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PRODUCT LIFE CYCLE

A ROADMAP FOR VALUE MANAGEMENT

VOORTMAN
STEEL MACHINERY

UNIVERSITY OF TWENTE.

Product Life Cycle: a roadmap for value management

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Abstract: In the current literature a Product Life Cycle (PLC) is often presented in terms of phases, with most common models including introduction, growth, maturity and decline phases. These phases are characterized by such variables as number of sales and number of competitors. However, today's global markets are increasingly more dynamic as a result of open innovation and ever-expanding globalization. As such, the current PLC models are obsolete as they are too static and limited in use in today's business environment, where non-measurable fluctuations commonly occur. A new PLC model is therefore needed to accurately plan PLC's in a faster, more dynamic, and more fluctuating market. This paper proposes a new model, which is tested for its usability within an industrial company.

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"The only true wisdom is in knowing you know nothing"

~ Socrates ~

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Introduction

Current business environments are increasingly competitive; they force organizational managers to constantly evaluate how their business should respond to opportunities and market changes (Birou, Fawcett, & Magnan, 1998). In order to maintain organizational goals such as market growth or profit enhancement, organizations need to develop new products, services and improve their processes by implementing innovations and adopting marketing strategies to achieve their goals. Examples of strategies are Porter's value chain models and cost/differentiation strategies (Porter, 1980), the market orientation strategy (Narver & Slater, 1990), and Miles and Snow's strategic types (Miles, Snow, Meyer, & Coleman, 1978). Others refer to typical value strategies such as that of Treacy and Wiersema (1993) and, related to that, typical marketing strategies as discussed by Blythe (2009). An important facet of any strategy is the inclusion of the so-called Product Life Cycle (PLC) for each product group of a company (Dean, 1950).

PLC is a strategic management tool for business marketers and managers to make decisions on the lifecycle of a product (Brennan, Canning, & McDowell, 2011). This lifecycle refers to the period from the product's first launch on the market until its final withdrawal and is currently split up into phases (Komninos, 2002). PLC's draw on a set of criteria (sales, time, etc.) that enable managers to make the right decisions regarding the adjustments of marketing mix components over time. The PLC is an important part of marketing management for three different reasons. (1) The turning point in PLC causes variation in pressure on managers. (2) The sales and growth level varies dramatically across PLC. (3) Prices and costs descend substantially over the life cycle. (Golder & Tellis, 2007). It is the ability to identify and define competitive priority and product characteristics that makes PLC an appropriate model to serve as an integrating facilitator, which can lead to effective and efficient use of resources in today's competitive environment (Birou et al., 1998). The frequent analysis of PLC had led to the concept becoming a 'given' for many executives (Grantham, 1997).

However, in contemporary marketplaces, it is increasingly difficult for managers to identify the exact phase of a product offering in a PLC. This is especially the case in turbulent markets. For instance, Dean argued as early as 1950 that the length of PLC phases is a function of the rate of market acceptance, technical change and competitive entry. In addition, competitiveness and the rate of technological change increase due to globalization and concepts like open innovation (Chesbrough, 2003) and cluster innovation, which can be characterized by a network of closely interdependent production or services firms linked to each other in a value adding process (Roelandt & Den Hertog, 1999). The current literature on PLC provides tools to analyze PLC together with some basic strategies (Clifford, 1965; Polli & Cook, 1969; Hofer, 1975), but the prevailing strategies to adjust the market offering to the PLC phase display a relative neglect in their inclusion of market dynamics and technological developments.

The goal of this paper is therefore to design a usable PLC model based on identified gaps in the literature with which to analyze PLC in the current turbulent business environment. This model has been tested using action research in the form of participant observant to ensure its usability; a roadmap is be provided to increase usability. The model is needed because an understanding of PLC provides a good balance between product design, manufacturing, marketing and sales approach, and is

fundamental for organizational success (Rink & Swan, 1979; Cohen, 1997; Lowry, 1997). The goal is attained by answering the following research questions:

(1) *How can a PLC be analyzed integrally from a dynamic perspective so that companies can improve their decisions regarding PLC strategies?*
(2) *How usable is the designed model in a business environment?*

The usability of the designed model, which will be the outcome of the above research question, is illustrated in a business context. By applying the designed model in a business context, errors can be identified and adaptions made that will increase the usability of the model for further use in practice. The designed model will be used within Voortman Steel Machinery, which is one of the highly innovative, internationally operating companies of the Voortman Steel Group (Voortman Steel Group). Voortman Steel Machinery has designed, developed and manufactured machinery for steel fabrication and plate processing industries for more than 45 years. With international subsidiaries responsible for sales and service, the company is are a globally recognized supplier with thousands of Voortman systems installed. The range of equipment is continually under development to stay at the forefront of technology and in step with any new developments in the market (Voortman Steel Machinery). The problem that occurs within the management of Voortman Steel Machinery is that of understanding PLC within the current dynamic market. This paper is an attempt to clear the ground for Voortman Steel Machinery to provide a tested model to improve their understanding of PLC.

The paper is structured as follows: (i) The next section provides a literature review on the concept of PLC and its compositional features, which identifies the need for a dynamic PLC framework with it specific variables. (ii) After that, the framework is introduced in the company context and data are collected about how actors in this company deal with the model and how it informs their market strategy. (iii.) The result section will reflect on the practical use of the model. (iv) Thereafter, we conclude the research and discuss the theoretical contributions and implications as well as its practical implications, including a roadmap showing how to use the designed model, who needs to be involved, and the actions that need to be taken. Finally, we discuss the limitations of this study and offer avenues for further research.

Theory

In this section, we first analyze and summarize the existing literature on PLC, together with the known variables showing how to analyze PLC and which strategy to follow in a particular situation. After identifying the gap in the literature, we propose our tentative framework for analyzing PLC and it strategies.

What is known about PLC and its strategies.

The literature emphasizes that PLC usually consists of four basic phases: introduction, growth, maturity and final decline (Levitt, 1965; Cox, 1967; Hofer, 1975; Terzi, 2005; Golder & Tellis, 2007; Cao & Folan, 2012). However Rink, Roden and Fox (1999), and Komninos (2002), differ from the majority by stating that PLC needs an extra phase before introduction. They call this 'pioneering' or development. This phase focuses on developing, testing and adjusting the product before it enters the market. Others have introduced a saturation stage between maturity and decline (Souerwine & Schnidman, 1984) or, instead of the terms maturity and decline stages, they used the terms early growth and late growth (Canning & Berry, 1982). Reviewing the basic four phases, and based on the existing literature, the following can be concluded.

- *Introduction phase* - The introduction phase is characterized by introducing the product to the market. Bringing a product to the market is fraught with uncertainties, unknowns and frequently unknowable risks. One such unknown is the demand for the product. Demand has to be created during this introduction phase and the speed of demand growth depends on the complexity, degree of novelty, customer needs and substitutes (Levitt, 1965). The demand rate can be enhanced by communication activities such as public demonstrations, exhibitions, trade shows and other possibilities for attracting market publicity. A rapid growth in demand is needed because the introduction phase is the first opportunity to contribute to the development costs. This does not mean that this phase automatically provides profit for organizations. Due to high marketing costs there is a chance that costs will still exceeds sales (Brennan et al., 2011). The main objective of the introduction phase is to create a widespread awareness whereby the investment made in new products pays off and the product or service moves into the growth phase (Ryan & Riggs, 1996).

- *Growth phase* - This phase is characterized by market acceptance. Market acceptance can be recognized by a more rapid increase in demand in comparison to the introduction phase. The ground rule of the growth phase is a rapid increase in demand and sales, which exceed costs (Brennan et al., 2011). Within this phase competition increases due to rising demand and market opportunities together with lower risks. This higher competition leads to the third -maturity- phase (Levitt, 1965).

- *Maturity phase* - Sales stagnation and market saturation characterize this phase. Most prospective customers, whether companies or households, already own the product. Sales only increase when new households or companies enter the specific market. Suppliers need to find other ways to increase profit than by just selling more (Levitt, 1965). Or, as Rudenko and Brisov put it: "The maturity stage is a good stage for every product, but wrong manager decision can change the stage to decline" (2008, p.

1).

- *Decline phase* - Within this phase sales drop; a few firms survive this descent longer than their competitors. The descent now characterizes the industry. Only cases where drastic action is taken can play a revivifying role in the market (Levitt, 1965).

Product life cycle is fundamental to determining a successful business strategy (Hofer, 1975; Anderson & Zeithaml, 1984; Birou, Fawcett, & Magnan, 1998), which is needed to gain a competitive advantage, leading in turn to increased business performance (Day, 1984; Porter, 1985)**.** There are some differences within PLC. The literature emphasizes that not all cycles are like the classic cycle explained above. Cox (1967), together with Swan and Rink (1982), state that there are different kinds of PLC patterns. The length of different stages in PLC differs from product to product. Some products have scarcely any growth stage, whereas others have an introduction and maturity stage that is hardly visible (Dhalla & Yuspeh, 1976). "Product managers should not plan their marketing strategy blindly around the classic PLC. Rather they need to realize that a number of PLC patterns have been found, and that marketing strategy should be both a response to and an effective agent on the cycle." (Swan & Rink, 1982, p. 76)

To align the PLC with a coherent strategy, the PLC needs to be reliably identified since it gives organizations opportunities to evaluate tactical and strategic considerations related to product and market policies (Polli & Cook, 1969). But do managers have a good understanding of PLC? Mercer (1993) and Birou et al. (1998) studied managers' understanding of PLC's. Both studies found that the majority of managers perceive PLC as a concept that is relevant to the introduction phase of a product. This indicates that managers do not understand the importance of having PLC in place to manage the evolution of value over time, which may result in a poorer competitive advantage, because competitive advantage can be created by aligning the strategy to PLC (Birou et al., 1998). To create this alignment, managers need to know how to analyze PLC and how to anticipate changes. The current literature fails to provide the appropriate tools in the current dynamic environment to analyze the current state of a PLC of any product in the dynamic market.

The main tool that the literature identifies for PLC analysis is based on sales. The PLC model hypothesizes that sales follows a specific pattern for the different phases of PLC since the principal components of the model are: (1) stage identification, (2) changes in sales, and (3) sequential sales behavior (Polli & Cook, 1969). Polli and Cook (1969) analyzed the normal distribution of sales to determine in which phase a product is, based on the standard deviation. They state that when managers look at sales data relating to well-defined markets with a certain class of goods, the percentage change in real sales for each product would vary from strong negative to large positive values. Plotting these percentage changes is expected to yield a normal distribution with a mean of zero. Polli and Cook assigned specific boundaries to the theoretical distribution of percentage changes. Polli and Cook (1969) emphasized that the introduction phases can be defined as a sales period where the sales are less than five percent of the observed peak level. The growth phase is represented by values greater than + ½σ. Values between - ½σ and + ½σ are considered to represent the maturity phase. This phase is divided into three sub-phases: sustained maturity phase for small positive percentage change; decaying maturity phase for small negative percentage change; and stable maturity phase for no significant percentage change. Finally, values less than -½σ are

considered to represent the decline stage. Testing the validity of this model resulted in a recommendation to use the model in a given market, where it was found to be valid. The question that arises is how to take the environmental factor into account. Clifford (1965) identified a seven-step approach to pinpoint the location of a product in its life cycle by taking environmental factors into account. The analysis of these steps may vary among companies but the baseline is the same. According to Clifford (1965), to pinpoint the location of a product managers should look at: the historical trend of the product (including prior strategies regarding the product) and similar products, competitors' trends and short-term strategies, estimate expected sales, and lifetime.

Levitt (1965), together with Swan and Rink (1982), state that PLC does not just happen, but is a result of a number of factors that need to be taken into account (e.g. marketing factors, strategy factors, environmental factors). Close familiarity with these factors can result in a better PLC in the future. Swan and Rink (1982) distinguish between three different future PLC's; potential PLC, forecast PLC, and demanded PLC (Figure 1). Optimal use of the above factors could result in a transition to the potential PLC, whereas minimal interaction with these factors can result in a transition to the demanded PLC. So strategic planning has become a vital part of the organization practices (Kiechel, 1979). The literature on strategic management emphasizes the need to understand the interactions of organizations with their environment and stresses the alignment needed between products and their environment.

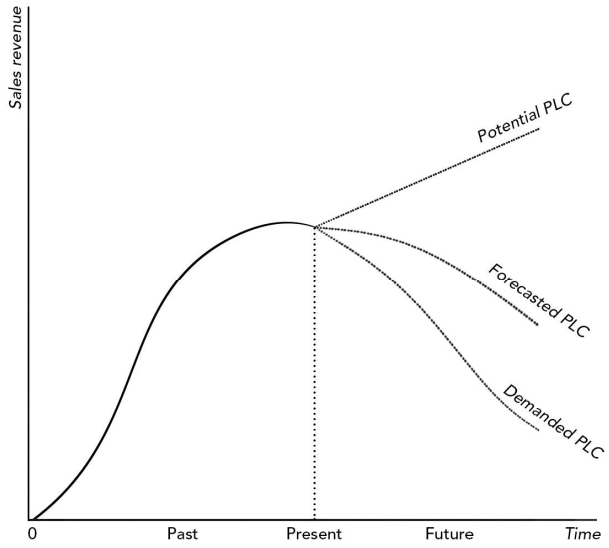

Figure 1: Realized, Demanded, Potential and Forecasted PLC
Source: Adjusted from Swan and Rink (1982)

However, the current analytical tools (Clifford, 1965; Polli & Cook, 1969), as mentioned above, and the specific strategies to follow (table 1), are due to globalization and dynamism not able to perfectly align products with their environment and are therefore not able to perfectly improve PLC.

Phase	Main Strategies (variables)	Sources
Introduction	- Create awareness	Wasson (1974); Ryan & Riggs (1996)
	- Spotty distribution	Hay & Ginter (1979); Wind (1982)
	- Informative advertising	Hay & Ginter (1979); Wind (1982)
Growth	- Product meeting customer need	Rumel (1979)
	-Enhance efficiency, economies of scales and avoid unnecessary costs	Rumelt (1979); Hambrick et al. (1982); MacMillan et al. (1982)
	- Full coverage distribution	Hay & Ginter (1979); Rumelt (1979); Wind (1982)
	- Premium pricing	Mac Millan et al. (1982)
Maturity	- Reducing Costs, improvement in efficiency and differentiation	Fox (1973); Hofer (1975); Hamermesh et al. (1978); Hay & Ginter (1979); Hall (1980); Wind (1982); Mac Millan et al. (1982)
	- Increasing market share	Buzzell & Wiersema (1981)
Decline	- Dry of all possible profit	Wasson (1974)
	- Decline in advertising and number of outlets	Hay & Ginter (1979); Wind (1982)

Table 1: Strategies per PLC phase

Regarding the analytical tools, the deviation in sales of Polli and Cook (1969) should be mentioned first. Problems may occur when using this tool when organizations have such a low unit of output that it is hard to determine the PLC. Sales can fluctuate in organizations for different reasons. For organizations with lower unit sales, internal and external environmental factors can have a huge impact on total sales. Therefore, a manager should not only look at an increase or decrease in sales to determine the PLC. Clifford (1965) identified environmental variables to take into account. However, these factors do not keep pace with the current dynamic market where the source of competitive advantage is shifting to customer value (Woodruff, 1997).

Regarding the various strategies to follow in the specific phases: although the literature intervention strategy recognizes each phase and identifies strategies for those phases, which covers the whole life cycle of the product, the process of this intervention strategy is too static in terms of successive phases. It cannot cope with dynamic markets where strategies change rapidly and specific strategies are needed in specific times for specific products at specific locations. Therefore, a more dynamic adaptation of strategy planning to the life cycle of a product is needed.

Towards a dynamic PLC model.

To identify a dynamic model to analyze PLC it is important to have an understanding of variables that affect the value proposition of products. A value proposition is: “the set of

benefits or values (that a brand) promises to deliver to consumers to satisfy their needs" (Kotler & Amstrong, 2013, p. 6). The higher value proposition will result in a better PLC. The gaps in value proposition can identify the potential PLC by exposing missed opportunities. There are few variables that affect the product's value proposition. The usability of the model designed and presented in this paper is focused on four main variables affecting the value proposition of a product and, consequently, affecting the PLC strategy. These key variables are: Product Specific Factors, Value for the Customer, Technological Turbulence, and Market Turbulence. Analyzing these variables can provide an insight into the product's current lifecycle and potential lifecycle. The main source for analyzing the current lifecycle is the product specific factors, technological and market turbulence. The gaps in value for the customer contribute to the analysis of the potential PLC. When managers understand the potential of a product and know the product's current situation, specific business strategies can be selected to formulate the potential lifecycle strategy. Within the model a distinction is made between market turbulence and technological turbulence, both of which can be classed as environmental turbulence. This distinction between technological and market turbulence is important, because organizations may have better technological capabilities than marketing competence. Competitive advantage can be created by balancing technological and marketing capabilities (Rajkovič & Vehovec, 2008). Appropriate actions can be taken by understanding the differences and their values.

- *Product specific factors* – An insight into the current lifecycle can be obtained by analyzing the units sold and sales margins. When the units sold and the sales margin drop, it could mean that the product is at the end of its cycle. However, some macroeconomic factors may also be responsible for this descent. Managers should therefore look at all the variables before drawing a conclusion.

- *Value for the customer* - "Value for the customer is any demand-side, personal perception of advantage arising out of a customer's association with an organization's offering, and can occur as reduction in sacrifice; presence of benefit (perceived as either attributes or outcomes); the resultant of any weighted combination of sacrifice and benefit (determined and expressed either rationally intuitively); or an aggregation, over time, of any or all of these" (Woodall, 2003, p. 21). The customer's valuation of the product has a major impact on sales. Therefore, understanding how the customer values the product in practice is important to adjust strategies in order to increase the value proposition, and improve the PLC. This is especially important in the current business environment, where customers have increased power through the Internet and Web 2.0, which provide them with more information and alternatives (Urban, 2005). Understanding the customers means that a contribution to business performance can be made (Narver & Slater, 1990). In their research Narver, Slater and MacLachlan (2004) found a positive relation between proactive market orientation and new product success. In order to understand customer value, various publications have identified drivers that describe / value the whole buying and experience process of the customer. Ulaga (2003) identified eight relational value drivers: product quality, delivery, time-to-market, direct product costs, service support, supplier know-how, personal interaction, and process costs. However, together with Smith et al. (1999), this paper distinguishes between four different values for the customer because these drivers provide a relatively compact description of the whole buying / experience process. (1) Value in acquisition (expertise of salesperson, role of information, payment terms, etc.); (2)

Value in delivery (customization, fitting into a production process, delivery time etc.); (3) Value in use (quality of the output, variation in quality and quantity of the output etc.); (4) Value in support (services, guarantee, etc.). In order to understand the value that a product offers to the customer an organization could ask customers questions about their value belief in the product and so determine their value perception.

- *Technological turbulence* – Technology can be divided into process technology and product technology and defined as the devices, knowledge and tools that participate between inputs and outputs (process technology) and/or create new product and services (product technology) (Rosenberg, 1972). The change in technology can be described as the concept of 'technological change', which has an impact on economic growth (Klein, 1984) and industry development (Lawrence & Dyer, 1983). The fluctuation and degree of technological change can be described as technological turbulence. Threats to the organization's product can be identified and appropriate action can be taken by analyzing differentiation in technology opportunities. This technological turbulence can be measured by patents. Patents, when sorted by date, can provide a good indicator of R&D activities in a market segment due to its highly disaggregated forms (Griliches, 1990; Popp, 2005). However, there are some limitations and it is important to be aware of them. The quality of patents varies widely among submissions, as does the rate of patents submitted per market segment (Popp, 2005). Besides patents, organizations should focus on new product or process introductions in their market segments. Competitors can introduce new products or processes without applying for a patent, looking only at patents can cause missed opportunities for analysis, meaning that a broader analysis is needed. This broader view is provided by asking organizations three questions relating to consequences of technological turbulence. These questions originate from Floricel and Ibanescu (2008) and are adapted to measure technological turbulence in particular. (1) Is your sector going through significant developments that nobody anticipated because of technological innovations? (2) Do external technological factors force unpredictable transformations in your sector? (3) Are the boundaries of your sector undergoing a major redefinition due to technological changes? Answering these questions permits technological turbulence to be detected and valued.

- *Market turbulence* - In this paper market turbulence is defined as different variables that affect the market and have an effect on a product's value proposition. Variables affecting the market are economic shocks (macro-economic), threat of new entrants, threat of substitutes, rivalry amongst existing firms, bargain power of supplier, and bargain power of customer (Porter, 1979). By understanding the market in which an organization is operating, fluctuations in sales can be explained and actions be taken. Economic shocks are macro environmental factors like hurricanes, earthquakes, boycotts etc., which affect sales. Other factors also affect sales. Porter (1979) identified five forces that influence sales and should therefore be taken into account when shaping the strategy. (1) New entrants bring new capacity and resources to the market, which will affect market share. (2) According to Porter: "Substitutes not only limit profit in normal time; they also reduce the bonanza an industry can reap in boom times" (1979, p. 142). (3) Rivalry amongst existing firms is characterized by price competition, product introduction, and advertising slugfest, which results in maneuvering the organization into the right position. (4) By raising prices or reducing the quality of product or services, a supplier can increase the bargaining power in a market where the

supply rate is low and the demand rate high. (5) In the reverse market, where demand rate is low and supply rate high, customers can increase their bargaining power by playing competitors off against each other – all forcing higher quality, lower prices and more service (Porter, 1979). Fluctuation in value proposition and sales can be explained by analyzing these macro environmental factors together with micro environmental factors, and adjustments can be made in value propositions together with product offerings (figure 2).

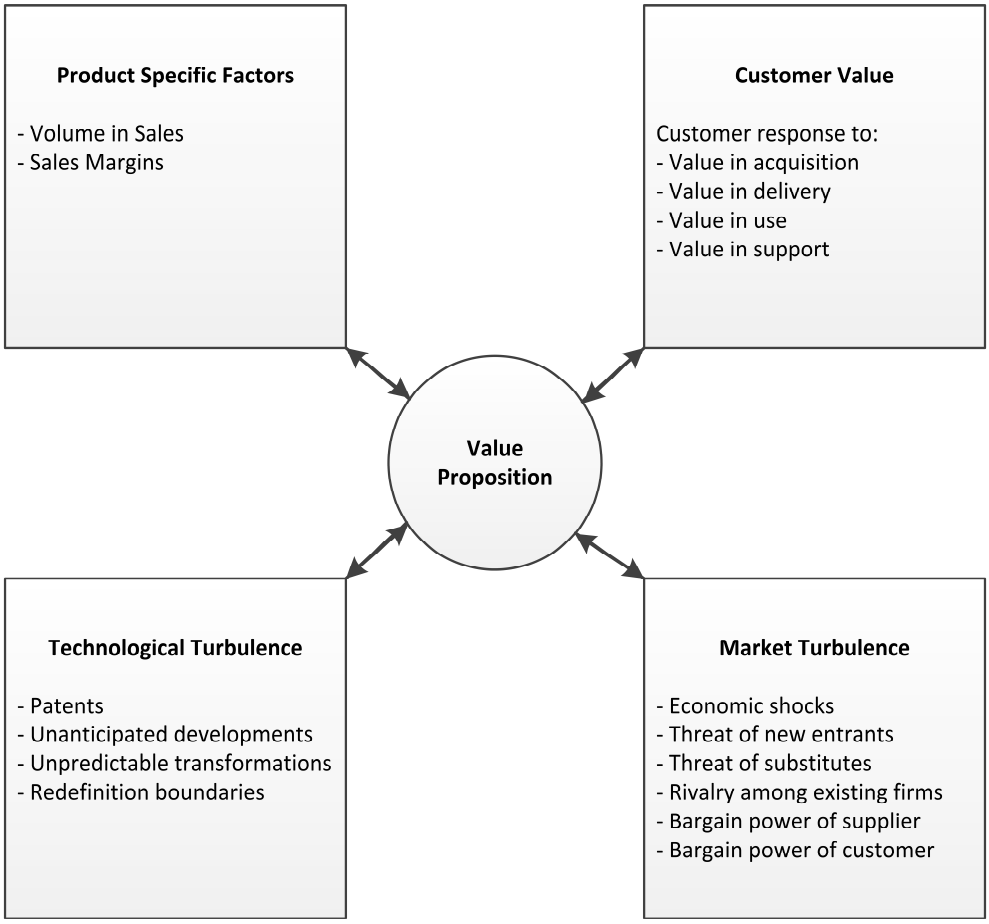

Figure 2: Variables to measure

In order to do so the following conceptual model (figure 3) has been developed. The first step to understanding and evaluating the PLC of a product in a dynamic market is to place the model in its context. This is done by describing the current situation of an organization (zero point) and thereafter evaluating the current situation on the basis of the variables: product specific factors, customer value, technological turbulence, and market turbulence, with their features (figure 2). The next step is to analyze the PLC and its potential on the basis of the earlier identified variables and current situation. After this an organization can choose either to adjust its value proposition or to wait and evaluate again after a period of time to determine the variation in product specific factors and customer value together with the degree of technological and market turbulence.

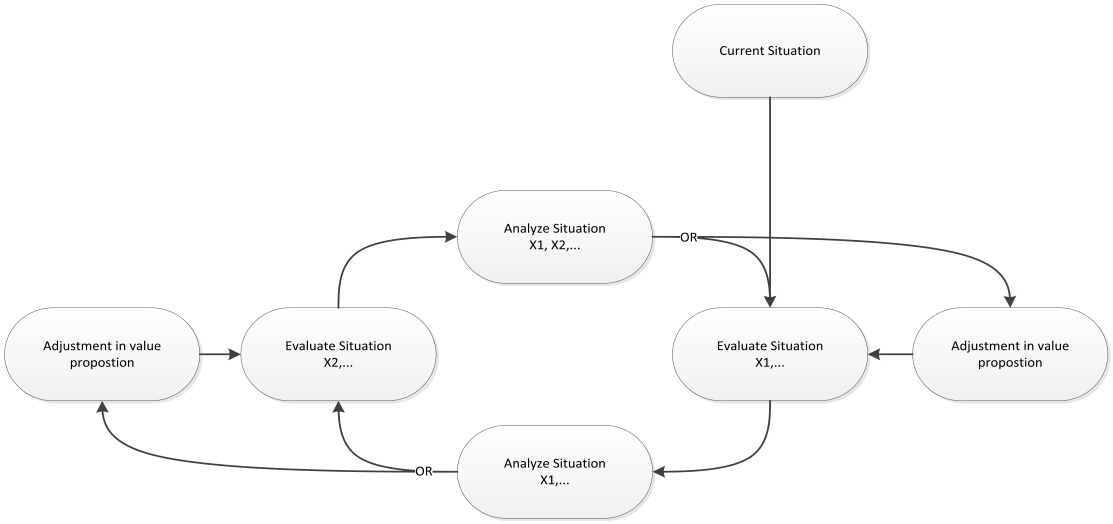

Figure 3: Model for PLC in dynamic markets

The question that arises is what period of time do organizations need to reevaluate their PLC? This question is hard to answer because it depends on technological and market turbulence in combination with economic shocks. Organizations operating in markets with high technological and market turbulence where, for example, new products are introduced to the market every year, need to evaluate their PLC more often than organizations where new products are introduced only once every five years. Besides that, economic shock may force organizations to re-evaluate their PLC faster than planned. Therefore it is hard to say how often the PLC should be (re-) evaluated, because this differs per market over time.

However, one thing is clear, there is a need for this conceptual model. By applying this model, organizations are able to expend the lifecycle of their product. This expansion of lifecycle together with a better understanding of the product in a particular market can lead to an increase in value proposition and therefore an increase in sales. It can even lead to such an understanding of products that decisions can be made regarding new product development or terminating the current product. The difference between the use of the classic PLC and the new dynamic PLC is shown graphically in figure 4.

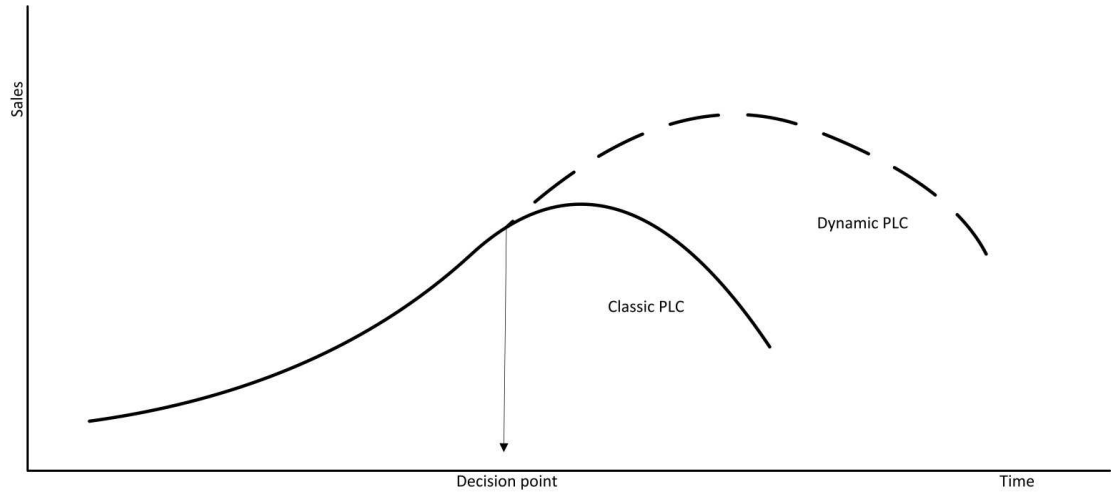

Figure 4: Expected difference in sales of Classic or Dynamic PLC

Methodology

The proposed model is the outcome of a theoretical discussion. Therefore, there is a need to validate the usability of the model in practice. In doing so, this chapter outlines the methods used to validate the model in a real-life business setting. Using the feedback of practitioners in the field, further improvements can be made to present a validated and useable PLC tool especially designed for practitioners concerned with strategic marketing concerns.

Research method

The methodological challenge of this thesis is to validate the usability of a theoretical model in practice. Therefore the model will be applied within Voortman Steel Machinery in Rijssen. Voortman designs, develops and manufactures machines for the steel fabrication and plate processing industries. The operations performed by these Voortman machines are drilling, sawing, cutting (oxy fuel and plasma), punching, cutting, marking, shot blasting, and spraying. All machines are equipped with a VACAM (Voortman Automatisering Computer Aided Manufacturing) operating system, developed by Voortman. With customers all over the world (America, Russia, Asia, Scandinavia, Middle East, etc.), Voortman has experienced major growth. Within 15 years the company has grown from a machine builder making customer specific machines produced by 35 employees to a medium-sized international organization with a total of over 200 employees that offers a self-developed product range of machines for various steel markets. Voortman is a highly globalized organization operating in an oligopoly market, which can be described as: "a market model of the imperfect competition type, assuming the existence of only a few companies in a sector or industry, from which at least some have a significant market share and can therefore affect the production prices in the market" (Severova, Kopecká, Svoboda, & Brčák, 2011, p. 580). These few companies with a significant market share are Penninghaus, Kaltenbach and Ficep. Voortman distinguishes itself by providing the best price / quality ratio.

The designed model will be applied to Voortman's V320. The V320 is especially designed for plate cutting and drilling applications, with specifications like a drilling unit and a ten-fold automatic tool changer. With this machine Voortman focuses on the Steel Fabrication market segment.

Due to our interest in how practitioners work with the model and collect the necessary data underlying each of the model's dimensions, we decided to rely on a participant observation study (Czarniawska, 2004). This choice enables us to observe what actors do in practice while using the model and provides us with the opportunity to guide actors whenever there is a need for interpretation (Coughlan & Coghlan, 2002; Coghlan & Brannick, 2005). This empirical research approach rests to a certain extent on the principles of action research (Middel, Coghlan, Coughlan, Brennan, & McNichols, 2006), with the difference that no cycles of interventions are involved. An advantage of this approach is that "the researcher attempts to participate fully in the lives and activities of subjects and thus becomes a member of their group, organization or community. This enables the researcher to share their experiences by not merely observing what is happening but also feeling it" (Gill & Johnson, 2010, p. 161). An

additional advantage is that the resistance to change is reduced by involving members of the client in the process, which increases the probability that any recommendations conceived will lead to practical improvements (Shani & Pasmore, 1985).

Design strategy

Data for this research are gathered by observing participants within Voortman Steel Machinery who are applying the designed model to a specific machine (V320) to identify the product's current and potential PLC. This observation is organized by providing them with one presentation (creating a platform) about the importance of PLC for Voortman Steel Machinery and two workshops to apply the designed model to identify PLC. Attendees / the units of analysis are: the Sales Director, Financial Director, Marketing Manager, Product Managers, and Engineering Manager. The designed model's usability can be identified by analyzing their problems and feelings. At the end of this process questions will be asked to verify the analyzed problems and feelings defined by the researcher with the feelings and problems of the participants to increase the validity of the designed model.

Results

This section describes the responses of the actors while working with the proposed PLC model. We divided the validation process into stages: Introduction, workshop 1 and workshop 2. At each stage we collected the actors' responses regarding the use of the model, including any problems that occur, and relate them to the implications for the model and its use. Finally, an overview of the actors involved, their responses and the implications is given.

Introductory presentation

During this presentation a platform for PLC within Voortman Steel Machinery was created and the necessity of PLC explained. Overall, the participants were enthusiastic about the designed model. However, this enthusiasm may vary among companies due to difference in organizational cultures, which affects the attitude towards new ideas and change.

Some minor issues regarding the implementation of the model came up. The questions that came up were: what output does the designed model deliver and why is it useful for our organization? How do we measure the difference in value proposition? What product do we need to choose? These are all questions regarding the usability of the model – before the participants had read the theoretical part of this paper – and are relatively easy to answer. The output of the designed model increases the information regarding the current and potential value proposition / PLC, which provides the organization with opportunities to apply a specific designed strategy in order to achieve its potential. By applying the model over time, differences in value proposition can be identified and conclusions can be drawn. The application of the designed model is to investigate the PLC of a specific product in a particular market segment. However the model can provide information about a product in different segments or different

products in one market segment, but it cannot provide enough information to determine their PLC's.

Workshop 1

This workshop was designed to determine the product market combination to investigate. The participants chose to investigate the V320, as mentioned earlier, with the focus on the Steel Fabrication market segment. As a participant, I divided the tasks among the attendees. The product specific factors and market turbulence were the responsibility of the Sales Director together with the Product Managers. The Marketing Manager investigated the Customer Value segment, and the Engineering Manager investigated the technological turbulence. As emphasized in the introductory presentation, there needed to be a zero point of the V320 in the Steel Fabrication market segment. After some brainstorming the value proposition of the V320 was found to be determined by good sales price, stable, simplicity, good service. Voortman might lose customers because they cannot meet some competitor specifications. Overall, during this workshop no questions were asked nor problems identified regarding the designed model. Therefore there are no implications for the model and process arising from this workshop.

Workshop 2

During this workshop the main goal was to determine the PLC for Voortman's V320 by applying the designed model. During the preparation for and presentation of this workshop, a few problems came up by analyzing the variables and determining the PLC. This section describes the problems that came up per variable.

- *Product specific factors* – No problems were revealed by analyzing the product specific factors. The units sold and sales margins where easy to analyze and gave a good insight into the revenue stream of the V320.

- *Value for the customer* – The problem that occurred with the customer value variable regarded its operationalization. The customer value variable certainly contributes to the analysis of the PLC, but the level of contribution depends on its operationalization. Within Voortman, due to a limited amount of time, it was chosen to measure the customer value using questionnaires. All customers who bought a V320 received a questionnaire containing questions regarding their value belief. This resulted in a good understanding of the customer value for buyers. However, to analyze the product's potential we needed the value belief of customers we had lost, to detect the potential gap, which would result in a possibility for Voortman to analyze their PLC and determine their future steps.

- *Technological turbulence* – The technological turbulence questions were very usable and resulted in a good analysis of the technological turbulence in the V320 market. Due to the identified technological turbulence, Voortman concluded that the V320 market is facing technological changes and therefore the V320 needs to be upgraded.

- *Market turbulence* - During the analysis of the market turbulence it was revealed that the Voortman attendees had problems when trying to operationalize and

apply these variables due to their selective knowledge, which is mainly focused on technology. Therefore they needed some help to understand the variables and apply them to the V320. For example, they had problems understanding market shocks. To solve this problem a good definition of market shock is given in this paper.

	Key activity	Actors involved	Responses	Implications for model	Implications for process
Presentation	- Introduction of the designed model. - Emphasizing the importance of the designed model.	- Financial Director - Sales Director - Marketing Manager - Product Managers - Engineering's Manager - Supervisor R.P.A. Loohuis	- Importance of the designed model is recognized. - Determine zero point. Which value proposition do we think we deliver? - What is the output of the designed model? -How do we measure the differences in value proposition?	-Insert zero point. Already described in the model as the current situation.	- Create a platform at management level by emphasizing the importance and lower the resistance to the application of the designed model.
Workshop 1	- Determine which product market combination to investigate. - Determine which actors investigate the specific variables of the designed model. - Determine zero point.	- Financial Director - Marketing Manager - Product Manager - Engineering's Manager	- V320 to investigate. - Value proposition: good sales price, stable, simplicity, and good service. Customers might be lost because some competitor specifications may not be met.	-	-
Workshop 2	- Applying the designed model. - Determine PLC for the V320.	- Sales Director - Marketing Manager - Product Managers - Engineering's Manager	- How do the variables need to be operationalized? - How does the designed model explain the PLC? - What are market shocks?	- Providing a good definition in the research paper of market shocks.	- Involving the right people with the right capabilities to analyze the specific variables to determine PLC. - Provide a roadmap how to optimal use the designed model.

Table 2: Summary of results

Conclusion

This section answers the main questions:

(1) *How can a PLC be analyzed integrally from a dynamic perspective so that companies can improve their decisions regarding PLC strategies?*
(2) *How usable is the designed model in a business environment?*

The first question permits the following conclusions to be drawn. This paper has emphasized the need for a new model to measure PLC in dynamic markets. The current literature provided too static and linear a model to measure PLC, which is therefore unable to cope with changing markets due to globalization and innovation, which thus emphasizes the need for a new model. A new model was therefore developed, as explained above, whereby the value proposition is a function of the PLC and is affected by the following variables: product specific factors, customer value, technological turbulence, and market turbulence. By analyzing these variables and indirectly the value proposition of the product a company can integrally analyze the dynamic PLC and therefore improve decisions regarding PLC strategies.

Regarding the second question, it can be concluded that the designed model as presented in this paper (figures 2 and 3) with all its variables is usable in a business context. Voortman concluded that the PLC of the V320 is at the end of its life cycle and that is no appropriate actions are taken, sales of the V320 would decline. This outcome proves the usability of the designed model, but the extent of its usability depends on the organizational culture and employee knowledge. When the organizational culture is resistant to change the possibility increases that employees cannot invest the time needed to properly investigate the variables and therefore cannot determine the (potential) PLC. The employees' knowledge about analyzing these variables has a significant influence on usability because people with a business analysis background can analyze the PLC more easily based on the designed model than people with a technological background.

Discussion

This chapter has discussed four substantial parts of this research thesis. First, the practical implication by placing the significance of the results in a practical context and providing a roadmap showing how to use the designed model, who needs to be involved, and which actions need to be taken. Second, it has described the theoretical implication, putting the significance of the results into the context of previous literature. Third, the potential limitations of this research is discussed by giving a critical reflection on it strengths and weaknesses, together with a discussion of its generalizability. This chapter ends by describing suggestions for future research.

Practical implications

By using the designed model presented here, organizations are able to position their product in its dynamic market context due to a good understanding of the product's value proposition. This understanding of the value proposition provides managers with opportunities to expand the product lifecycle and can lead to such an understanding of the market that decisions can be made regarding new product development or termination of the current product. To achieve these possibilities, organizations need to make optimum use of the designed model, which can be achieved by following the roadmap below.

First, managers need to create a platform to emphasize the importance of PLC and the designed model, because it provides an effective and efficient use of resources in competitive environments and therefore contributes to a good balance between product design, manufacturing, marketing and sales, which is fundamental to organizational success. By creating this platform organizations will lower their resistance to applying the designed model.

Second, managers need to determine a zero point. What value do we think we deliver? By asking themselves this question, managers get an insight into the value proposition they believe they deliver. This value proposition can be compared with the outcome of the model and actions can be taken.

Third, managers need to investigate the following variables: product specific factors, customer value, technological turbulence, and market turbulence. To create an optimized output for the conclusion, managers should bear the following in mind.

- *Product specific factors* - The goal of this variable is to investigate the past of the product based on sales. Investigating the units sold and sales margins can permit a conclusion to be drawn about the past, which provides input for the future. When the unit sales are still increasing and the sales margins remain the same, the product might still have the potential to increase sales. On the other hand, when the unit sales and the sales margins decline it might indicate that the value proposition of the product is low and the product is at the end of its lifecycle. However, to determine the PLC, conclusions are needed, drawn from other variables. The investigation of this variable can best be done by sales directors or sales managers, because they know what the sales margins and units sold are and can draw a conclusion based on their knowledge and perspective.

- *Value for the customer* – The main goal of this variable is to determine how customers value the product. By investigating the delivered customer value, gaps can be identified and potential value delivery defined. This is the most important part of the designed model for determining the future direction of the PLC. Therefore the right questions need to be asked. To do so employees need to be involved with market knowledge and affinity with customers, value delivery etc. (for example a marketing manager) when investigating this variable. This can be accomplished by sending questionnaires to (lost) customers and or by visiting customer organizations and discussing the value that the organization delivers. It is important that gaps within value delivery can be identified so actions can be taken to increase PLC.

- *Technological turbulence* – Measuring this variable allows potential market threats to be analyzed and patterns of turbulence detected. When the technological turbulence is high organizations need to evaluate their product lifecycle more often than when technological turbulence is low, because the value proposition that an

organizations offers may decrease faster due to technological changes. Besides the effect on value proposition, the technological turbulence tells us something about the product's lifecycle. With high technological turbulence the lifecycle will be shorter than with low turbulence. This variable should be investigated based on patents and the three questions proposed here, by people with knowledge of technology and the market. Therefore someone like a marketing manager, engineering manager and product manager need to be involved to determine the turbulence of technology.

- *Market turbulence* – The main goal of this variable is to measure market behavior by analyzing market shocks, threat of new entrants and substitutes, rivalry among existing firms, bargaining power of customers and suppliers, in order to explain fluctuation in value proposition and sales. To do so, organizations need to investigate what happened in the market. This can best be done by market and sales managers. When the market turbulence is high, the value proposition will fluctuate more than when the market turbulence is low. This fluctuation affects PLC and influences strategies to follow.

Finally, managers should determine the PLC of the specific product and that actions that need to be taken based on the application of the designed model. This could, for example, involve terminating the production of the product because the product specific factors indicate a decrease in sales. The customer value for the product is low and the customer gives an indication that there are shortcomings in the current product. The technological turbulence is high in the market, which leads to a shorter PLC and fluctuation of technologies used.

Theoretical implications

This research contributes to the existing literature by analyzing gaps regarding PLC in the literature. The existing literature provides PLC models that are obsolete – meaning they are too static and limited in use in today's business environment, where non-measurable fluctuations commonly occur. Therefore this research paper has developed a dynamic model to measure PLC in the current environment, which is characterized by dynamisms and concepts like globalization and innovation. This designed model was tested in a business context for its usability. This designed model is just a start at measuring PLC in dynamic markets so there are some limitations and options for future research, which are named in the following section. With these suggestions this research paper also tries to encourage other business researchers to think about PLC, and the need for it, in dynamic environments.

In conclusion, the scientific significance of this research is the newly designed and tested model to measure PLC in a dynamic business environment.

Limitations

This research paper has several weaknesses, which can affect its generalizability. First, by applying the designed model to just one specific business case (Voortman Steel Group) impairs its generalizability. Because Voortman Steel Group is operating in a specific market segment, the usability of the designed model may differ in other market

segments. However, observing the participants and asking them about the usability of the designed model provides us with a good indication of usability. Second, the designed model is appropriated for its usability. So the assumption made, regarding expected difference in sales of classic or dynamic PLC (figure 4), is just based on the literature, so it might different in practice. Finally, the designed model has not been tested over time as time remained limited. Usability might differ when the model is used over a lengthier period of time.

Future research

This research has developed a model to measure dynamic PLC based on gaps in the current literature. As stated above, there are some limitations. Future research could solve three limitations by: (1) applying the model in different market segments; (2) applying the model over a long period of time by using for example a time-series design; (3) looking at the usability of the designed model and differences in value proposition with their effect on sales, after applying the designed model.

To increase the overall usability of the designed model future research could operationalize the variables of the designed model in such a way that managers understand how they could best apply these variables to find their contribution to PLC.

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