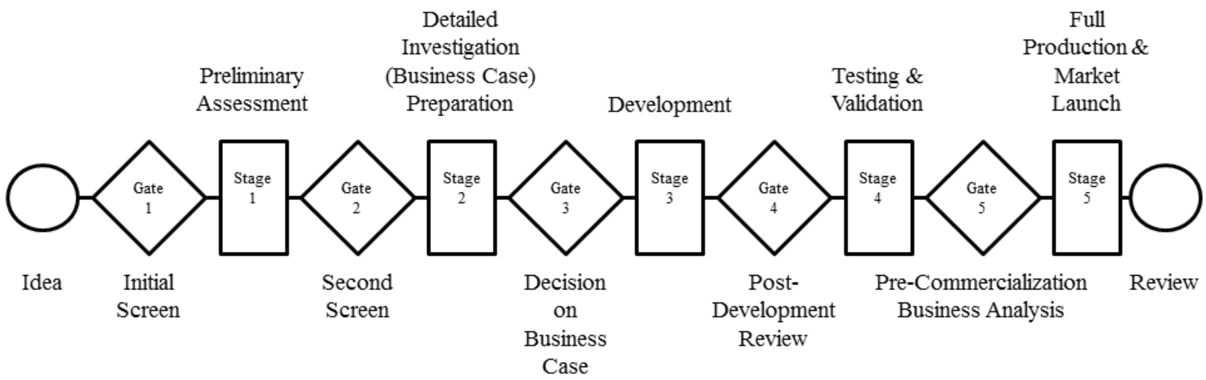

Figure 3. A typical implementation of the Stage-Gate model, adapted from Cooper (1990).

In the following section, each conceptual stage of will be briefly described as originally depicted by Cooper (1983) why some stages will slightly differ from the example implementation model in Figure 3.

Idea

The idea of a product is a technological possibility that may command a market demand (Cooper, 1983). Sources of ideas are usually divided into two main groups. First, market pull ideas originate from the market place. Such ideas may be expressed directly by customers, inspired by competitor's products, or stem from a recognized need in the market. The second group is technology push ideas, which are ideas that often are the result of internal R&D

discoveries. In the first gate, the initial screening, only the ideas that fulfil the criteria may progress and turn into a new project. Examples of such criteria in the first gate are product fit with company strategy, project feasibility, if there currently are enough resources to carry out the project, and of course a market size estimate to determine if the idea is at all worth pursuing.

Preliminary Assessment

In the preliminary assessment stage, resources are committed to the idea, which now has the status of an actual project (Cooper, 1983). In this stage, there are two main activities to be carried out. First, a preliminary market assessment is needed to provide an overview of the market, its segments, and size of the segments. No fieldwork is performed here, as the preliminary market assessment is usually desk study report. The second activity is a preliminary technical assessment, which has the purpose of involving technical personnel such as R&D and engineering to provide further insight on the technical feasibility of the project. Based on the two types of preliminary assessment, an evaluation is performed on which the GO/KILL decision for the project is made.

Concept Stage

According to Cooper (1983), the concept stage is commonly neglected by firms, sometimes with devastating project results. The concept stage consists of three activities. First, the concept identification is a market study aiming to identify gaps, which are unsatisfied needs or market segments where customers are not satisfied with current solutions to their needs. The value of identifying these gaps is that they may serve as suitable spaces for market entry later on. Further, the concept identification should also isolate the key success factors, i.e. the most important benefits and features a successful product should provide. The second activity is the concept development, which is translation of the findings of the concept identification into a concept product that can be engineered. The concept product is then used in the third and final activity of this stage, the concept test. The idea of the concept test is to assess the likelihood of market acceptance by showing something tangible, which could be sketches, formulas, or a built version of the concept product.

Development Stage

Together with product testing, the development stage is the stage that is generally executed best in the new product development process (Cooper et al., 2004). The reason for this may be that the development stage heavily relies on internal technical processes as opposed to external activities that commonly cause companies to struggle. It is in this stage that the R&D and engineering departments go to work with the goal of creating a prototype or sample of the product, which is rather the case in the chemical industry (Cooper, 1983). Additionally it is here that the marketing plan is created with contents such as pricing, target markets, positioning and distribution.

Testing Stage

According to Cooper (1983), there are two purposes of the testing stage. First, in-house testing must be conducted in order to find and eliminate any technical defects that could cause malfunction or human harm. Testing methods vary greatly between industries. Software product testing is very different from chemical product testing for example. For chemicals, ECHA, the European Chemicals Agency, introduced the REACH regulation in 2007, which specifies what type of testing a new chemical has to go through in order to sell it on the European market (Commission Regulation (EC) No 1907/2006/EC, OJ L 396, 30.12.2006, p. 1–849). The testing stage has thus become expensive for firms wishing to sell new chemical products in the European Union due to the extensive amounts of testing required by the REACH regulation. The second purpose is to conduct a customer test, to let the customer identify any flaws that may be difficult to discover without observing the product in the customer's application.

Trial Stage

The trial stage is a pilot production where all aspects of the new product such as the marketing plan, product design, and production method are tested on a smaller scale (Cooper, 1983). The trial is in essence a mini-launch that tests every operation required from supply chain and production to distribution and sales to spot issues whose consequences may increase magnitudes in size if not acted upon before the full-scale launch.

Launch Stage

The launch stage is when the product becomes fully commercialized (Cooper, 1983). The target market segments, product functionality and design all should have gone through successful testing why the launch is only a matter of execution. A handover to the line organization should be performed since the project has essentially ended, sales and marketing of the new product will be handled by the regular functions of the company from here on. The activity level of project-related tasks decreases considerably, however an evaluation of the project is usually made together with tracking of product performance indicators.

New Product Development Performance

Since the process of new product development is prevalent in many firms, naturally the question has been raised what distinguishes successful firms from the less successful. This section aims to outline two specific areas. First, it outlines how top performers of new product development manage resource allocation. Second, it seeks to find what the success factors of new product development of top performers within the chemical industry are.

New Product Development Performance and Resource Allocation

Few would dispute the basic economic premise of the scarcity of resources. Sources mentioning the issue of scarcity can be traced back to the 18^{th} century (Burke et al., 1800). Product portfolio managers are forced to deal with scarcity on regular occasions (Cooper et al., 2004). While it is not always possible to increase the availability of resources, the allocation of the available resources can be optimized. There is plenty of evidence that management frequently neglects the allocation of resources to projects. The effects of resource deficiencies may be that certain stages of the new product development are not properly conducted or not conducted at all, which can lead to poor project results. Which company functions suffers most from this resource deficiency? Is there any difference in the resource deficiencies between poor performers and best performers? Cooper et al. (2004) found that marketing is most commonly mentioned as the function that lacks the resources to perform its duties among all categories of performers, as shown in Figure 4. Further, the function displaying the greatest gap in resource availability between best performers and worst performers was the salesforce, where 60.7 % of best performers reported they had sufficient resources as opposed to 0.0 % of the worst performers.

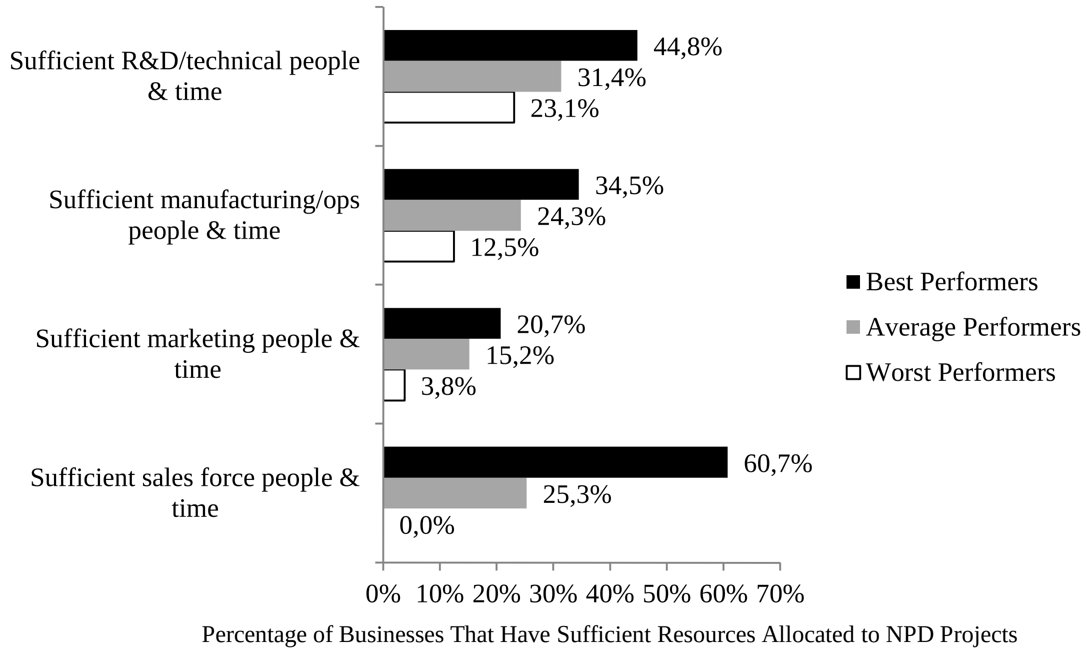

Figure 4. Resources available split on functional area and performance (Cooper et al. (2004).

New Product Development Performance in the Chemical Industry

Since the chemical industry is the setting for this study, it only makes sense to look at the specific success factors of new products in this particular industry. In their study of new major products in the chemical industry, Cooper and Kleinschmidt (1993) come to four interesting conclusions. First, unsurprisingly, is that product differentiation is the main discriminator between a success and a flop in new products. The lesson is that new product development must give every effort to improve factors such as quality, price per performance, and superiority to competing products. Second, competing on non-product variables such as brand name and technical competence is less effective than competing on product variables. The exceptions are differentiating on technical support and customer service as well as the technical competence of the company, which correlated quite strongly with new product success. Third, using low price as main selling argument for a new product proved to be an unsuccessful strategy in this industry. The fourth and final conclusion is that the external market environment has a moderate impact on the performance of a new chemical product, but that these factors tend to be overemphasized in new product development screening processes. It should be noted that this conclusion is rather unique for this study. Others, for example Maidique and Zirger (1984), found external market environment factors to be an important determinant in new product success, they however did not study the chemical industry but the electronic industry.

Iterative Methods in New Product Development

The new product development process has faced some critique from the startup sphere. The startup guru Steve Blank has directed criticism towards what he refers to as waterfall development, saying that it is a too rigid process (Blank & Dorf, 2012). Once waterfall development is set in motion, the product's original requirements and features are difficult to modify due to market and technical activities existing in separate universes in many companies. Blank's critique is coming from a startup perspective where great uncertainty characterizes the entire business model, and he also states that traditional waterfall development is usually suitable for established companies with a validated business model. The reason why the startup perspective is brought up is that it shares some characteristics regarding uncertainty with the development of diversification projects, especially with regard to market uncertainties.

A contrasting view is presented by Cooper (2014) who claims that there is no contradiction between his tool for new product development, the Stage-Gate model, and adaptive or agile forms of development. Other research support the concept of adaptive new product development, often referred to as hybrid new product development (Sommer et al., 2015). The issue with this research is that it focuses heavily on software development rather than traditional product development. Cooper (2014) provides three suggestions of how to make the process more adaptive. The first suggestion involves spiral development, which consists of iterative loops that are performed in each stage of the development process. The iterative loop described by Cooper (2014) is very similar to the iterative loop proposed to startups searching for a scalable business model by Ries (2011), see Figure 5 for a comparison.

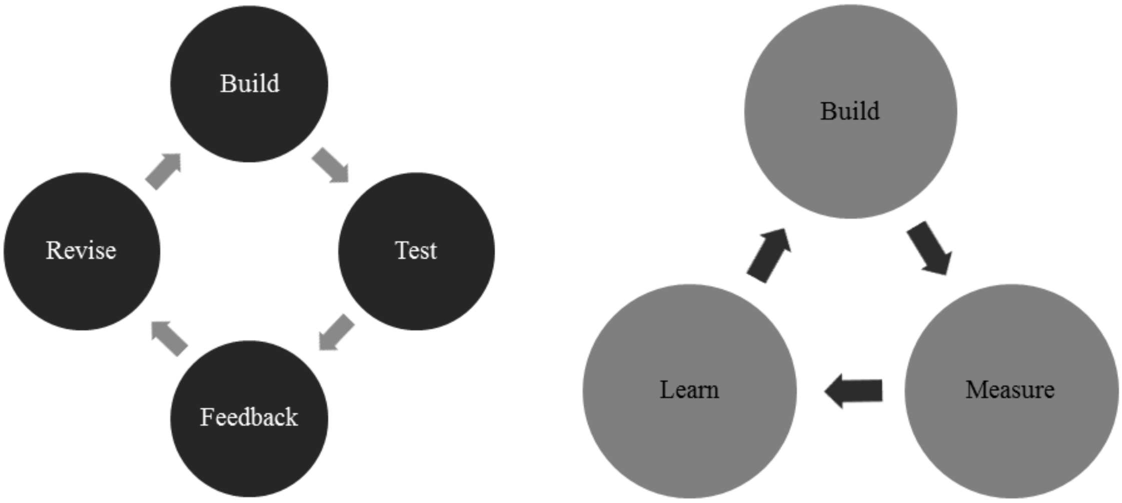

Figure 5. Comparison of iterative loops. To the left, the loop proposed by Cooper (2014). To the right, the loop proposed by Ries (2011).

The second suggestion from Cooper is to adopt a risk-based contingency model. This approach is, quoted, “designed to gather information to reduce uncertainty and thereby manage risk” (Cooper, 2014, p.24). Further, it is noted that the gathered information only is valuable if it can reduce uncertainty or validate assumptions of economic consequences. Again, the description bears close resemblance to startup methodologies such as the one described by Blank and Dorf (2012), especially since the tool proposed is a project canvas to state critical assumptions. The third and final suggestion of Cooper (2014) is a revision of criteria in the gates where the GO/KILL decisions of projects are made. Financial criteria are of little use since the economics stated in the project business case most often are wrong. The example of Exxon Chemical is mentioned, who adapted their development process for research-based products using market potential, competitive advantage and strategic fit as criteria rather than financial metrics.

Business Modeling

The previous section dealt with the intricacies of new product development, which has a rather internal focus on the technical capabilities and the products a company may create with these capabilities. Business modeling instead aims to adopt a broader, more external view on how a company can monetize on a product or service. There are numerous definitions of what a business model is, but what every definition agrees on is that the business model is a model of the way a company does business (Taran et al., 2015). According to Osterwalder and Pigneur (2010), a business model describes the rationale of how an organization creates, delivers, and captures value. The aim of this section is to provide a brief description of two tools used to map out a firm's business model, known as the business model canvas and the value proposition canvas.

The Business Model Canvas

The business model canvas is a tool first mentioned by Osterwalder and Pigneur (2010) that builds on earlier work on business models by Alexander Osterwalder. The canvas consists of nine building blocks that are intended to describe the logic of a company's operations. Figure 6 depicts the nine building blocks. The following subsections will describe each block of the canvas.

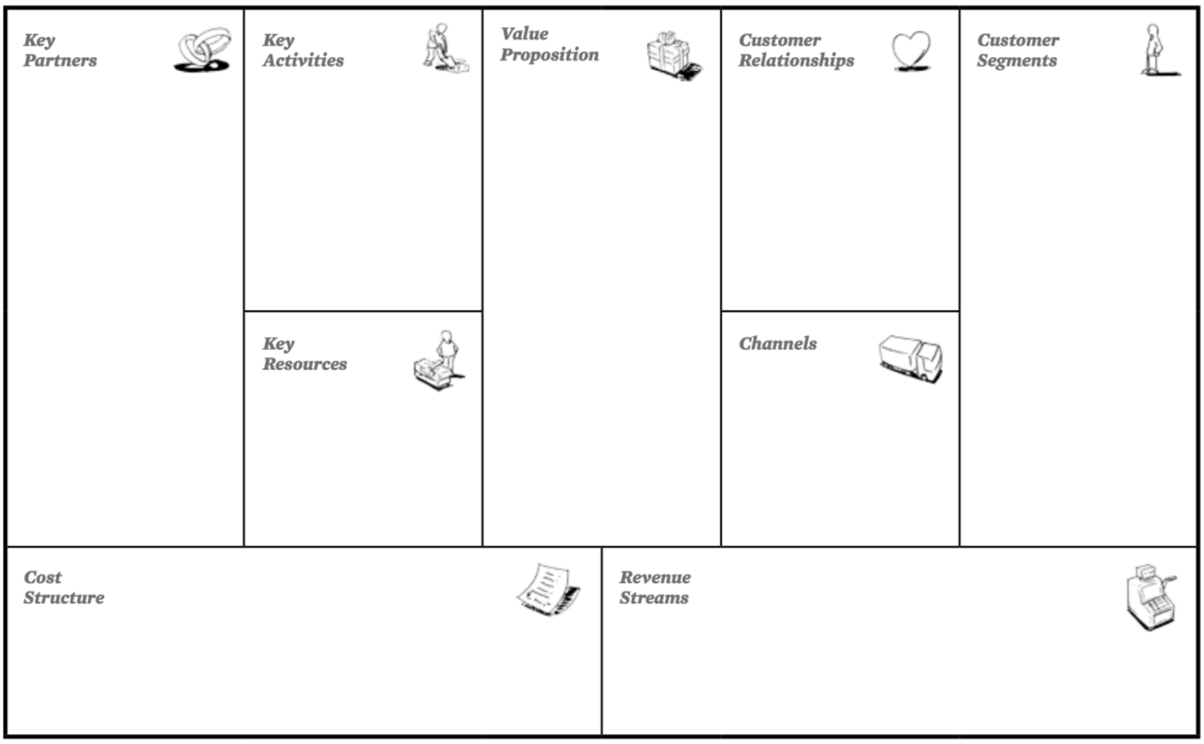

Figure 6. The Business Model Canvas (Strategyzer, 2015).

Customer Segments

Customer segments define the target customers of the business model. There is a vast body of marketing literature on segmentation. Such literature will not be brought up here, but one must recognize the importance of segmentation variables, as they will determine the behavior and characteristics of the target customer groups. There are other examples of customer segments. One is mass-market, which do not distinguish between different segments but target one large group of customer with the same offer. Another is the niche market, which caters to a smaller part of a broader market. Customers in niche markets usually share very specific needs that are not catered to by mass-market offers.

Value Propositions

The value proposition block describes in what way the bundle of products and services offered satisfy the needs of prospective customers. What needs to be stressed is that this is not a technical performance sheet where one details the product specifications, which is rather common among actors with a high technical competence. The value proposition should be described from the perspective of prospective customers, which means that different customer segments may have separate value propositions even if they purchase the same product.

Channels

The channels block refers to both channels of communication and distribution to customer segment. Channels should be chosen based on how a specific customer segment wants to be reached with its corresponding value proposition. There are two types of channels, which have different advantages. First, direct channels do not dilute the margins of the selling company and allows for greater control of how the product is displayed and sold. A sales force is an example of a direct channel. Second, indirect channels lowers the margins for the selling companies but may on the other hand give access to markets that would otherwise have been unreachable. Wholesalers are an example of indirect channels.

Customer Relationships

Customer relationships describe how a company establishes and maintains the relationships with its customer in order to spur customer acquisition and retention. Transactions between a seller and a customer can be characterized by the level of involvement of both parts and range from an arms' length distance to a partner type of relationship. Examples of different forms of customer relationships include personal assistance, self-service, communities and co-creation between the seller and customer.

Revenue Streams

The revenue streams block describes the different sources of income that a particular business generates. This block will heavily influence what the cash flow will look like over time. In recent years, the servitization of industries, i.e. the transformation from goods to services, has increased the popularity of recurring income models such as usage fees, subscriptions fees, licensing, and leasing. However, the traditional asset sale, the transfer of ownership rights of a physical product remains the most common form of revenue. The revenue streams block also includes the formation of pricing strategy. There are two basic forms of pricing. First, cost-based pricing simply adds a fixed margin to the cost of producing a product. Second, value-based pricing aims to capture the value a product creates for its customer, since a customer may be willing to pay more than what a generic cost-based formula would set the price of a product to.

Key Resources

The key resources block is a list of the most important assets required to create the value proposition. There are four generic kinds of resources. First, physical resources can be machines or other equipment, buildings, or vehicles. Second, financial resources are quite self-explanatory and may be used for operational or capital expenditure. Third, intellectual resources refer to intellectual property. Intellectual property can be in the form of a patent, copyrighted material, trademarks or design rights. Fourth and final, human resources are all the skills, abilities and experience of the employees of the company.

Key Activities

The key activities block describes how a company's key resources should be deployed in order to create the value proposition. Key activities can be categorized into three different types. First, production activities are those that relate to the design and making of a product in substantial quantities of a certain quality. Second, problem-solving activities involves coming up with new solutions to customer problems, which is common in consultancy industries. Third and final, platform activities only apply to business models that are built on platforms, and may serve to create value for many products simultaneously. An example is operating systems, such as Microsoft Windows or Apple iOS, where the primary value is not created in Windows or iOS itself, but for the surrounding products in their ecosystems.

Key Partnerships

The key partnerships block specifies which external actors are to be cooperated with to create the value proposition. In some cases, companies find themselves lacking the key resources they need to make their business model work, and the cheapest alternative is often to acquire a partner that can provide the resource. Partnerships can be categorized into four types. First, the strategic alliance is a partnership between two non-competitors. Second, coopetition is a variant of the strategic alliance where the partnership is between two competitors who join forces to achieve a common goal. Third, the joint venture is used when it is required to set up an entirely new business, which is jointly owned by two cooperating companies. Fourth and final, buyer-supplier relationships are a form of partnership that may form when transactions are costly and a buyer just cannot choose any supplier on the market to provide them with the same product or service.

Cost Structure

The cost structure block describes the operational costs of running the business model. Costs are divided into two categories. First, variable costs are costs that depend on the volume produced. The raw materials required to manufacture a product is an example of a variable cost. Second, fixed costs are such costs that they remain fixed regardless of the volume produced. Granted, over time, every cost is a variable cost. Company-owned facilities are an example of a fixed cost. All costs incurred by a business model together make up the cost structure of the model. The structure may give opportunities to take advantage of economies of scale, i.e. producing additional units of the same kind at a lower marginal cost, or economies of scope, which arise when two separate products can be produced cheaper together than the sum of the costs of producing each separately.

The Value Proposition Canvas

The value proposition canvas is an extension of the business model canvas (Osterwalder et al., 2015). The purpose of the value proposition canvas is to provide a tool with greater granularity, since the value proposition and customer segments block of the business model canvas make it difficult to differentiate targeted customer segments with different needs. Figure 7 depicts the buildings blocks of the value proposition canvas.

The canvas consists of two sides. The right-hand side corresponds to the customer segment block of the business model canvas, and is intended to clarify customer understanding. It is divided into three blocks. The customer job block describes the type of activity the customer is trying to perform. A customer job can be of functional, social, or emotional character, of which functional is the most important one in a B2B-setting. The pains of the customer describe any event that the customer finds annoying during, while or after performing a customer job. Examples of customer pains are undesired outcomes of quality of a production process or risks that the customer is exposed to in its current way of working. The gains of the customer can be categorized as required gains, expected gains, desired gains, and unexpected gains. Required and expected gains are the features of a product that should be present for a customer to consider switching to your solution. The desired gains can be thought of as the features that will increase the bonuses of the customer's employees, for example increasing the purity grade of a produced chemical. Unexpected gains are those that go beyond the expectations and desires of the customers, which they were not even aware that they could get. The left-hand side corresponds to the value proposition block of the business model canvas, and describes how the product or service creates value for a customer segment. The left-hand side, the value proposition, has corresponding boxes to the right-hand side, the customer segment. When the value proposition fulfills the requirements and needs of the customer segment, a so-called product/market fit is achieved.

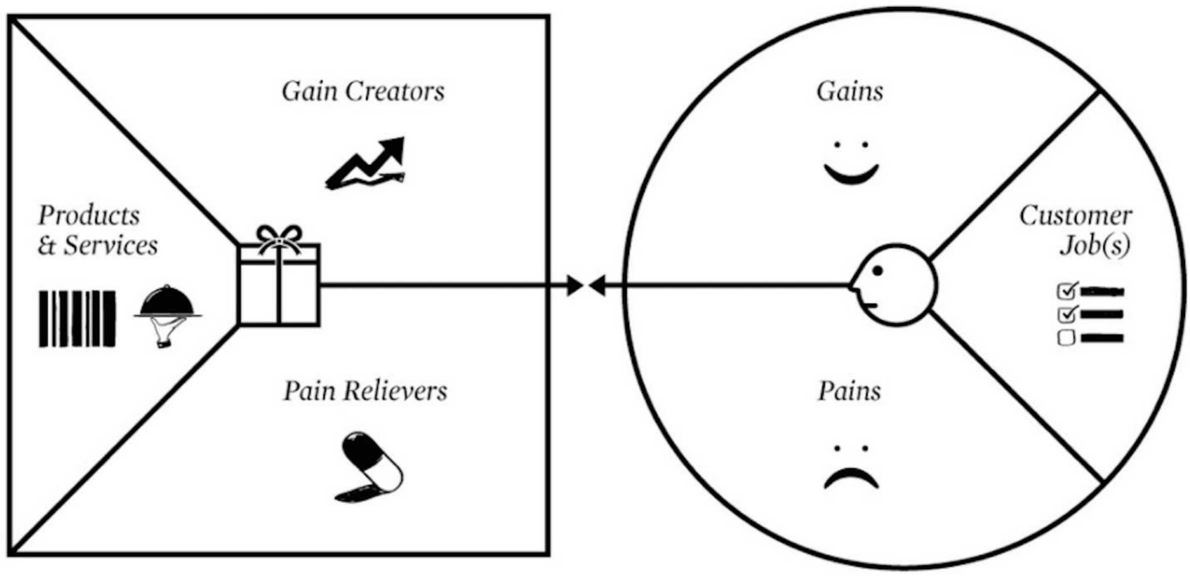

Figure 7. The Value Proposition Canvas (Strategyzer, 2015).

Methodology

This section will provide details on how the research in this thesis was conducted. The research design and data collection is presented, followed by the data analysis.

Research Design

In the initial phase of the project, the issue at hand was loosely described. There was however more clarity regarding the goal of the research. The sales performance of new product development projects at ChemCo had to be improved. With a clear goal to aim for, the identification of the problem obstructing the goal may begin after devising an appropriate research design. Edmondson and McManus (2007) argues that the nature of the research questions, envisioned research design, prior work and desired contribution by the researcher are factors that should decide whether a topic should be approached quantitatively or qualitatively. Quantitative approaches are usually associated with the positivist research traditions while qualitative approaches are commonly associated with the social constructionist traditions (Easterby-Smith et al., 2012).

In positivism, explanations must demonstrate causality and the research progresses through hypotheses and deduction (Easterby-Smith et al., 2012). The sampling requires large numbers that are selected randomly to ensure that the sample is independent and identically distributed. Further, the units of analysis should be reduced to the simplest terms in order to enable quantification of data. Comparatively, in social constructionism, explanations aim to increase the general understanding of the situation and the research progresses through the gathering of rich data from which ideas are induced. The sampling requires a small number of cases chosen for specific reasons, which are thoroughly investigated in order to come up with a general explanation. Additionally, in social constructionism, the unit of analysis may include the complexity of the 'whole' situation since the data need not be translated in quantitative terms.

From the description of the quantitative and qualitative approaches and their underlying epistemologies, it was reasonable to select a qualitative approach in this study for the following reasons. First, the natures of the research questions were ones that did not lend themselves easily to quantitative methods of hypothetical deduction. Since the research questions asked 'what' and 'how', it was more appropriate to choose the qualitative path of induction of ideas from the general understanding of the situation, especially in the case of the second research question were something new is to be created. Second, the availability to new product project data was limited, both in terms of the data existing at all for some projects and issues of confidentiality for certain sensitive projects. This required the chosen approach being able to handle different sources of data since data availability sometimes required to use whatever data was in reach. The third and final reason, a quantitative approach requires a large sample size to achieve a high statistical power in calculations. Since only a handful of previous new product projects were available to study, choosing a quantitative approach would have resulted in issues with both validity and reliability.

Because of the three reasons above, the research design had a qualitative approach with an involved engagement style, which immerses the observer in the study setting to understand the meaning and interplay between the employees of the organization studied. Besides studying previous new project data, which should be considered a detached engagement form, part of the research was made in the form of participation in a current project to capture insights not recorded in previous new project data. Additionally, each product manager was interviewed in hour-long sessions to give an account of the outcome and reasons behind it for their respective products.

Data Collection

The sampling of new product projects of the study aimed to provide a representative picture of both typical projects as well as projects never undertaken before by ChemCo. The sampling was conducted early in the study together with the vice president of marketing and the vice president of specialty solutions, who had significant impact on which projects were included in the study. In the initial sampling, eleven new product projects were included. Of those eleven, eight product managers were interviewed since the others were unavailable, but only six new product projects were included in the final version since there were only fragments of documentation for two of the projects.

The conducted interviews were of a semi-structured character, which according to Easterby-Smith et al. (2012) can give a higher degree of confidentiality in answers in addition to allowing greater opportunity to ask follow-up questions or employ the laddering interview technique. The interviews consisted of two parts. First, the product manager presented the chemical properties, technical features and intended applications of the product to provide technical context and target market technology. Second, the actual project process was discussed using open-ended questions regarding technical problems, market research conducted and its results, customer feedback, suggestions for amendments to the process, and the product's future prospects. In addition to interviews, each product manager was asked to provide documentation on actual product sales performance, the expected product sales performance forecasted in the business plan, and product pricing.

Data Analysis

The data was analyzed using a variant of narrative analysis as described by Easterby-Smith (2012). Narrative analysis is based on people's personal experiences of events, which are put in a sequence to foster understanding of for example a process or project. This form of analysis is especially useful in the analysis of interview data. Narratives have the following characteristics that make them suitable for social constructionist ways of inquiry. First, they are concerned with the temporal ordering of ideas. Second, narratives are concerned with the roles of objects or actors in the sequencing of events. Third, they enable the researcher to build a complex picture of situations to examine the actions of actors, how these affected the outcome of events. All these three characteristics were desirable traits in a technique to find an answer to the first research question. The second research question involved the creation of something new in a very specific company setting, which meant that there were no empirically tested solutions to copy. This meant that the second research question had to be answered by combining the results of the first research question with similar processes from settings resembling ChemCo's, in this case the startup field.

The new process was created in three stages. In the first stage, the application area had to be decided. Since the objective of the thesis was to adapt the existing NPD process to projects with both a new product and targeting new markets, the application area was given from the beginning. A search of literature on diversification led to the discovery of the Ansoff matrix that was deemed a good fit for the classification of ChemCo's development projects. In the second stage, the actual process steps were outlined. As mentioned, the creation of these steps were heavily influenced by startup methodologies. The motivation for applying startup methods to ChemCo's NPD process was that startups and established companies seeking to diversify face a similar problem. By Ansoff's definition of diversification, startups are also simultaneously departing from present product line and market structure since they have no previous product line or market structure. However, there are two major differences between startups and established companies, which need to be taken into consideration when adopting startup methods (Blank & Dorf, 2012). First, established companies already possess a working business model while startups are in search of a scalable business model. Consequently, the organizational inertia of the established companies makes them less agile in terms of changing their business model while startups are more likely to adapt to previously unknown business environments. To account for the organizational inertia of ChemCo, the pivot step of the startup methodology was modified and called the revise step, which purpose is rather to abandon segments that do not fit the value proposition. A pivot for a startup can take a business model in an entirely different direction than originally intended, but established companies cannot accommodate such drastic change. The second difference is available resources. Established companies command considerably more resources, especially financial, than startups do. This gave more options in what ways segment-specific information could be gathered in the testing step. In the third and final stage of creating the new process, a draft of the process steps was tested by theoretically going through the process with two products. No amendments resulted from these tests, likely because it is a weak form of testing. The effectiveness of a process should be gauged by observing it in a real scenario, which could not be done due to time constraints.

Findings

This section aims to describe ChemCo's organizational structure briefly, their new product development process, and historical new product development projects at ChemCo. First, ChemCo's organization is described generally. Second, the New Product Development process currently employed by ChemCo is shown. Finally, some previous new product development projects are examined to find how sales performance has behaved historically.

Organization

ChemCo's organization is built on a standard hierarchical structure, which can be seen in Figure 8. ChemCo's products are divided into two business areas. First, Intermediates & Derivatives mainly consists of commodity chemicals. Products belonging to this business area are sold in large volumes and they compete primarily on price. Second, Specialties & Solutions consists of specialty chemicals. Products belonging to this business area are sold in much smaller volumes than those in Intermediates & Derivatives, and are usually differentiated so that a premium price can be charged. Each product that has entered commercialization has an assigned product manager in the business area. The product manager has the commercial responsibility of his assigned product portfolio, which means he/she has the responsibility to establish and manage key business relationships for his/her products.

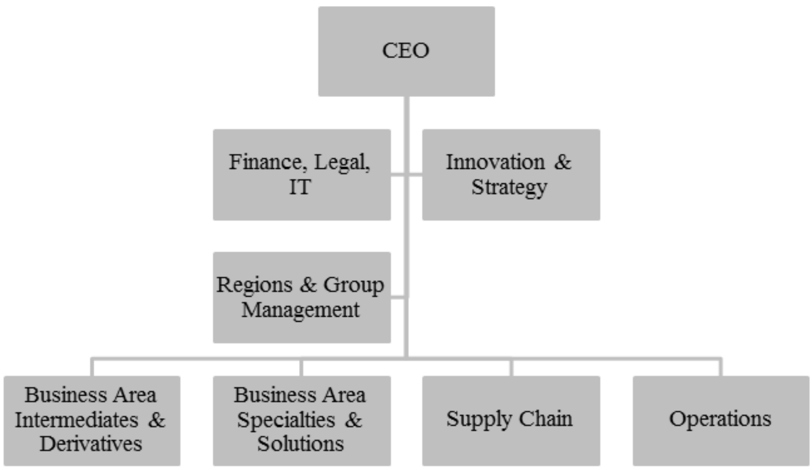

Figure 8. ChemCo's organization chart.

The Innovation & Strategy function has the responsibility to create and manage projects with the aim of developing new products that will expand company market share and increase profitability. The Research & Development function is a sub function of Innovation & Strategy, and it has the responsibility of the technical development of new products. When a new project is initialized, a project manager is assigned from Innovation & Strategy. The project manager is then put in charge of a team from R&D so that technical competence is provided to the project.

New Product Development Process

The new product development process at ChemCo is referred to as the new product introduction process, abbreviated the NPI process. Originally, the intention was to use the process for all types of new products, regardless if the products were of Product Development or Diversification type as defined by Ansoff (1957). However, the NPI process was recently renamed to the Global Project Model. It is now supposed to be used for all projects regardless of if the project is new product development or changing a production technology within a factory. All new products as well as change projects within the plants are to go through a variant of this process even though it is constructed to accommodate new products. The variant process excludes some stages in the NPI process not applicable to change projects, but is in general poorly adapted for use in change projects. The NPI process was implemented in mid-2014 in ChemCo, which is quite recently. Of course, ChemCo developed new products for decades before the creation of the NPI process. A routine for new product development existed in some form, but it was not a formalized and documented process, the NPI process is basically the formalization of this previously used routine. Since new product projects in the chemical industry usually spans a few years from idea to launch, ChemCo is yet to launch a product that has undergone the full NPI process. The stages and gates of the NPI process are shown in Figure 9.

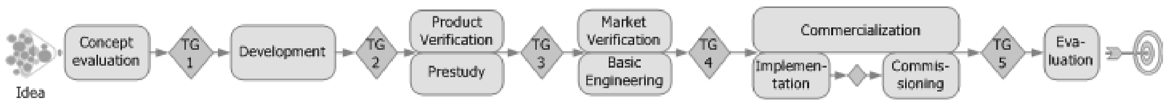

Figure 9. The new product development process implementation at ChemCo, called New Product Introduction.

Stages of the New Product Introduction Process

In this section, each phase of the New Product Introduction process is described.

Concept Evaluation

The purpose of the concept evaluation phase is to gather enough information to be able to eliminate unsound concepts, and continue with concepts that fits with the business strategy. In this phase, the concept is not yet considered a project. The aim is to gather enough information to be able to decide if a project should be started. The information gathering is done in four different activities. First, a feasibility analysis is made, which is a brief evaluation of a proposed idea based on experiments and possibly customer interaction. Second, a market desktop study is made, which is the gathering and analysis of information available in print or published on the internet. The market desktop should assess the global market size, estimated growth, regional trends, producers and their production capacity, competitors, applications, and other competitive products. Third, the technical desktop is similar to the market desktop an information gathering activity but for technical information available in print or published on the internet. The technical desktop should assess possible methods of synthesis, production platforms, catalysts, and any issues relating to intellectual property that may hinder ChemCo from exploiting the concept commercially. Fourth and finally, a customer survey should be conducted. Peculiarly enough there is no information on what this survey should reveal or aim for.

Development

The purpose of the development phase is to verify the concept in practice by creating samples of the product on a laboratory scale. The samples are mainly for internal use but can be used for customer laboratory testing after approval. There are five main activities to be done in this phase. First, chemical analysis is conducted to identify and conclude the amounts of by-products, solvents, impurities and catalysts. Second, chemometrics, the discipline of using mathematics and statistics to provide information on chemicals, is used for robustness testing, optimization, process control, and fault diagnostics. Third, a preliminary process concept is created. The process concept is the production technology intended for use on a manufacturing scale to perform the chosen method of synthesis. This is an important activity since chemical production equipment is expensive and requires large investments to be undertaken. Fourth, the preliminary product specifications are set, which tie together the product with its application use since customer for different applications will have minimum specification requirements that must be fulfilled for them to even consider the product. Fifth and final, the Responsible Care department of ChemCo is consulted to assure legal compliance and the possibility to obtain applicable certificates for the targeted segments, where Responsible Care is the chemicals industry's global initiative to ensure continuous improvement in environmental, health, and safety performance.

Product Verification

The purpose of the product verification phase is to get customer acceptance that the product works in intended applications. In this phase, the product is available in laboratory or pilot scale quantities, which means that either the product can just be tested in customer labs or it is produced in enough quantities to be used in customer production. Further, the preliminary process concept and preliminary product specifications are finally set during this phase. There are four main activities to be done in the product verification phase. First, a prospect list is created with the purpose of keeping track of potential customers and in which stage of the opportunity pipeline the customers are. Second, some especially promising customers are selected from the prospect list to perform collaboration testing. Usually, the customers with the highest technical competence are selected since the resource requirements of supporting the customers with adapting their production process to the new product are high. In addition, the reasoning is that if these customers fail in adapting their production process to the new product, how should then customers with lower technical competence be able to adapt their production process? Third, tolling, the outsourcing of production is investigated if it is applicable. As previously mentioned, since new chemical production equipment is expensive, if there is suitable equipment with available capacity at another producer, tolling could be a viable option requiring significantly less investments than building a new plant. If tolling is not applicable, a decision to build a pilot plant must be made. Fourth and final, a proper market research study should be conducted to verify customer needs and preferences. The market research study could either be performed in-house or delegated to a third party.

Prestudy

The purpose of the prestudy phase is to identify and evaluate different alternatives of where the new product shall be produced. Normally, an existing site will be used to produce a new product, but it may require new equipment. However, the infrastructure requirements of the new product must be assessed to make the decision where the product will be produced. Examples of such requirements are roads, railway, cooling water, steam, and fire protection.

Additionally, some areas require specific permits for production of certain chemicals to be allowed.

Market Verification

The purpose of the market verification phase is to build the market and increase product volumes. In this phase, the product is offered for sale to selected customers and is available in pilot quantities or larger. There are four activities to be done in this phase. First, promotional material such as technical leaflets is created for use in marketing activities to raise customer awareness of the new product. Second, market-building activities are performed. Examples of market-building activities are newsletters, promotional articles and advertisement in trade journals, participation in trade shows and exhibitions, and performing informational webinars. Third, a product launch plan is to be prepared before the final commercialization decision is made. The purpose of the launch plan is to ensure that the timing is coordinated with the market since some markets are seasonal, but also to ensure that the product is ready on launch. Fourth and finally, a hand over plan should be created with the intent of preparing the line organization of assuming responsibility of the product once the project team is disbanded. This involves preparing the selected product manager and the sales organization so that they feel confident in showing the product to customers.

Basic Engineering

The purpose of the basic engineering phase is to confirm that the contents of the prestudy are realistic, and from that define a technical change project with scope, cost and time schedule that can serve as a basis for a decision to progress through the fourth gate. Further, the production capacity must be set depending on the estimated market share that the new product will acquire within the foreseeable future. It is after this phase that the major investment of a new full-scale plant is decided on that may incur large losses for the firm if made on false assumptions.

Commercialization

The purpose of the commercialization phase is to make the new product commercially available and hand over the responsibility for production, product control, sales, marketing, logistics, and customer support of the product to the line organization. Some launch activities have actually started already in the market verification phase and continue into the commercialization phase. The product launch and hand over plans are implemented, and if applicable, the new production plant is tested and started up. Lastly, project documentation is archived and the project is evaluated by the same committee that has been in charge of the GO/KILL decisions in the five different gates.

New Product Introduction Documentation

The New Product Introduction process includes dozens of template documents that are to be filled in as the project progresses. Three of these are used as living documents and are to be delivered and updated when a project is to progress from one stage to the next through the gate. First, the business plan is the master document. Its intended purpose is to provide a comprehensive picture of technical as well as market aspects of the new product. Second, the business charter is a short one-page document that aims to clarify the business opportunity with both external and internal justifications, and their alignment with the business strategy. Since the business charter only contains a few boxes to fill in, it provides a quick and easy overview of the project. The template for the business charter can be seen in Figure 10. Third and final, the project risk assessment is a standard probability/impact matrix used in many forms of risk management.

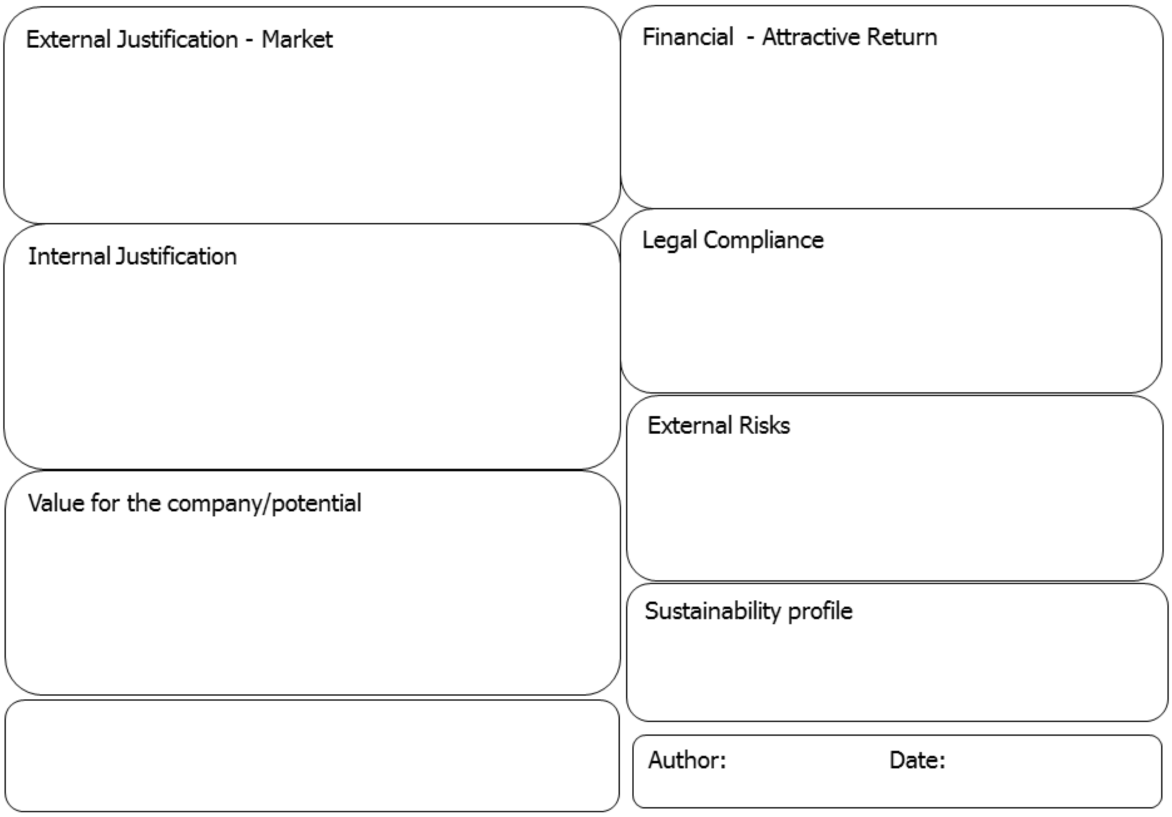

Figure 10. The template for the business charter used in the New Product Introduction process.

New Product History

This section will present a few examples of recently developed products that has partly been subject to the NPI process, some considered successful by ChemCo, and some considered unsuccessful. In the presented data of each product, expected numbers from the business plan are contrasted with the actual outcome. Note that the NPI process allows sales of a product before the product has reached the commercialization stage in the process, which can be quite confusing. The reason this is done is to learn in which customer settings the product works best in, and which settings the product does not work in. For confidentiality reasons, only a limited amount of information can be disclosed about the products.

Product A

Product A has not yet been commercialized, it is currently residing in the product verification phase. The development of Product A is a diversification project to develop a new plastic mainly for use in packaging of consumer goods. The target customers of Product A are closer to the end consumer than usually, as ChemCo mostly serve customers far from the end consumer in the value chain. As seen in Table 1, three things can be discerned. First, there is a large difference between expected volume sold and actual volume sold. Second, there is also a large difference between expected margin contribution and actual margin contribution. Third, the differences are sustained over the time span covered in the data, with the exception of actual margin contribution Year 2.

Table 1. Expected and actual sales of Product A.

Product A	Unit	Year 1	Year 2
Expected volume sold	MT	100	900
Actual volume sold	MT	5,3	7,1
Expected margin contribution	SEK/kg	6,02	5,02
Actual margin contribution	SEK/kg	2	5,1
Expected total margin contribution	KSEK	602	4518
Actual total margin contribution	KSEK	10,6	36,2

The product manager named three reasons why the actual outcome deviated from the expected plan. First, an important certification needed for sales to take off in Europe was delayed more than 2.5 years due to unexpected requirements from the European Union. Several customers have clearly stated that they will not invest any more time in investigating Product A as a potential replacement for the products they use today until it has been approved for this certification. Second, the expected price that could be charged turned out to be much lower than anticipated since Product A is a specialty chemical targeting a traditional commodity market where. This was not really a surprise, but there was thought that niche segments existed with other requirements where a premium could be charged, however those segments proved to be few. Third and final, when the initial plan was formed there was demand from the market to replace the current main product. Since then, competing products has met most of this demand leaving little space for a new product to enter the market.

Product B

Product B is a commodity chemical which rather easy to produce but hard to handle and simultaneously keep a tolerable work environment. The development of Product B was not a diversification project since the main customer for Product B is ChemCo themselves, a market which is known. Table 2 shows two things. First, actual volume sold exceeds the expected amount outlined in the plan. Second, actual margin contribution exceeds the expected amount by almost double.

Table 2. Expected and actual sales of Product B.

Product B	Unit	Year 1
Expected volume sold	MT	670
Actual volume sold	MT	838
Expected margin contribution	SEK/kg	4,36
Actual margin contribution	SEK/kg	8,04
Expected total margin contribution	MSEK	2,9
Actual total margin contribution	MSEK	6,7

The product manager named four reasons why the actual outcome deviated from the plan. First, the price was set with a conservative approach. Second, the price was the basis for the expected volume, and with a conservative price, the volume was also set conservatively as a result. Third, the expected volume had no real basis in the form of customer lists or similar helpful documents, and was mostly a qualified guess. Fourth and final, the plan was only created to show the profitability of another product, of which Product B is an important part. A significant part of Product B is bought internally for this reason, which gives ChemCo a cost advantage in comparison with other manufacturers that has to purchase material similar to Product B elsewhere to a higher cost.

Product C

Product C has not yet been commercialized and is currently in the market verification phase. Little information is available on the business plan of Product C, and it is unclear whether a business plan at all exists. The development of Product C is not a diversification project since it builds on an existing product line. It does however target the bioplastics market, which is unknown to ChemCo. Table 3 reveals that actual volume sold is in a decreasing trend over the time span of the data.

Table 3. Expected and actual sales of Product C.

Product C	Unit	Year 1	Year 2	Year 3	Year 4
Expected volume sold	MT	N.A	N.A	N.A	N.A
Actual volume sold	MT	181	126	120	111
Expected margin contribution	SEK/kg	N.A	N.A	N.A	N.A
Actual margin contribution	SEK/kg	N.A	N.A	N.A	N.A
Expected total margin contribution	KSEK	N.A	N.A	N.A	N.A
Actual total margin contribution	KSEK	N.A	N.A	N.A	N.A

The product manager names four reasons to explain the actual outcome. First, there was limited internal laboratory equipment that has limited testing capabilities. This caused ChemCo not being able to provide prospective customers with enough support to enable switching to Product C. Second, Product C is a specialty chemical, which means that a customer cannot simply switch from their current solution to Product C without modifying their production process. Customers have needed technical help with this, which ChemCo has seldom been able to provide due to limited resources. Third, Product C is missing an approval for a certification that is important for several target applications, which has caused some customers to look for competitors' solutions. Fourth and final, the pricing strategy for Product C has not been properly propagated to ChemCo's sales organization. The product manager frequently encounters customers that have declined a price quote for Product C that is far above the decided margin interval, despite repeated reminders to the sales organization.

Product D

Product D has not managed to get a commercial breakthrough despite having been commercialized for quite a few years. Table 4 reveals two things. First, there is a large difference between actual volume sold and expected volume sold. Second, the actual margin and expected margin seem to correspond fairly well, but such low volumes are usually for testing purposes only and are not sold at a price representative of commercial sales.

Table 4. Expected and actual sales of Product D.

Product D	Unit	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Expected volume sold	MT	10	40	200	400	600	800	1000
Actual volume sold	MT	2,3	14,6	5,8	20,4	10,9	5,6	1,9
Expected margin contribution	SEK/kg	25	25	25	25	25	25	25
Actual margin contribution	SEK/kg	35	35	26,2	25,4	25,3	6,2	0
Expected total margin contribution	KSEK	250	1000	5000	10000	15000	20000	25000
Actual total margin contribution	KSEK	81,9	511,7	151,5	517,1	275,1	34,9	0,0

The product manager names fours reasons why the actual outcome deviates from the expected plan. First, Product D suffers from performance issues that limit its application to very rigid materials. Second, there are technical limitations to Product D in certain applications where it causes carbon dioxide emissions that deform the storage drums because of the pressure. Lots of effort went into resolving this issue but failed since it was an inherent property of Product D. Third, Product D is a specialty chemical that requires adaption of the customer's production process. ChemCo has lacked the resources to provide prospective customers with this technical support. Fourth and final, the price of Product D has been too high to compete with similar products, and since Product D has never been produced in a larger scale, it has not been possible to reduce the price.

Product E

Product E is a product that is commercialized and sold directly to end-consumer, which is quite unusual among ChemCo's products. The product is made from a commodity chemical with some modifications. Most of the sales of Product E outside the EMEA region are handled by distributors. Table 5 shows that Product E's actual volume sold matches quite closely to the expected volume from the plan.

Table 5. Expected and actual sales of Product E.

Product E	Unit	Year 1	Year 2	Year 3	Year 4
Expected volume sold	MT	N.A	130	480	1030
Actual volume sold	MT	29	198	444	831
Expected margin contribution	EUR/kg	N.A	N.A	N.A	N.A
Actual margin contribution	EUR/kg	1,06	1,23	1,27	1,12
Expected total margin contribution	KEUR	N.A	N.A	N.A	N.A
Actual total margin contribution	KEUR	30,5	245	563	929

The product manager says that Product E performed according to the plan, but that the plan was rather limited in scope. Further, the product manager thinks that the reevaluation of the value proposition in conjunction with well-funded marketing campaign was the starting point of a fast growth rate in sales. However, it took ChemCo two years to find out which grade of Product E that was right for the target customers. Additionally, sales were slowed initially due to a limited sales capacity, which was why the decision was made to use distributors in some markets.

Product F

Product F is a product that is new to the world and has been commercialized. Table 6 shows two things. First, there is a large difference between expected volume sold and actual volume sold. Even when the plan was revised in Year 4, Product F struggled to reach its volume targets. Second, there is a large discrepancy between expected margin contribution and actual margin contribution, and the actual margin contribution seems to fluctuate rather much from year to year.

Table 6. Expected and actual sales of Product F.

Product F	Unit	Year 1	Year 2	Year 3	Year 4*	Year 5*	Year 6*	Year 7*
Expected volume sold	MT	300	400	500	50	50	50	75
Actual volume sold	MT	0	8	8	20	32	59	70
Expected margin contribution	SEK/kg	17,40	17,40	17,40	31,00	31,00	31,00	31,00
Actual margin contribution	SEK/kg	0,00	20,00	20,00	11,27	3,43	0,06	16,30
Expected total margin contribution	KSEK	5220	6960	8700	1550	1550	1550	2325
Actual total margin contribution	KSEK	0	156	163	230	110	4	1131

* Original plan was updated after Year 3.

The product manager names two reasons as to why the actual outcome deviated from thee expected plan. First, Product F is a specialty chemical that has one major competing product established on the market. Like most specialty chemicals, Product F cannot be used interchangeably with competing products without adapting the customers' production processes. Product F did in general receive very positive feedback but was considered too expensive to adapt to for the customers. Second, the variable cost of producing Product F became higher than expected due to losses in the production. It is the opinion of the product manager that a drop-in solution that could be used interchangeably with the major established product should have been developed in order to be successful.

Analysis

In the introduction, two research questions were formulated. The first research question aims to find the sources of poor sales performance of new products, while the second asks how the new product development process can be improved. Since the second questions builds on the first, the first question must be addressed before an improvement can be suggested.

The New Product Introduction process, ChemCo's implementation of the Stage-Gate model, covers most of the stages prescribed by Cooper (1983), as depicted in the comparison of corresponding stages in Table 7. It is therefore likely that the NPI process, similar to the Stage-Gate model, will create successful products when the customer and market is known, and there mostly exists technical uncertainty. However, what about the projects where the customer and market are unknown, where there is both market and technical uncertainty? Those projects do not constitute a very good fit with the NPI process since it is not designed to minimize market uncertainty, and are therefore at higher risk of poor sales performance. Moving away from process structure and zooming in on a more detailed level, an examination of project documentation may give additional insight on the subject matter.

Table 7. Corresponding stages of the Stage-Gate model and the New Product Introduction Process.

Stage-Gate	**New Product Introduction**
Preliminary Assessment	Concept Evaluation (Market desktop)
Concept	Concept Evaluation
Development	Development
Testing	Product Verification/Prestudy
Trial	Market Verification/Basic Engineering
Launch	Commercialization

The business plan is the master document in which all information on a project is gathered in a vast pile of data. Recall Cooper's (2014) words on managing uncertainty in new product development that gathered information is only valuable if it can reduce uncertainty or validate assumptions of economic consequences. Even if the business plan contains information that can be used for decreasing market uncertainty, it is not valuable if the information is too dispersed. A lengthy document such as the business plan that is managed by a team of people quickly becomes difficult to understand and hard to get an overview of. Further, it is questionable if the form in which the information is presented in the business plan actually conveys that it is indeed assumptions that the project is built on.

The business charter is a document considerably shorter than the business plan and thus easy to understand and overview regardless of the number of people managing it. Therefore, it is a document where it would be suitable to gather all the assumptions that the business model of the new product builds on. The issue with the business charter is that it fails to make the connection between the product and the market. Only one element of the business charter considers the market, the external justification, but even that justification is based on ChemCo's internal view than that of the market. Further, there is no connection between the external justification and the value proposition of the new product assessing the fit between product value and target segment needs.

To sum up the documentation, problems have been revealed in two important documents used in the NPI process. First, the business plan contains too lengthy and dispersed information to identify the assumptions and information gathered to validate these assumptions. Second, the business charter uses improper categories of assumptions to be an efficient tool in assessing the product/market fit. If the assumptions of a product's value proposition and targeted markets are not understandably stated anywhere in the project documentation, how can it be clear when these assumptions are valid and market uncertainty is low? With the reasoning above, one should expect to find empirical evidence of invalid assumptions relating to market uncertainty in the projects that ChemCo has previously developed.

Out of the six new products developed by ChemCo that were presented in the findings, four are considered suffering from poor sales performance. First, in Product A, the requirements for the certification needed were more elaborate than expected. Further, the expected price that the market was willing to pay was considerably lower than assumed. Second, in Product C, the assumption was made that the target market could be entered without a certification, which proved to be wrong. Third, in Product D, again the expected price the market was willing to pay was considerably lower than assumed. Additionally, Product D had fewer application areas than assumed due to performance issues. Fourth and final, in Product F, the customers' costs of adapting their production processes were too high to make a switch to Product F worthwhile. These are all examples of new products that have progressed through development with invalid assumptions. Product D for example, should most likely have been killed off in a gate if the process of stating and validating assumption had been properly set up. Instead, new products have been allowed to progress all the way to the commercialization phase without the market uncertainty surrounding the assumptions being reduced. A plant is built, which requires a production volume similar to the sales volumes estimated in the original business case to be economically viable. When those sales volumes turn out to be much lower than expected, products have caused poor sales performance. It should be noted that all the unsuccessful products (A, C, D, and F) were specialty chemicals while the two successful products (B and E) were commodity chemicals. It is not too farfetched to assume that assumptions pertaining to commodity chemicals are more likely to be correct than assumptions pertaining to specialty chemicals, since markets for specialty chemicals are subject to more uncertainty. The evidence suggests that the NPI process is unsuitable for use in projects with high market uncertainty as it does not provide the tools for reducing market uncertainty.

Other factors likely also play a part in why sales performance is low. When the product managers were inquired about marketing efforts, not a single product had a marketing plan or marketing budget until last year, when a marketing function consisting of three employees was deployed in the organization. Cooper (2004) found that the organizational function that most commonly experiences insufficient resources across all levels of performers is marketing. ChemCo's marketing budget for 2015 is approximately 1.2 ‰ of the revenues of 2014. While no studies or reports of average marketing budget as share of revenues for the chemical industry have been found, Forrester Research Inc. (2014) found that B2B-firms spend on average 4 % of revenue on marketing activities. Since the report covered large B2B-firms in general, the figure for the chemical industry should be expected to be a few percentage units lower due to the nature of the industry, which contains rather few but large firms due to the firm scale required for profitability. Still, the 1.2 ‰ figure is most likely very low also in the chemical industry setting, and has been even lower in previous years prior to the deployment of the marketing function. Insufficient marketing resources could also help explain why specialty chemical products have performed worse than commodity chemical products. Potential customers of commodity chemicals need less information about a product in order to make a purchase. It is enough knowing the price of the product and the delivery capacity of the supplier. Potential customers of specialty chemicals have less knowledge of the product beforehand, which means that marketing has an important role in educating these customers on the benefits and features of using specialty chemicals products. Therefore, insufficient marketing resources will probably have a larger impact on sales performance of specialty chemicals products than commodity chemicals products. Besides the amount of resources spent on marketing, it is unclear if the available marketing resources are spent efficiently. The marketing plan is an imperative tool in the commercialization phase of the NPI process to spread maximum awareness at product launch. Since marketing plans were missing, there is reason to believe that either the marketing activities used in previous product launches have been uncoordinated and inefficient or too few of them have been done. Obviously, ChemCo has also identified room for improvement in their marketing since they have deployed it as a new function in their organization.

On a final note on sources of poor sales performance, the comparison between expected and actual sales may cause misconceptions since ChemCo takes actual sales of products that have not reached the commercialization step into account. Products that have not reached the commercialization step may not have had any marketing efforts to increase the awareness of them. By not recognizing this distinction may lead one to believe that it is the value proposition or performance of the products that are the source of poor sales performance. Instead, the cause could be project delays that cause a time lag between expected and actual figures, which leads to comparing apples and pears. The issue then, is to investigate the cause to the project delays, which could be technical issues in development or issues with obtaining a critical product certificate.

Process Suggestion

In the previous chapter, it was found that new products previously developed by ChemCo suffer from poor sales performance for several reasons. This chapter aims to outline a method to reduce market uncertainty by testing and validating assumptions of value proposition and customer segments in the development process. This will not necessarily boost the sales of new products, but rather aims to increase profitability by discarding new products relying on false market assumptions. Issues stemming from market uncertainty particularly affected specialty chemical products. Among the new specialty chemical products developed at ChemCo, many would be categorized as diversification projects as defined in the introductory section. The connection to diversification projects has a purpose. Even if not evident in this sample of products, there is nothing stopping commodity chemical products from being categorized as diversification projects. A modified process should hence not depend on the type of chemical in the new product. Rather, it should depend on the level of market uncertainty subject to the assumptions of the value proposition and customer segments of the new product. Since products of diversification type are subject to the greatest market uncertainty in the Ansoff matrix, those should be targeted by this modified process. Products that are not of diversification type should still be developed with the NPI process.

The suggested process consists of four steps. The first step is classification, since the process is intended for use on projects classified as diversification projects only. The second step is to depict the envisaged business model of the project for use as an overview support document. The third step is to evaluate each individual customer segment that has been identified as target segments of the product in the business plan, in order to assess the fit between the segment and the product. The fourth and final step is to summarize the segments and compare the result with the original business plan. An overview of the process is shown in Figure 11.

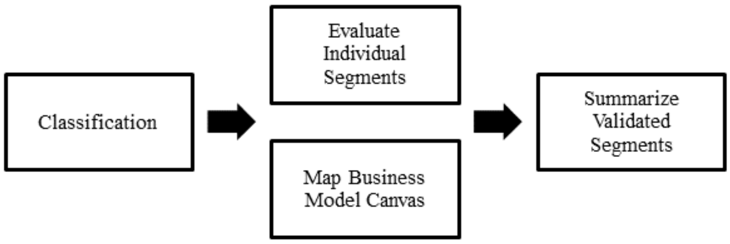

Figure 11. Overview of the suggested process.

Three tools are used in the process. First, the Ansoff matrix is used to classify projects in the classification step. Second, the business model canvas is used to carry a summary of the business model of the product. Third, and most important in this process, is the value proposition canvas, which is utilized to evaluate the segments that are targeted by the product. A separate value proposition canvas is used for each segment that is evaluated.

The suggested process is to be initialized and run in parallel to the concept evaluation stage of ChemCo's NPI process, and must be completed before the TG3 gate as seen in Figure 12. The reason for this placement is the important decision of whether to build a new pilot plant that is made in the TG3 gate based on the outlook of the project in the preceding stage. The purpose of the suggested process is to provide material for improved decision making in this gate, which may save ChemCo from wasting considerable financial resources on projects with poor target segments fit. The suggested process is to be performed in addition to the activities specified by the NPI process. The suggested process does not replace any other activity.

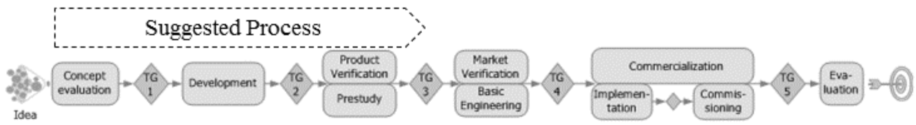

Figure 12. Initialization and completion points of the suggested process in relation to the NPI process.

Classification

The initial step of the suggested process is to classify the project in the Ansoff matrix. If the product to be developed is of diversification type, the project shall be classified as a diversification project and subject to the suggested process. The classification type shall be recorded in the business plan. The suggested process is not mandatory for projects that receive other classifications, but are recommended for projects subject to high market uncertainty.

Map Business Model Canvas

This second and the third step run in parallel, as the second step requires little effort to complete. The intended business model is to be mapped onto the nine building blocks of the canvas. Since ChemCo has an established business model, the business model canvas of different projects will likely not differ by much. The value the canvas can provide to the project is to describe the logic of key partners such as tolling producers, key resources such as important compounds or intellectual property, and key activities. This is useful to make sure that all members of a project make decisions based on a common premise and agree on how the company can appropriate maximum value from the project. Therefore, the business model canvas is to act as a supporting document in a project.

Evaluate Individual Segments

The third step is evaluating individual segments that the product is targeting. This step is a sub process of the main process and is to be invoked for every segment that is to be evaluated. The steps of the sub process are shown in Figure 13.

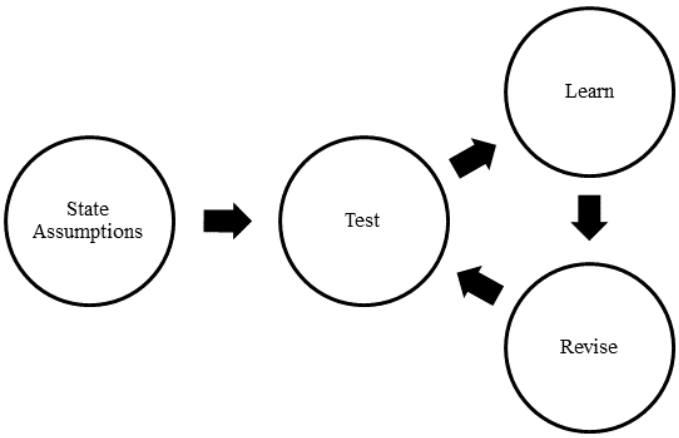

Figure 13. The process of evaluating each individual segment.

The sub process consists of four steps. The activity and purpose of each step is briefly summarized in Table 8 below.

Table 8. Summary of the steps of the sub process.

Step	Action	Purpose
State Assumptions	State assumptions on the value proposition canvas	Visualize what uncertainties the product depends on in each segment in order to make them testable
Test	Conduct interviews and utilize consultancy or market research firm	Gather data
Learn	Analyze gathered data	Draw conclusions from the test step
Revise	Update the canvas, adapt the product when possible	Decision to move forward or scrap a segment

State Assumptions

The first step is to state the assumptions the project relies on regarding the specific segment. The assumptions are to be written down on a new value proposition canvas specific to the segment. The pain and gain block of the customer side of the canvas are the most important parts of the canvas to fill in extensively since they should contain the assumptions that give rise to market uncertainty for ChemCo. This activity should be done through a meeting where the project members jointly come up with the assumptions of the segment that are necessary for the product to be successful in that segment.

Test

The second step is to design and perform tests to validate the value proposition and customer segments assumptions. A test should show a repeatable outcome in order to validate or invalidate an assumption. Two ways to perform a test are at ChemCo's disposal. First, interviews with prospective customers are an excellent way to collect first-hand information of customer needs. The downside is that scheduling an interview with a customer that ChemCo has no previous relationship to may prove challenging. Second, ChemCo has access to a consultancy firm that connects clients with industry experts for both telephone interviews and in-person meetings. Interviews with industry experts may provide excellent opportunities to test assumptions on a market level, such as pricing for example. The test step should start in the development phase, but some assumptions may require to have progressed to the product verification phase before testing can be initiated.

Learn

The third step is learning. Learning takes place when analyzing the data acquired in the testing step to either validate or invalidate an assumption. When an assumption is validated or invalidated, a new updated version of the value proposition canvas for the segment should be created so that canvas version history is preserved. Since the available population size to sample from may vary greatly from one segment to another, it is difficult to specify a threshold of how many data points that should be acquired in order to validate or invalidate an assumption. However, it is recommended that ChemCo does not validate an assumption on less than 10 data points.

Revise

The fourth step and final step of the sub process is revising. The purpose of this step is to adapt the product to reflect what was learnt in the previous step. Note that the chemical industry is special in the sense that the degree of freedom in changing a new product may sometimes be very limited due to physical properties of the chemical. Therefore, it may not always be possible to revise the product properties so that the value proposition fits with the target market segments. In those cases, either the specific segment should be dropped and other segments should be targeted, or if the financials do not make sense without the specific segment, the entire project should be killed. The cycle of the three last steps is to be repeated until all assumptions on the value proposition canvas have been validated or the project is killed. The reason to why they are placed in a cycle is two-fold. First, it is difficult to test all assumptions in the same test. Second, if new information on a segment that may constitute a gain or pain assumption is discovered, the sub process should accommodate consecutive rounds of testing and learning to adapt to this information.

Summarize Validated Segments

The fourth and final step of the suggested process is to quantify the potential value of the project for the company in the segments that constitute a good fit with the product. The valuation is to be conducted the same way as ChemCo forecasted the expected sales in the original business plan. The idea is that this valuation supposedly is made on a foundation of better market knowledge of each targeted segment than the original forecast of expected sales. Some segments that were included in the original forecast of expected sales may have been discarded due to poor fit with the product, which will lower the value of the project. Conversely, some segments may have a greater fit than expected and the new product will gain a greater market share than expected, which will increase the value of the project. Some variables must be known or estimated to be able to summarize the value of all validated segments. These variables are the size or volume of each segment, the share of that size or volume the product may overtake, and the price and cost of producing the product per unit of volume. The summarization of the total value of all validated segments is recorded in a document, and can now be properly compared with the forecast of the expected sales in the original business plan. The documentation created in the suggested process is a business model canvas, one value proposition canvas for each targeted segment, and the summarization of the value of all validated segments. All of these documents is to be delivered to the TG3 gate where the decision whether to build a pilot plant and continue the project, or scrap the project, is made.

Conclusion

The analysis names three reasons to why sales performance of new products is poor. First, the NPI process is lacking a structured method to reduce market uncertainty. This leads to the commercialization of products in segments that does not fit well with the product's value proposition. Second, it is a possibility that the absence of a marketing function has impeded sales performance of new products, both in terms of coordinating product launch activities as a low marketing budget. Third, the way ChemCo compares expected sales and actual sales does not make for a fair comparison since the actual sales is measured for products that have not even been commercialized. As for the second research question, the suggested process offers a method to mitigate the problem of how to reduce the market uncertainty of diversification projects. The suggested process consists of four steps to classify a project, evaluate its targeted segments by validating project assumptions about the market, map its business model, and value the validated targeted segments.

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