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JARI KOSKINEN

A Dynamic Business Model for High-Tech Industry in a Global Environment

The Origin of Operational Patterns by
Means of Social Selection

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Reviewers

Professor Angappa Gunasekaran
Charlton College of Business
University of Massachusetts Dartmouth
285 Old Westport Road
North Dartmouth,
MA 02747-2300
USA

Professor Joanna Paliszkiewicz
Warsaw University of Life Sciences
Department of Economics
Ul. Nowoursynowska 166
02-787 Warszawa
Poland

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	Julkaisun nimike Dynaaminen liiketoimintamalli korkean teknologian teollisuuteen kansainvälisessä liiketoiminnassa	
Tiivistelmä Viime vuosien aikana on tapahtunut lukuisia muutoksia, joista monet vaikuttavat yritystoimintaan. Jotkut muutoksista ovat aiheuttaneet jopa taloudellisia kriisejä maailmalla. Tämä aiheuttaa epävarmuutta ja vaikuttaa johtamiseen ympäri maailmaa. Johtamisen ja liiketoimintamallien merkitys on kansainvälisessä liiketoiminnassa kasvanut tällä vuosikymmenellä. Tämä tutkimus vahvistaa käsitystä, että yritykset, jotka reagoivat nopeasti yrityksen ympärillä tapahtuviin muutoksiin ovat kilpailijoitaan menestyksellisempiä. Tutkimus esittää uuden näkökulman dynaamisiin kyvykkyyksiin ja joustaviin toimintatapoihin esittelemällä uuden liiketoimintamallin nimeltä dynaaminen liiketoimintamalli (DBM). Tutkimus osoittaa, että rohkea strategia, yrityksen kyky tuoda tuotekehityksestä markkinoille tuotteita tehokkaasti, toiminnallinen erinomaisuus ja aineeton pääoman yhdessä hajautetun organisaation kanssa ovat äärimmäisen tärkeitä yritykselle, joilla on korkean teknologian tuotteita kansainvälisille markkinoille. Tutkimus keskittyy tehoelektroniikka-alan liiketoimintaan ja laajempien johtopäätöksien tekeminen vaatii lisää tutkimustyötä. Uusi liiketoimintamalli auttaa yrityksiä luomaan tehokkaamman johtamisjärjestelmän ja toiminnalliset prosessit tukemaan yrityksen asiakkaiden tarpeita entistä paremmin.		
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Abstract <p>In recent years numerous events have had a huge impact on the way people conduct business. Some of these events have even resulted in a global economic crisis. This state of affairs has led to an uncertain and challenging business environment and has affected the management of businesses throughout the world.</p> <p>Effective management and business models in the global market place of the twenty-first century have become more and more crucial. This study supports the view that those companies that can react quickly to their changing surroundings will become successful than their competitors. The research presents a new view of firms' dynamic capabilities and flexibility operations, introducing a new business model called the dynamic business model (DBM).</p> <p>Study shows that a number of key factors, including entrepreneurial strategy, R&D to market performance, dynamic operational excellence, and intellectual capital with decentralized decision-making processes are critical for high technology companies.</p> <p>As this project focuses mainly on the power electronics business industry, more empirical studies are needed in the future to make broader conclusions. Nonetheless, the new model will help firms to create more effective management systems and operational processes in order to better serve their customers.</p>		
Keywords Business model, business, dynamic capability view, strategy, operations, performance, intellectual capital		

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Due to the fast development of technology and the demand for migration from traditional countries to developing countries, managers and directors need new capabilities in this fast changing world. I have witnessed this megatrend during my work in IT-technology and high technology industrial companies. The journey toward this thesis has been amazing and inspirational after over 20 years' experience in global industry, both at home and abroad. However, the journey would not have been possible without the support of many friends and assistants. The Dynamic Business Model presented later in this thesis has been finalized over a hundred kilometres to North of the Polar Circle in the small Lappish village of Kurtakko, where under the North Star the air is clean and the sky is clear, making great inspiration possible.

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Vaasa, January 2014

Jari Koskinen

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Abbreviations:

NIC	National Intelligence Council
DBM	Dynamic business model
High tech	High technology
R&D	Research and development
CE	Concurrent engineering
SCA	Sustainable competitive advantage
EFQM	The European Foundation for Quality Management
TQM	Total quality management

This dissertation consists of an introductory chapter and the following seven publications:

- 1 Rymaszewska, Anna, Koskinen, Jari, Takala, Josu, Zhao, Shi & Chen, Yang (2008/2013). The implementation of the balanced critical factor index methodology in the strategy redevelopment process. *Management and Production Engineering Review* 4:1 (March), 50–55 55
- 2 Koskinen, Jari (2014). The ‘mini factory’ concept: how to access market fast in china by using dynamic capabilities in production. *International Journal of Innovation and Learning* (forthcoming)..... 63
- 3 Koskinen, jari (2014). Modular product design for dynamic capabilities of manufacturing organisations: a case study. *International Journal of Business Innovation and Research* (forthcoming). 75
- 4 Koskinen, Jari & Sahebi, Daniel (2013). Customer needs linked to production strategy and firm’s dynamic capabilities. *Management and Production Engineering Review* 4:2 (June), 63–69..... 89
- 5 Koskinen, Jari, Sahebi, Daniel, Nikookar, Hassan & Zhan, Wang (2013). Improvement of service offering connected to customer satisfaction in the power electronics field. *Management and Production Engineering Review* 4:2 (June), 70–77..... 97
- 6 Takala, Josu, Koskinen, Jari, Liu, Yang, Tas, Mehmet Serif & Muhos, Matti (2013). Validating knowledge and technology effects to operative sustainable competitive advantage. *Management and Production Engineering Review* 4:3 (September), 45–54 105
- 7 Koskinen, Jari, Takala, Josu & Awali, Joseph Sebuwufu (2013). Dynamic business model based on research in power electronics industry. *Management and Production Engineering Review* 4:4 (December), 35–44 115

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1 INTRODUCTION

1.1 Background of the study

The National Intelligence Council (NIC) formed in 1979 is the centre for midterm and long-term strategic thinking within the United States Intelligence Community. According to the NIC, during the next 15 to 20 years the world will change dramatically. By 2030 large countries will no longer have hegemonic power. The power will be switched to networks and coalitions. Based on a NIC report the new world will be technology driven and non-state actors will take the lead. By 2020 emerging markets will almost double their financial assets (NIC 2012). The NIC believes that the world will be totally different compared to the world today. There are six major drivers that will dramatically affect the world: global economy, governance, conflicts, regional instability, technology and the role of the United States. This means that firms need to react faster to changes happening around the company and they also need new competencies, such as dynamic capabilities. This would make it possible for companies to bring new products and processes into use and adapt to the market (Teece, Pisano & Shuen 1997).

There is a broad consensus that the global climate is changing at rapid speed primarily because of greenhouse gases (GHG) as a result of the increased use of fossil fuels. This means that there is increased intent to use new technologies that relieve the use of fossil emissions. The weight of decentralized energy production is increasing and it is estimated that the market size of renewable energy will increase dramatically in the future. According to the EIA (2013), solar, wind and biomass lead the growth in renewable energy production, and solar energy represents the highest annual average growth rate at 9.8 % per year through 2040.

Firms' new capabilities

Companies should improve their capabilities to become more agile and resilient in the business sector due to the new companies, which have totally new technologies changing the rules of competition. New companies from emerging markets are also expanding their operations to be global. The need for new capabilities forces firms to become more agile and fit for the prevailing competition in the market. However, new competences should be in line with the firms' resources, knowledge and tools (Koskinen, Takala & Awali 2013). One such new competency is the dynamic capabilities. Firms should react quickly to the changes to reconsider and reconfigure their capabilities, and this should be agile and resilient in order to cope with the dynamic market.

The development of capabilities has been recognized as a potential source of competitive advantage for companies; knowledge and capabilities can give firms a continuing competitive advantage (Helfat & Raubitschek 2000). In this fast-changing world with in a new business environment, companies need new capabilities to manage their operations more effectively and to become competitive.

Power electronics industry

This dissertation focuses on the frequency converter business in the power electronics industry, which covers industry solutions as well as renewable business. In this study high technology, the most advantageous technology available in the market is defined. The main function of the frequency converter is to control and adjust the speed of the electronic motor. In many solutions accurate motor control is crucial. Typical solutions for frequency converters are elevators, lifts, pumps, fans and conveyors. Frequency converters are also used in solar and wind turbines to supply energy to the net. Technology life cycle describes the technological maturity of a product. Figure 1 shows the technological trends in the frequency converter business. The first commercial applications of frequency converters came into being in the 70's.

In the present study companies with operations in many foreign countries are considered to be in global business. The major case study company used in the present study has sales offices in 27 countries and partners in approximately 100 countries.

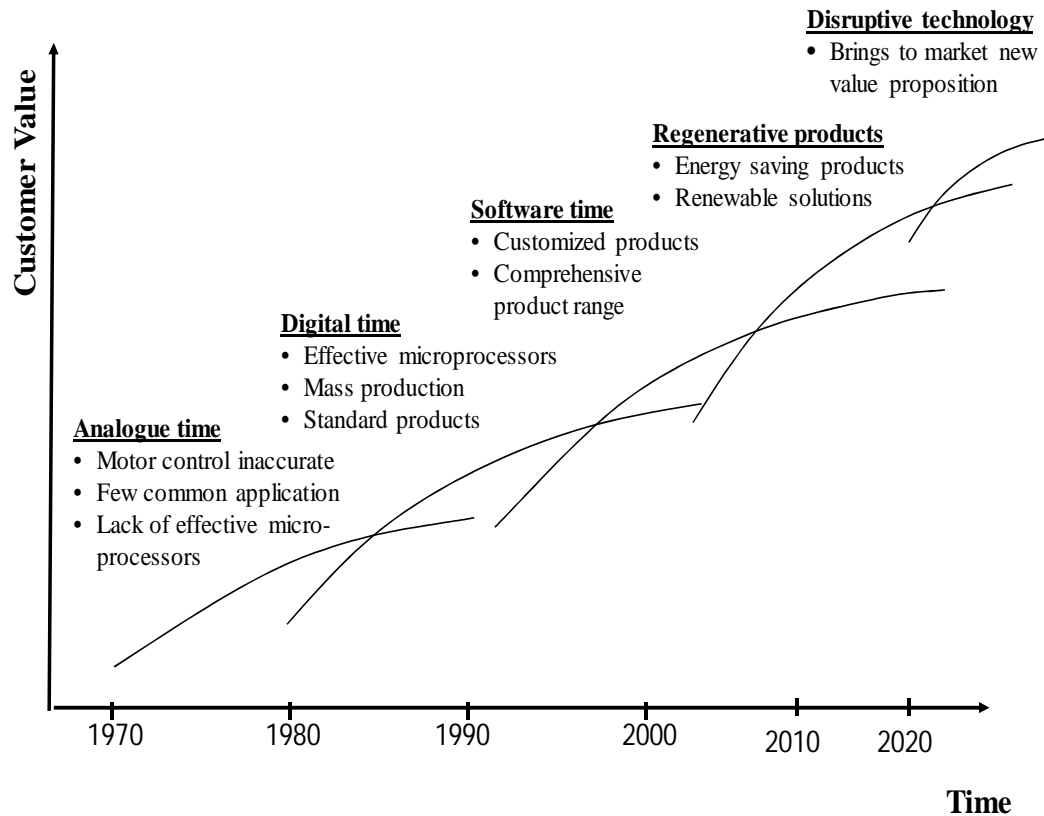


Figure 1. Technology development in frequency converters.

Dynamic business model

Most research on dynamic capabilities has focused on “what” defines dynamic capabilities: however, this dissertation concentrates on “how” providing a model explains how firms can react faster to various changes. The present study introduces a new dynamic business model (DBM). The model helps managers to make appropriate decisions in an environment where business-making rules are changing rapidly.

Efficient use of the model requires management, leadership and learning skills. Managers are responsible for guiding, planning, controlling and monitoring the entire process. The process needs to recognise and respond to market requirements. Furthermore, management and leadership should be transformational in order to create an interaction between leaders and their subordinates. This enhances their collaborations and also creates a procedure for improving motivation and morale levels among the leaders and subordinates (Bass 1985).

Garvin (1993) proposed that a learning organization can become more skilled at creating, acquiring, and transferring knowledge which in turn helps it to adapt to new knowledge, interaction behaviour and insights. This interaction and communication allows for peer learning, teamwork building, collaboration, and creative thinking. This creativity becomes innovative knowledge and offers techniques that help in problem solving, i.e., overall performance of the organization (Yahya, S., & Goh, W. K. 2002). However, while businesses are in this innovation process, positive results might become significant. However, firms face challenges, such as various threats and changes in the company's actions or actors in the business environment.

It is necessary for businesses to have different strategic architecture for different purposes that do not inhibit the flexibility or strategy of the firms. This architecture should have core a competency in the business operations, as well as strategic intent; the objective of the firm is designed to capture the winning position (Mäkinen 1999). Bessant (2000) argues that training and development are associated with an increased market share and growth. It is necessary and important for firms to keep up with the training and organizational learning within the strategies. Such knowledge could be extended further to global operations or large scale operations.

In addition, the management should be innovative, encouraging subordinates to be creative and make new innovative proposals as well as empowering them to make decisions. This should be done in a flexible but agile manner. The decision-making process in the organization should be decentralized in fast-changing technology environments in order to speed up the implementation of new ideas (Zabojnik 2002). Furthermore, the process should be efficient, including all firms' processes, primarily marketing, research and development (R&D) performance, key performance indicators (KPIs) and production processes. This is necessary to sustain superiority in performance of an enterprise in a turbulent global market with rapid innovation and scattered sources of manufacturing capability, innovation, and invention (Teece 2007). This calls for an agile use of dynamic capabilities as suggested by Teece (2012). In order to capture value, the managerial nature and objective should be entrepreneurial with managerial sustainable competitive advantage activities that are more than mere authority (Pitelis, Teece 2009).

Input data used in the dynamic business model

The dynamic business model introduced in Chapter 5 incorporates the above studies and ideas. The model is also based on Porter's strategy studies (Porter 1996,

Porter 1985, Porter 2008) and the research-based view introduced by Barney (1991).

The typical research problem and challenge for researchers is how to get input data for an articles or dissertation. Based on my lengthy experience in industry, valuable and unique input data collection were possible. Without this input data it would not have been possible to develop a dynamic business concept that worked in real life. The data for this dissertation has been collected from 48 people working in 19 different countries and five continents.

1.2 Research objectives and research question

The first objective of this thesis is to define the constituent elements of the key success factors and relationships from planning to action. Most research on dynamic capabilities has focused on “what” defines dynamic capabilities. This research, however, brings value added by introducing “how” to help business managers to make accurate decisions and take appropriate actions. The second objective is to help entrepreneurs and business leaders improve the company’s practices through a dynamic business model. The third objective is to create increased employment and human well being by helping managers to think broadly and make better decisions.

This thesis focuses on the turbulent market of the power electronics industry where the business scope is international and the business environment is complex.

The central research questions of the present paper are:

1. Under what conditions is it possible to create a dynamic business model for power electronics firms with global operations?
2. What are the key elements of the model?
3. How can the key elements be implemented and what are the main actions?

1.3 Research design

Arbnor and Bjerke (2008) distinguish three methodological approaches: the analytic approach, the systems approach, and the actors approach. This study follows all of these approaches. The system approach can be further divided into goal-means orientation and trial and error orientation. This study includes both orienta-

tions since data was collected by questionnaires and then later systematically synthesized to identify key elements and key actions that define key performance indicators (KPIs). However, the orientation of this study shifts to mainly goal-means since the study focuses on improving the performance of organizational success.

The research methodology is also based on Eisenhardt who focused on understanding dynamics in management as well as on particular events in a real life context (Eisenhardt 1989). Eisenhardt proposes an inductive theory building and brings realism to define and predict social behaviour when a phenomenon is not yet fully discovered and comprehended. The case method was deemed suitable for gaining a deep understanding for inductive building of new phenomena. It contributes to the existing literature and knowledge through analysis from another perspective (Eisenhardt 1989). This builds a logical stage and offers the possibility of new knowledge (Bhaskar 2008).

The essential literature of the model theory in the study also reflects the research of Teece et al. (Teece, Pisano & Shuen 1997, Teece 2007, Teece, Pisano & Shuen 1990, Teece 2010) on firms' dynamic capabilities, technological innovations, resources, and the concept of strategy. In addition, it also incorporates a strategic intent for firms' to win (Mäkinen 1999). Furthermore, it utilizes Yin's (2003) research. He concentrates on how or why something occurs, when the research focuses on contemporary action of top management where no controls of behavioural events are necessary or present. It is designed to meet the construct validity, internal validity, external validity, and reliability checks due to the reliability of the informants that were used for collecting data.

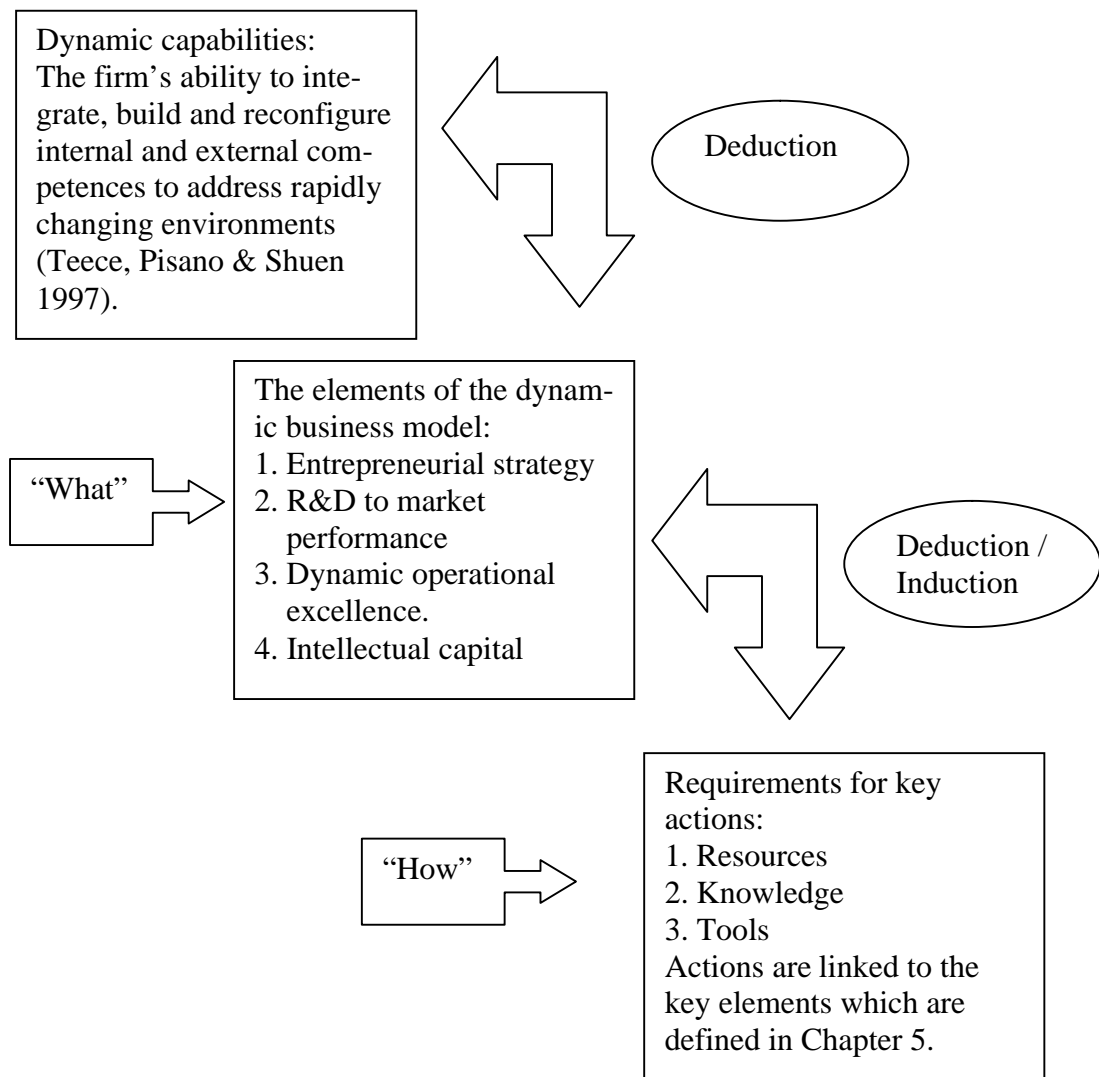


Figure 2. Research design.

Figure 2 shows the principle of research design. The dynamic business model is based on Teece et al.'s definition of dynamic capabilities. The present study continues to define major elements and the key actions which is totally new in the research of dynamic capabilities.

Another key source of literature for the model theory was made by Sykes (1990) whose model revolves around reliability in qualitative research. Sykes focuses on the following:

1. Are the results the same from the same study, when conducted by different researchers?

2. Can the researcher obtain the same results from the same study using the same correspondents when the research is repeated?

The dynamic business model uses a constructive research approach (Figure 3), which is normally used in the discovery process, where many possibilities are still open, in the sense of ontological choices (Kasanen, Lukka & Siitonen 1991). The model extends the existing knowledge to combine and correct the possible missing links.

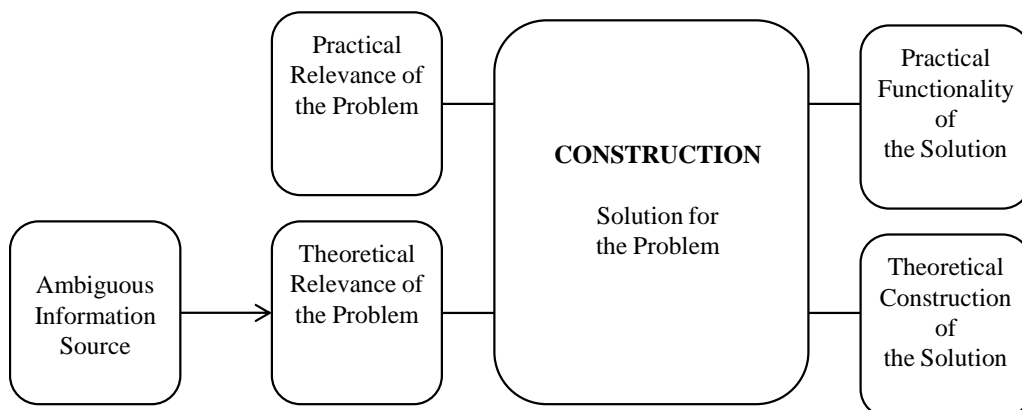


Figure 3. Model theoretical diagram adapted from Kasanen, Lukka and Siitonen (1991). Constructive Research Approach in Business Science.

The construction of the model

The construction of the model starts with an ambiguous information source that is relevant to the study. This information is from other ambiguous theories and claims, of which, some are tested, and others are yet to be tested. In addition, data has also been collected from different informants who are reliable and have lengthy experience in their fields. The main objective of combining this ambiguous information is to formulate relevant theories for the model to find a solution for practical application and implementation.

The relevance of the model

The relevance of this thesis's DBM is also derived from different researchers whose works have explained the need for agility and resilience dedicated to the turbulent market environment. Previous studies on long-term dynamical behaviour of supply chains showed the possibility of better understanding the dynamical

attractor for customers (Holmström & Hameri 1999). Koskinen et al. claimed that in manufacturing firms, both communication and efficient information flow are necessary, and these would also improve their value added services in addition to their operations in the global market (Koskinen, J., Sahebi, D., Nikookar, H., & Zhan, W. 2013). This could also be achieved by developing the firm's specific concept called a "mini factory" (Koskinen 2014a). Although this model could be implemented in firms, the results from the case study should not be generalized except to expand and simplify on other theories.

Fundamental drivers and analytical hierarchy process compound to the DBM

The last two decades have revealed the importance of competitiveness in the business environment and the turbulence of the market condition. To cope with such a business environment, firms have to employ dynamic capabilities, which are characterized by responsiveness in speed, quality, and flexibility, all of which are main components in agile capabilities (Jackson, Johansson 2003). The model in this research utilises fundamental drivers for agility such as time reduced response cycles, information flow and decision making, into dynamic systems while balancing the extremity of ideal lean and sense and response (Preiss 2005). In addition, the model also utilises the analytic hierarchy process (AHP) technique while considering the agility models (Baramichai, Zimmers Jr. & Marangos 2007) and the key performance indicators.

Customer needs and dynamic capabilities

Customers' needs and trends are changing at an increasing speed in regard to product variety, features, and quality while companies focus on reducing net assets. Firms must reconfigure their operations and models into a long-term client solution (Pekkarinen, Piironen & Salminen 2012), especially new technology companies (Zheng 2012). Christensen (1997) argues that modularity enables companies to produce differentiates and quick market access. The DBM (dynamic business model) seeks alternatives towards solutions while considering modularity as a theory to quick market access, since modularity simplifies the creation and extend of dynamic capabilities (Ravishankar, Pan 2013). A study conducted by Koskinen et al. (2013) on innovativeness and operational excellence about key factors of efficient customer-oriented production strategy, revealed that more focus is needed in the study of dynamic capabilities and customers' needs (Koskinen, J. & Sahebi, D. 2013).

Relationship between concept, competence and connection

The analysis of the DBM uses the managerial theory aspect of model, competence, and connection as key success factors (Kanter 1995). Kanter argues that firms can have an unprecedented opportunity even at a local level. She further argues that businesses should be more actively involved in their communities in order to deliver what they need, not what they think they may need. Kanter identifies a criterion for success composed of three elements: concept, competence, and connection (also known as the 3Cs). Although Kanter's models do not carry much weight in this study, her models are somehow attractive and interesting for the study. Kanter refers to leading edge ideas as competence in the ability to translate ideas into applications (innovation) for customers. By connection, she refers to alliances among other businesses to create more value for customers (customer satisfaction). This enforces the importance of treating customers as mental assets to make the R&D process much easier. Kanter urges businesses to be imaginative, to innovate, to be more professional in order to perform, and to be open to collaborate, leading the Change Adept Organization (Kanter 1997). Conversely, the model is also based on the ontology concept, which has a close relationship with the above mentioned 3Cs, as shown in Table 1.

Table 1. Relationship between concept, competence and connection (3Cs) and ontology.

Concept, Competence and, Connection (3Cs)	Ontology
Concept	Class (concept)
Competence	Slot (role or instances)
Connection	Facets (restrictions)

The role of the ontological view in this model is to create and share a general understanding of the structure of information among people and domain knowledge. The ontology ideology assumes that the domain assumption is explicit, can separate domain knowledge from operational knowledge and can analyze it in order to be reused.

The model and firms' weaknesses

Since the late 60's, there have been studies that have identified weaknesses in firms' new product success (Hopkins 1980). Some of these weaknesses for failure are still a problem in many firms today: high costs, competitive strength, bad tim-

ing, distribution weaknesses, and the list go on. The model is meant to address these problems that managements faces. In addition, it tries to find how product managers can improve new product performance and eliminate similar mistakes in their new product programs. The research contributes to management practices and to product performance of how firms could develop and launch new industrial products as well as separate successes from failures. The model also considers Cooper's seven stage model, which contains important lessons for management (Cooper 1983).

1.4 The structure of the dissertation

This dissertation consists of seven chapters. In Chapter 1 the background of the study including the challenging business environment that international firms encounter in their global business operations is addressed. Research objectives and questions define the target and research problem of the study. Research design describes the methodological approaches, and the type of study is defined as well.

In Chapter 2 the theoretical construction of the research model is introduced. The model consists of four main elements: entrepreneurial strategy, R&D to market performance, dynamic operational excellence and intellectual capital. These divisions are connected to previous studies in the chapter.

Chapter 3 describes the research methodology including the process of the study.

In Chapter 4 articles of the study are introduced, including the contribution of the author in previous publications. Also input and output of the articles are introduced.

Chapter 5 presents the dynamic business model which is a major result of the thesis.

Chapter 6 discusses the results and the limitations of the study and proposals for further studies.

Chapter 7 addresses the conclusion of the thesis.

2 THEORETICAL FOUNDATIONS

2.1 Theoretical construction of the dynamic business model

The theoretical construction of the dynamic business model is based on the idea of dynamic capabilities (the firm's ability to integrate, build and reconfigure internal and external competences to address rapidly changing environments) to achieve agility in an organization in order to improve organization performance. Second, the model is centred on the research-based view, which is a fundamental determinant of an organizational performance and a means to improve internal and external capabilities and develop new ones. Third, Porter's strategy studies including five forces have been used (Porter 1996, Porter 1980, Porter 1979). Fourth, the model is built based on personal industrial experience that includes more than 20 years in international companies. Fifth, the model is based on personal articles, other researchers' articles and interviews.

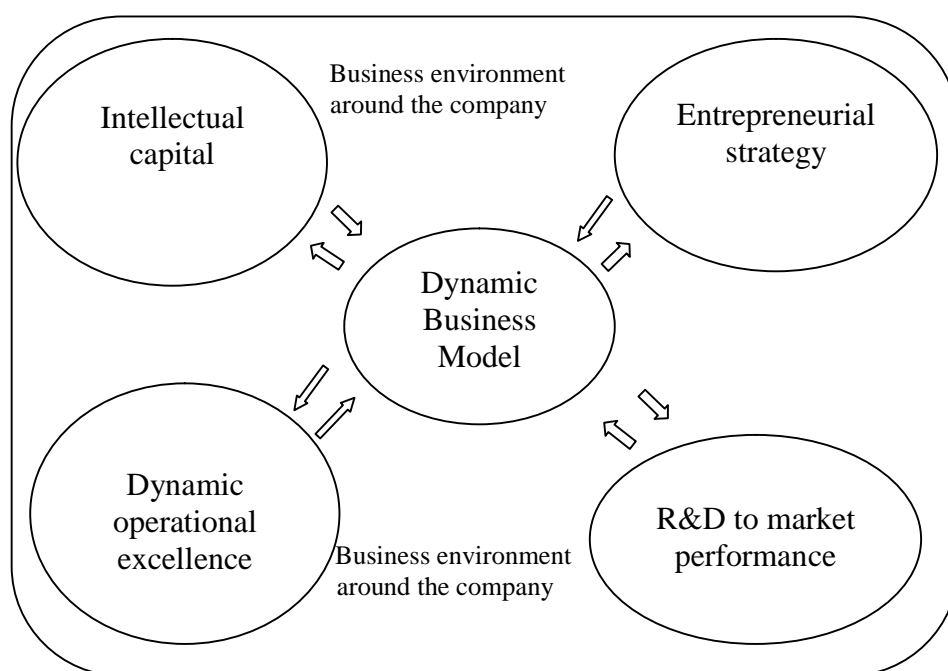


Figure 4. Theoretical construction of the model.

Figure 4 illustrates the theoretical construction of the model including flexibility and responsiveness that is used in the model. The theoretical construction supports the dynamic capabilities framework that is also composed of the following ele-

ments: organizational structure, organizational performance, and competitive intensity (Wilden et al. 2013).

2.2 Previous studies related to the present study

Previous studies related to the present study

Despite the fact that organizational and firm performance is influenced by entrepreneurial strategy structure performance, only limited empirical research has been conducted to link it to the firm's dynamic capabilities. The model to be presented in the present study is designed to address the link with a dynamic that is under examined in many studies. There is a need for firms to harbour entrepreneurial strategies on how to be more innovative with ideal efficient processes, technologies that harness rapid operation from the firms' intellectual capital. Much of the model is guided by technology (Schumpeter 1911, Schumpeter 1939) for swift and accurate decision making in order to tally the performance in research and development (R&D). This in turn helps the firms follow an operational excellence strategy needed for competitiveness in the product price, quality, lead time, and on time delivery, to mention a few.

In the following sections the major elements of the model are introduced and linked to the theoretical view.

(1) Entrepreneurial strategy

In entrepreneurial strategy, there should not be a gap between business management and technology, but rather, they should be intertwined (Hakkarainen & Talonen 2006). Business and technology strategies are dualistic viewpoints to a mutual strategy. The model in the study is designed in a way that considers technology as a key player in the strategies. Strategy, in a business, organizes the firms' resources to position it to win (Teece 2007). Matthews proposed a conceptual framework that linked management and technology for communication and decision making (Matthews 1992). It emphasizes that in a business one has to know the business one is in, competitive advantages, position and how to improve on it, as well as how to create added value. Conversely, Kaplan and Norton observed that no two organizations thought of strategizing in the same way (Kaplan, Norton 2004). This is due to the fact that the strategy to be used is defined by "what" and "when", whereas for the technology, it is "how" and "by which or what means".

Nonetheless, even with an extremely high strategy, companies can still fail. The dilemma lies in the creation and implementation of strategies. An extensive study

conducted by Scott (2000) on critical technology management in high tech companies revealed that it is possible even for companies in a winning position to fail. One informant responded, “*Companies do not have big problems in general if you take out strategy.*” As the model in the study suggests, entrepreneurial strategy involves strategic management that develops efficient strategies and planning. It requires supervision and aims at combining all management tools to output most of the plans. There is an increase of uncertainties in firms around the world. These uncertainties create an unexpected dynamic structure of firms. Consequently, strategies have to become dynamic (dynamic strategic planning, DSP) (Çelebi 2008a).

It should be noted that the creation and implementation of strategic management of technology has its challenges. It is ideal for firms to think that strategic objectives will connect to business and technological developments and see them as an intertwined issue. Talonen & Hakkarainen suggested that strategic thinking should take place at three levels: the strategic level for strategic positioning and generation (development), the tactical level for continuous planning and adaptation (short term) and the operational level for implementation (long term). Talonen & Hakkarainen observed that, strategic challenges require a better understanding of the internal and external business environment changes in order to analyze the potential, and then consequently make decisions on strategic business options for the future (Hakkarainen & Talonen 2006).

(2) Intellectual capital

The impact of innovation on processes and products extends as far back as Schumpeter’s work from 1911 (Schumpeter 1911). Schumpeter acknowledged technological change as a driver in a firm’s competition as well as economic process development. His model defined technological innovation, industrial organization, market and supply chains and their role in the competition. Economic policy and those in charge of management need to be concerned about how far institutions and organizational forms promote innovations (Schumpeter 1939, Schumpeter 1934).

Schumpeter distinguishes between product innovations and process innovations (Schumpeter 1939, Schumpeter 1934). The DBM model in this study suggests creating improvements in the production process through the adoption of new technologies and innovations: “radical” or “incremental.” Since the 1980s, there has been an increase in attempts to use innovation models and to add innovation into other models. This implies that, there is a need for firms to interact regularly with their main customers (de Jong, von Hippel 2009), suppliers (Walton, Handfield & Melnyk 1998), and competitors (Gassmann & Zeschky 2008, Enkel &

Gassmann 2010). Today's hi-tech environment includes indefinite technological uncertainties for the innovators, and, in turn, this heightens the importance of R&D cooperate strategies to cope with the evolving technology (Eisingerich, Bell & Tracey 2010). However, there are still barriers to better innovation strategy. One of those barriers is financial coupled with failure of returns from an innovation.

The firm should encourage people to make innovative proposals. To accelerate the process as a whole, there is a need for open innovation. This focuses on ease of knowledge and technology flow, interactive processes outward through firm boundaries. This is due to the fact that the open innovation concept considers invention and innovation, but they should not necessarily happen at the same location of transformation. However, outside-in open innovation should also be encouraged, since it creates an "innovative semipermeable membrane" (Herzog & Leker 2010).

Innovation and management

Managers should encourage innovation in large traditional organizations. In Christiansen's studies, he attempted to showcase how some firms have managed to encourage innovation rather than inhibit it. An intensive study made by Inauen and Schenker-Wicki revealed that, in innovation, openness led to a higher process of innovation performance due to improved processes (Inauen & Schenker-Wicki 2012). Furthermore, the study also revealed that companies that were closed in their innovation performed well in product innovation. Innovativeness is one of the key elements becoming efficient in a new marketplace when firms create their own solutions (Koskinen 2014a).

However, managing strategy in innovation requires understanding the what, why, when and where of the innovation activity. In addition, it involves developing, reviewing, setting goals, and updating an innovation strategy consistent with the organization's mission. One informant suggested of the present study, "*Straight forward and direct management is necessary to encourage people in daily contact to provide ideas, and to develop functions and processes, as well as tools.*" This may call for portfolio management techniques and support the cause of the study: a systematic way of assessing a set of R&D activities with business units in order to maintain sustainable balance. Such a cause is extremely important especially for "start-ups" (Igartua, Garrigós & Hervas-Oliver 2010). In innovation, it is crucial for management and leadership to visualise (Bessant 2007). Employers should lead the way to where they want to position the company, for; they know where it is going and where the firm has to be in the future. They must promote

innovation directions with an entrepreneurial culture throughout the company, by becoming directly involved in establishing and implementing clear and supportive guides for the innovations (Goffin & Mitchell 2005).

(3) Decentralized decision-making organization model

In today's competitive and uncertain markets, globalization has increased for many organizations. This globalization has created decentralized units that can be seen as "teams" of the organizations, and these need to be standardised with complete competitive advantages and access to competencies, especially in research and development. However, this process entails challenges such as collaboration, integration, and networking, to mention a few. This requires a dynamic strategic management that is efficient and will supervise these strategies. This supervision requires effective decision making in distributed project teams. Celebi suggests that a dynamic strategic management approach is how firms use their planning techniques to reach their goals, as variables' change with time. In addition, it should be a growing planning process with flexible internal and external factors. It should be both manageable and sharable in order to show individuals their targets (Çelebi 2008b).

Rubenstein saw patterns in decisions and conducted a study on the problem of decision making in phases, including analysis and statement of alternatives, best choice from the alternatives, communication and implementation of the decision as well as checking to see whether the decision was implemented as intended (Rubenstein 1964). Rubenstein observed that in the role of top management or supervision, there should be a clear idea of the objectives for which the company supports its R&D (Rubenstein 1964). Conversely, in an intensive empirical study using a quantitative approach study conducted by Bourgault et al. (2008) on decision-making processes in new product development (NPD) linked to team autonomy, he revealed that formal decision-making processes are even more necessary for distributed teams than for those that are highly dispersed. In addition, team autonomy is very important for the success of dispersed teams, while formalization will add value to teamwork, especially when team distribution is on the increase. This may result in less formal decision-making processes and teams could use it as a strategy. However, top management should retain the central role on the decision of how far dispersed teams should be empowered (Bourgault, Drouin & Hamel 2008).

(4) Effective processes

How should industries new product managers improve new product performance? In the past decades, a great deal of research has been conducted regarding reasons for new product success and failure, which has contributed to effective new product management. Cooper suggested that it is crucial to acknowledge technical opportunity, market, proficient internal R&D management, decision-making processes, and logistics (Cooper 1983). In addition to Cooper's view, Ulrich and Tung argued that it is also valuable to have modularity in an effective process (Ulrich & Tung 1991). Some of the benefits may include, flexibility, easier and faster tasks at the end of an assembly (Hyun 1993, Vokurka & O'Leary-Kelly 2000, Aprile, Claudio Garavelli & Giannoccaro 2005) and even more effective material flow through the factory (Koskinen 2014b). In today's turbulent market environment, business must be flexible and adjust whenever there is an opportunity (Upton 1994). In addition, Welborn suggested an approach of standardized design that could help with the inflexible process (Welborn 2009). Welborn argued that, the design "as-is", is one which could be used and also later be modified to use in a separate approach to counter inflexible processes.

Conversely, Anderson argued that acknowledging technical opportunity allows firms to compete for markets and satisfies the uniqueness and rate of customer demand by formulating processes that support rapid product changes while maintaining their operation (Anderson 2004). Furthermore, in this era of globalization, it is advantageous to acknowledge technical opportunity, for it also favours mass customization, which can be used as a business strategy to cater to unique customer demand (Coronado et al. 2004). In addition, there is an added significant feature in technical opportunity that allows for product modularity (Ulrich & Eppinger 1995) with noticeable lead-time due to easy product updating as well as economies of scale (Ulrich & Tung 1991).

A good process should also harbour motivation directed at the individual level, especially in the innovation processes. This is because there are differences in personality and every one's motivation is different, and in turn, this can jointly affect radical idea creation. In addition, it can promote breakthrough ideas and their later implementation. Nonaka (2007) suggested that idea generation of new products lies within individual employee. Although this may be the case, Baer argues that the idea is still receiving limited attention (Baer 2007).

(5) R&D to market performance

Schumpeter suggested the idea of capitalist economic evolution as a process of the innovative renewal of business routines. The model in this study examines the

current environment and the process of a firm and tries to modify the lagging or sluggish functions in order to improve the performance. In addition, it develops and coordinates economics of the firm within the “fundamental fields,” history, and statistics sociology (Schumpeter 1954). Schumpeter’s vision of development and innovation, argues, “*It is impossible to divorce any of the applied fields from the fundamental ones.*” This is due to the fact that “*the applied fields not only apply a stock of facts and techniques that lies ready for their use in general economics but also add to it*” (Schumpeter 1954).

Organization innovativeness related to the model

The model looks at different organizational fields observed by Schumpeter, which include science logistics, industrial dynamics, innovativeness, environmental sustainability, globalization, etc. These are still challenges and barter many firms’ managements in today’s era of turbulent markets. Conversely, the model also considers Porter’s (1979) view that defined his five forces that shape strategy on the field of innovation. Depending on the firms’ strategy, the model can be used either way: Porter’s argument that innovation can be used as a strategic barrier for new entries in the market and product or process innovations can nullify the entry barrier to compete favourably (Porter 1979).

R&D related to the model

Although research and development projects are necessary for outstanding corporate performance, a significant risk still remains. The model presented in this study can help to increase the success of product projects to higher than 55% as revealed by some studies. Although many new products performance is still at 55%, the past decades have revealed that, for instance, in the 70s’ and 80s’, new products accounted for 20% and 33% of corporate profits respectively (Takeuchi, Nonaka 1986), and the number is still on the increase today. Since this is the focus for many firms, the cost is also increasing. The model in the present study would also be convenient in increasing corporate profits, since managements seeks to improve new product success rates whilst reducing development cycle time and minimising failure rates. However, managements must recognise the difference between winning and losing in the new products arena; this is a critical success factor. One option for doing this is to benchmark both the internal and external insights necessary to pinpoint these critical success factors (Cooper & Kleinschmidt 1995).

Systematic way of doing things related to the model

In this era of turbulent markets, firms must move to a new level in order to capture the complete picture. Firms should have their processes well defined. In addition, they need an appropriate set of tools and technology or techniques in check, appropriate motivated human resources at the right time and, formal methods such as design, failure modes and effect analysis as suggested in the DBM. Cross-functional teams are also an option to handle the cross-functional responsibility as well as interfacing departments to promote better new product performance (John & Snelson 1988). Porter's competitive forces have changed high-technology organizations to adopt cross-functional project groups as in the deployment of new products and processes (Hauptman & Hirji 1996). In addition, when these teams combine their efforts, they tend to be more efficient and faster, which in turn helps in time-to-market. A study made by Holmström and Hameri and an earlier study made by Hamerim demonstrated how important operational speed is in industries today (Holmström & Hameri 1999, Holmström 1995).

As also observed in this study, Keller's intensive study revealed that there is better performance in, technical quality and better budget accuracy of cross-functional teams in research and new products (Keller 2001a). However, in support of John, and Snelson's view, Trent (1998) argued that there is still a need for individual effort in the teams. In addition, Trent (1998) conducted a study on managers and how global leadership teams are coping with the challenges of essential qualities. This study revealed that teams should be agile in their thinking and know whom to involve in the decision-making processes. Teams should be flexible and have a charter and operating principles (Thomas et al. 2012). Berman and Hagan argued that a firm's strategy process that involves markets with technological know-how would create good results in a number of innovative sectors. When responding to market changes, firms may find themselves setting the pace for innovation in their industries and consequently leading the competition (Berman & Hagan 2006).

Conversely, the model in this study is also related to performance and concurrent engineering. A study made on improving product development (PD) performance using concurrent engineering (CE) suggested that CE has diverse views and applications in and has potential to improve performance on innovation and new product development (Alemu 2013).

3 RESEARCH METHODOLOGY

Figure 5 reflects previous case studies by the author. The studies are based on the interviews and data collection in the case companies in 2011, 2012 and 2013 and published in 2013 (some of articles are still forthcoming). Based on the previous studies focusing on dynamic capabilities and a new business framework, weak market tests were performed. The results are shown in the conclusion chapter. The research process is described in Figure 5.

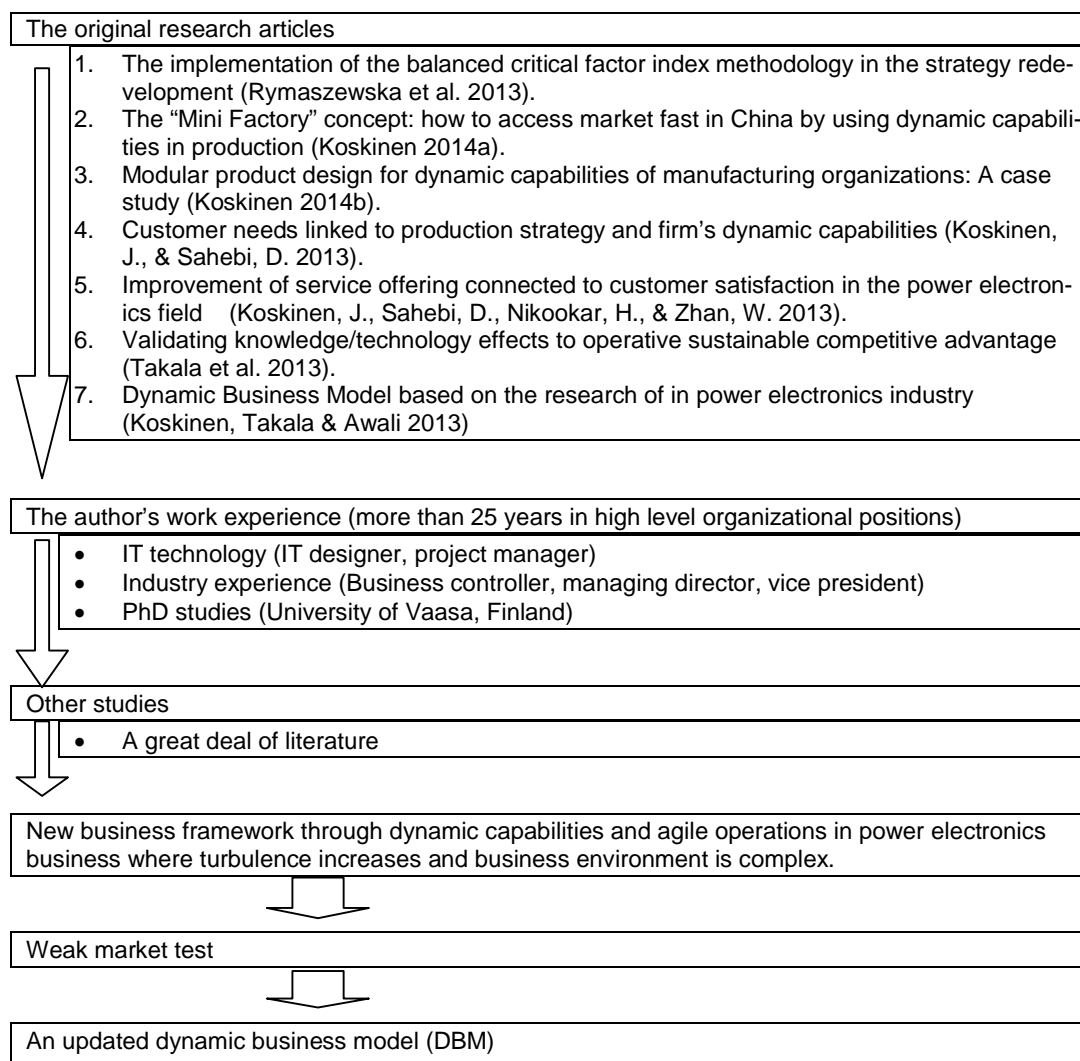


Figure 5. Research process.

The present study focuses on the domain of global electronics enterprises, which have a turbulent and complex business environment. The objective of the research is to test a new business model that includes dynamic capabilities and agility in primary roles. The main motive for this research is to create a framework with key

success factors and define classes and slots for the selected domain. In the results section the detailed dynamic business model is described including classes, slots and facets. In the model classes are marked with the letter “c”, subclasses are marked “sb” and slots are marked with a “v”, which stands for the value of the specific class. Facets are described on the model by using an indentation structure.

Most research on dynamic capabilities has focused on the question as to “what” defines dynamic capabilities; this study also focuses on the “how” side. As for practical implications, the new model helps firms to create processes that are more effective and to serve their customers in a better way.

An updated dynamic business model (Figure 5, Article 7) was tested by interviewing top management and analyzing their opinions. These managers have almost 200 years of collective experience in global business. Their experience is from high-level organizational positions, such as board of directors, management directors, vice presidents and global business directors. They have worked in a global business, and each of them has had global director experience; two of them are women and four are men. Respondents’ experience in global leading positions consist of the task of R&D director, marketing director, factory director, logistics director, business development director and human research director (Table 2). This study tests the framework of most important factors of successful companies under the dynamic capabilities and agile concept.

Table 2. Working experience of respondents

	Chairman of the Board	Managing dierector	Management team member	Global director	Work experience
01-respondent	X	X	X	X	= > 40
02-respondent	X	X	X	X	= > 35
03-respondent	X	X	X	X	= > 30
04-respondent	X	X	X	X	= > 35
05-respondent			X	X	= > 20
06-respondent			X	X	= > 25

Research methodology and data

The research consists of seven publications focusing on the areas of strategy, research and development, operational excellence and intellectual capital, which are the main elements of the dynamic business model. Methods that have been used in publications and input data for the publications are summarized in Table 3.

Table 3. Summary of the methods and data in the publications.

Title of the Article	Methods	Data
The implementation of the balanced critical factor index methodology in the strategy redevelopment	Qualitative: semi structured theme interviews, naturalism approach Quantitative: balanced critical factor index calculations	Interviews: 11 interviewees divided into two groups. Group 1: five group management team members, Group 2; six global directors. Numerical data collection performance data
The "Mini Factory" concept: how to access market fast in China by using dynamic capabilities in production	Qualitative: notes made by managing director of case company, naturalism approach Quantitative: case company's financial analyses	Project documents, presentation slides, minutes of the board meetings, minutes of the management team meetings, financial data
Modular product design for dynamic capabilities of manufacturing organization: A case study	Qualitative: several documents, naturalism approach Quantitative: financial analyses, literature review	Score cards, minutes of the project team meetings, presentation slides, interviews performance data
Customer needs linked to production strategy and firm's dynamic capabilities	Qualitative: Experts in power electronics industry, naturalism approach Quantitative: variability coefficient and correlation analyses literature review	Interviews: 31 interviewees in 19 different countries. informal questions, formal questions
Improvement of service offering connected to customer satisfaction in the power electronics field	Qualitative: Experts in power electronics industry, naturalism approach Quantitative: dependent variables, regression analyses, correlation analyses, literature review	Interviews: 31 interviewees in 19 different countries. informal questions, formal questions
Validating knowledge/technology effects to operative sustainable competitive advantage	Qualitative: semi structured theme interviews, naturalism approach Quantitative: sustainable competitive advantage analyses	Interviews: 11 interviewees divided into two groups. Group 1: five group management team members; Group 2; six global directors. Numerical data collection: performance data
Dynamic business model based on research in power electronics industry	Qualitative: semi structured theme interview	Interviews: Six in high level positions of organization (four have board of directors experience and all have had global director responsibility)

A total of 48 interviewees from 19 different countries and five continents took part in the collection of input data for the thesis. The main case company has more than 1,500 employees with revenue in 2012 of approximately 400 million euros. The company has aggressive growth and profit targets. The firm's aim is to achieve revenue of 500 million euros and to reach an operative profit of 14% in 2014. The case company focuses 100% on power electronics.

Conclusion

This thesis focuses on the power electronics industry where the business environment is global and the products are high-tech. The data were collected in 2011, 2012, and 2013 and based on a geographically wide range of material. The interviewees were from 19 countries and five continents. The present thesis consists of seven articles, a wide literature review, and personal work experience connected to market tests. The result of this thesis is a new business model called dynamic business model.

4 PUBLICATIONS

Seven publications have been included in this dissertation to cover all main key elements of the dynamic business model. All seven papers have been published in scientific journals. Six of the seven journal papers have also been introduced in international conferences held on three continents. Table 4 shows the input data of the publications and the outputs, which are related to the dynamic business model. The order of the articles in Table 4 is based on the written order.

Table 4. Input data, publications and output of the thesis.

Input data	Title of the article	Output/relationship to the dynamic business model
Interviews: 11 interviewees in two groups divided into Group 1: five group management team members, Group 2: six global directors Numerical data collection. Performance data.	The implementation of the balanced critical factor index methodology in the strategy redevelopment	Entrepreneurial strategy R&D market performance Dynamic operational excellence, systematic planning process, operational strategy's relationship to available technology and knowledge
Project documents, presentation slides, minutes of the board meetings, minutes of the management team meetings, financial data	The "Mini Factory" concept: How to access market fast in China by using dynamic capabilities in production	Entrepreneurial strategy Dynamic operational excellence Intellectual capital, company's efficiency with high flexibility and speed
Score cards, minutes of the project team meetings, presentation slides, interviews performance data	Modular product design for dynamic capabilities of manufacturing organization: A case study	Entrepreneurial strategy Dynamic operational excellence Intellectual capital, modular product design for improving company's efficiency, importance of flexibility and responsiveness
Interviews: 31 interviewees in 19 different countries. informal questions, formal questions	Customer needs linked to production strategy and firm's dynamic capabilities	Entrepreneurial strategy R&D market performance, customer oriented production strategy, the importance of effective information flow, flexibility, speed and responsiveness
Interviews: 31 interviewees in 19 different countries. informal questions, formal questions	Improvement of service offering connected to customer satisfaction in the power electronics field	Entrepreneurial strategy Dynamic operational excellence Importance of communication, service process, effective information flow are the key for the customers

<p>Interviews: 11 interviewees divided into two groups. Group 1: five members in firm's group management team, Group 2: six global directors</p> <p>Numerical data collection: performance data</p>	<p>Validating knowledge/technology effects to operative sustainable competitive advantage</p>	<p>Entrepreneurial strategy R&D Performance, Dynamic operational excellence Modeling of sustainable competitive advantage (SCA)</p>
<p>Interviews: six high level position of organization informants (four of them have board of directors experience and all have global director responsibility)</p>	<p>Dynamic business model based on research in power electronics industry</p>	<p>Dynamic business model Firms' key success factors: 1. Entrepreneurial strategy. 2. R&D market performance. 3. Dynamic operational excellence. 4. Intellectual capital Main actions to support the success.</p>

4.1 The implementation of the balanced critical factor index methodology in strategy redevelopment

Objective

This article aims at presenting the innovative analytical method, the balanced critical factor index (BCFI) to address the need for change in a company's operational strategy according to changes in available technology and knowledge. By examining a wide array of indexes, the presented method is expected to suggest the directions of development. The presented method also addresses the challenges of the complex process of decision-making. Moreover, the empirical evidence gathered in the studied case company serves as a source of important feedback regarding the further improvement of the BCFI method. The BCFI method was selected because of its relationship to strategy, R&D to market performance and operational capabilities and innovativeness.

Results and main contributions

The weak market test was conducted in order to validate the results of the analysis, and its results revealed several challenges regarding the interpretation of the suggested directions of development. Therefore, the question of the reliability of the final formula appeared. One of the opportunities for future research is to rede-

sign the final BCFI equation or its components in order to avoid extremely high values caused by the variance in responses.

The final values of the BCFI served as a reference for determining whether a given attribute is critical. Determining the criticality of attributes was followed by the suggestions regarding resource allocation (assigns more resources, assign fewer resources or restrain from any action). Therefore, the method is not only beneficial for the critical evaluation of a company's current situation, but it is also directly useful in the decision-making process and supports the understanding of the organization's situation in terms of critical attributes.

4.2 The "Mini Factory" concept: How to access market fast in China by using dynamic capabilities in production

Objective

The purpose of this case study is to deepen the understanding of dynamic capabilities in production and to offer a solution as to how to use dynamic capability in business life. Most research on dynamic capabilities has focused on the question of "what" defines dynamic capabilities; this article focuses on "how". The case company works in the field of power electronics, and the company decided to set up a factory in China. The case company developed their own concept called a "mini factory". The mini factory has high flexibility and speed as a result of networking, standardization and a modular product platform.

Results and main contributions

The main challenge was to make the Chinese operations profitable as soon as possible in a situation, where customer behaviour was unknown. It was almost impossible to estimate the local customers' volumes and needs, because of thousands of product variants. The company reduced the process time in China by 80% compared to the normal process time that they had during that time in China.

The case company reported several benefits to being near its local customers. First, through the mini factory concept, the profitability increased dramatically. Second, the company had better customer support by having a mini factory near the local customer. The mini factory housed ready-tested, readymade modules. After the customization work was done in the mini factory, the typical lead time could be only one day from customer order to delivery. Improved on time delivery

rates were reported. Third, better cash flow was another benefit relating to the concept. Fourth, because materials were continuously flowing through the mini factory, all modules and parts were up-to-date and reflected the latest revision.

4.3 Modular product design for dynamic capabilities of manufacturing organization: A case study

Objective

The importance of flexibility and responsiveness in the twenty-first century of global business is growing. Different strategies, techniques and tools have been used for achieving agility in an organization. One such strategy is the modular product design.

The purpose of the paper is to deepen understanding of the requirements for and implementation of modular product design and its benefits to customer relations.

Results and main contributions

The paper supports the view that modular product design can be used successfully for improving company efficiency in the power electronics industry.

Modular product structure enables many benefits for the company. In this article, the key performance indicators and trends from the years 2001 to 2011 are shown. The company's revenues and produced products increased more than threefold, and, at the same time, product variants increased significantly. Delivery accuracy increased seven percentage points. The first pass yield is a KPI that reflects the quality assurance capability. It indicates the number of units that pass the tests. The quality level has improved 79%, meaning that the production process and product quality improved substantially during the observation period. Inventory turnover was more than two times faster in 2011 compared to the year 2001.

4.4 Customer needs linked to production strategy and the firm's dynamic capabilities

Objective

This study identifies and analyzes the key factors of an efficient customer oriented production strategy. The paper supports the view that dynamic capabilities can be used successfully for improving a company's efficiency. This research is a case

study research related to production strategy. In the case company, a total of 31 interviews were conducted from 16 subsidiaries and 13 from end customers. The present paper focuses more on end customers than internal customers.

Results and main contributions

Entrepreneurial strategy, effective processes, innovativeness and dynamic capabilities which take into account environment changes, offer one way to develop a more agile customer-oriented company. Working in collaboration with customers and partners, it is possible to understand customer needs more deeply and to achieve faster, more flexible, and more agile processes to support the changing customer needs.

Key findings can be identified as follows: Effective information flow, flexibility, speed and responsiveness need more focus on the study of dynamic capabilities. Delivery accuracy is the key, while short delivery time is a competitive factor.

4.5 Improvement of service offering connected to customer satisfaction in the power electronics field

Objective

The research, a case study related to customer satisfaction, focuses on more effective service improvements and changes in regards to meeting the customers' needs. Through an empirical approach and related enterprise investigation, based on an employee and end-users perspective, a questionnaire system was designed to collect data. The main objective of this case study resolves around the factors that can affect customer satisfaction. This could be valuable when companies prepare their service strategies.

Results and main contributions

The outcomes of analysis show that communication and effective information flow, as well as effective service processes are the key factors, while technical knowhow is a basic requirement. This research helps manufacturing firms to improve their value added services in addition to operating closer to their global customers. It can be concluded that effective communication and rapid service processes have a positive effect on the dynamic capabilities of the company.

4.6 Validating knowledge/technology effects to an operative sustainable competitive advantage

Objective

This paper presents a fresh idea on how to model and examine the level of sustainable competitive advantage (SCA) with and without knowledge and technology (K/T) effects in a case company's operation. This is done by taking the manufacturing strategy's development directions and the efficiency of resource allocation among other attributes into consideration.

Results and main contributions

The achieved results through the model were found to be promising according to the feedback from the respondents. The model can provide a more dependable possibility of sustainable improvement to corporate operational excellence and strategy.

The model provides the possibility of:

- Observing the right type of operation strategies that may provide better performance for the company.
- Making adjustments to the general strategy and taking better strategic actions in operations using supplementary information.
- Investigating whether or not each unit in the company follows the general strategy.

4.7 The dynamic business model based on research in the power electronics industry

Objective

The study tests the framework of the most important factors of successful companies under the dynamic capabilities and agile concept.

In total, the six interviewees had almost 200 years of experience in global business. Their experience included high-level organizational positions such as board of directors, management directors, vice presidents and global business directors. They had all worked in global business, and each of them had global director ex-

perience. Two of the respondents were women and four were men. The respondents' overall experience in global director positions consisted of R&D director, marketing director, factory director, logistics director, business development director and human research director experiences. The interview also focused on the future by asking what the key success words are for the next five year period. Interviewees were also asked to describe the ideal company profile from an employee's point of view.

Results and main contributions

It appears that the firm's size as well as globalization affects the importance of the divisions defined above. We can summarize that the high-technology companies operating on an international level need broader competencies and knowledge than local companies. Most of the significant categories are listed below:

- Entrepreneurial strategy
- R&D to market performance
- Dynamic operational excellence
- Intellectual capital

Entrepreneurial strategy, effective processes, innovativeness, and dynamic capabilities, which take environment changes to the account, are one way to develop a more agile customer-oriented company.

4.8 Contribution of the author in the publications

Table 5 shows the author's contributions in the listed publications and demonstrates that the author has been the head writer in charge of the articles in five of the six publications. The author has been responsible for data collection in all articles.

The input data were collected from 48 informants working in 19 different countries and five continents.

Table 5. Contribution of the author in the publications.

Publication	Corresponding author	Planner of data collection process	Input data collection	Analysis of results	Writer of result and conclusion chapter
1. The implementation of the balanced critical factor index methodology in the strategy redevelopment		X	X		
2. The "Mini Factory" concept: How to access market fast in China by using dynamic capabilities in production	X	X	X	X	X
3. Modular product design for dynamic capabilities of manufacturing organization: A case study	X	X	X	X	X
4. Customer needs linked to production strategy and firm's dynamic capabilities	X	X	X		X
5. Improvement of service offerings connected to customer satisfaction in the power electronics field	X	X POWER INDUSTRY PART	X POWER INDUSTRY PART		X
6. Validating knowledge/technology effects to operative sustainable competitive advantages		X	X		
7. Dynamic business model based on research in power electronics industry	X	X	X	X	X

Conclusion

Chapter 4 introduces seven publications with results and conclusions. Table 4 shows the articles and input data of the articles with the conclusions that are related to the dynamic business model. Table 5 shows the responsibility of the author for each article. The author has been in charge in five out of seven published articles and has been a major researcher in the data collection process. All previously mentioned articles have been used to create a new dynamic business model.

5 RESULTS

According to the National Intelligence Council, the world will change dramatically during the next 15 to 20 years (NIC 2012). This means that firms should find new ways of working. The dynamic business model was developed based on the results of the research articles, the authors work experience and the literature mentioned in Figure 5. It is a model built to cover a firm's operations in such a way that the company can benefit from the changes that are taking place around the company and at the same time win market shares. The model is based on all seven articles which are attached to this study.

Weak market test

The model was tested by using a weak market test. Six high positioned business leaders were used to test the model, and changes were made based on their feedback. They also answered the question "What are the key success words in the next five-year period?" Employees' motivation is an important factor in building a successful company. High positioned business leaders were asked to describe fictitious companies with an ideal company profile. The simplified dynamic business model shown in Figure 6 is based on the above factors and previous studies. The first part of the figure shows the key elements answering the question "what". The second part indicates the actions in which a firm should be faster and more agile. These answer the question "how".

Simplified dynamic business model

The simplified model shown in Figure 6 is based on the analyses, previous studies, and interviews conducted for the present study. The first part of the figure shows the key elements and the second part shows actions that a firm should take regarding the key elements. Figure 6 answers the first research question "Is it possible to create a dynamic business model for power electronics firms that have global operations?"

The dynamic business model works in a business environment that is global and complicated. Products are high tech and there are changes around the firm. Based on studies, power electronics is such a business. The simplified model answers the first research question by describing the changing business environment with major elements and key actions with needed resources, knowledge and tools.

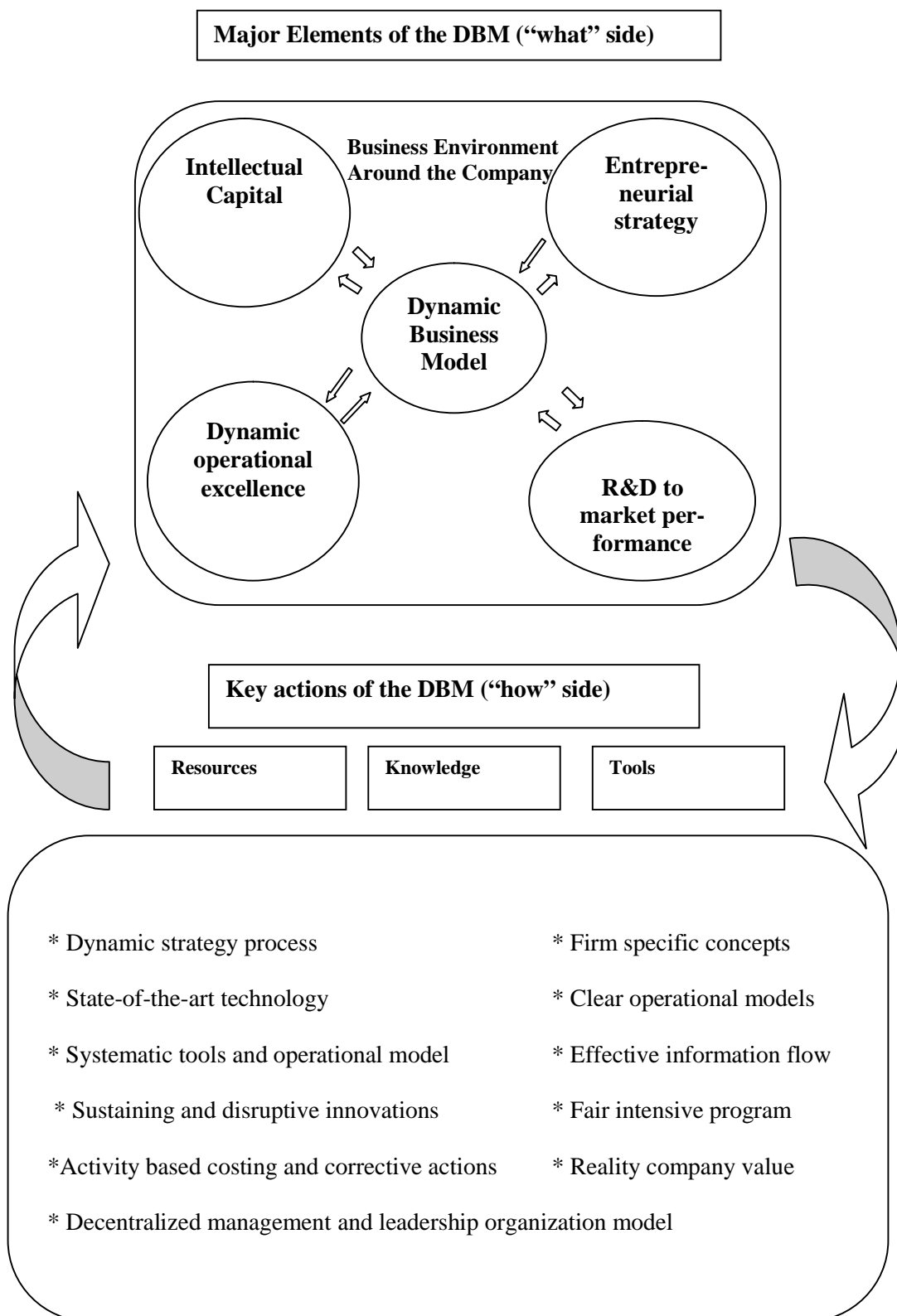


Figure 6. Simplified dynamic business model.

Companies need resources, knowledge and tools to assure that the actions of the dynamic model can be effectively implemented (See Figure 6, “how” side). Resources make the necessary actions possible. Firms must have people, materials, services and financial resources. Tools are needed to complete actions in a qualified manner. These include process descriptions, work instructions and problem solving tools. Knowledge is needed for an understanding of the bigger business picture, and to understand the importance of entrepreneurial strategy. Knowledge in itself is not sufficient; firms need competence and know-how to roll out the needed actions. In this thesis, the following definitions are used for knowledge, competences and know-how:

Knowledge: The highest level of comprehension, knowledge has a strong relationship to a firm’s strategy and future.

Competence: The ability to create, acquire and transfer information, to cooperate gross functionality, to solve problems and change behaviour.

Know-how: Know-how is created when the information leads to a specific activity; know-how is related to the daily work, such as knowing how to use IT systems or using the firm’s quality tools.

Firms’ should develop competences and know-how because without these knowledge is almost useless. Figure 7 shows the relationship between these definitions.



Figure 7. Relationship between knowledge, capabilities and know-how.

Table 6 presents major elements of the dynamic business model, key actions and the relationships among different journal articles.

Table 6. The major elements and key actions presented in different journal articles.

Major elements (What)	1	2	3	3	5	6	7
Entrepreneurial strategy	X	X	X	X	X	X	X
R&D to market performance	X			X		X	X
Dynamic operational excellence / effective processes		X	X	X			
Intellectual capital / innovativeness		X	X				X
Key actions (How)							
Decentralized organization model		X					X
State of the art technology	X					X	X
Firm specific concepts		X					X
Reality company values							X
Fair intensive program							X
Effective information flow				X	X		
Dynamic strategy process					X		X
Systematic tools and operational model	X					X	X
Innovativeness (sustaining and disruptive innovations)	X	X	X				X
Clear operational model (e.g. concurrent engineering, fast time to market process, effective teams)	X					X	X
Activity based costing with corrective actions	X						X

Codes and names of the articles

1. The implementation of the balanced critical factor index methodology in the strategy redevelopment
2. The “mini factory” concept: How to access market fast in China by using dynamic capabilities in production
3. Modular product design for dynamic capabilities of manufacturing organization: A case study
4. Customer needs linked to production strategy and firm’s dynamic capabilities
5. Improvement of service offering connected to customer satisfaction in the power electronics field
6. Validating knowledge/technology effects to operative sustainable competitive advantage
7. Dynamic business model based on research in the power electronics industry

Dynamic capabilities in high technology power electronics industry

More detailed specifications of a conceptualization and ontology-based description are shown in Table 7. The specifications are based on analyses, previous studies, and interviews. Table 7 shows how the model works at a detailed level connecting the major elements and key actions.

The dynamic business model was invented in a business environment that is global and complicated. The products represent the latest technology available, and there are constant changes in the market-place. The simplified dynamic business model shown earlier in Figure 6 answered the first research question: “Under what conditions is it possible to create a dynamic business model for power electronics firms with global operations”?

Table 7 presents a detailed list of the major elements or classes under the dynamic business model, which are considered to be the most important factors in the high technology power electronics field. Classes and subclasses are marked in bold. Values are marked with “v”, and sub values marked as “sv”. These marked descriptions answer the questions of “what” and “how.” The ontology list below answers the following research questions:

Question 2: What are the key elements of the model?

Question 3: How can the key elements be implemented and what are the main actions?

Table 7. Ontology-based description of dynamic business model relationships.

Dynamic Business Model (DBM)

- 1. Entrepreneurial Strategy (c)**
 - 1.1 Dynamic strategy process (v)
 - 1.1.1 Demanding business target (sv)
 - 1.1.2 Company specific (sv)
 - 1.1.3 International business concept (sv)
 - 1.1.4 Networking (sv)
 - 1.1.5 Continuous improvement (sv)
 - 1.2 Firm specific concept (v)
 - 1.2.1 Credible, simple, feasible (sv)
 - 1.2.2 Product concept (sv)
 - 1.2.3 Process concept (sv)
- 2. R&D to market performance (c)**
 - 2.1 State of the art technology (v)
 - 2.1.1 Technology push products (sv)
 - 2.1.2 Market pull products (sv)

- 2.1.3 Appropriate product portfolio (sv)
- 2.1.4 Modular product platform (sv)
- 2.2 Clear operational model (v)
 - 2.2.1 Concurrent engineering (sv)
 - 2.2.2 Cross functional "tiger" teams (sv)
 - 2.2.3 Fast time to market operations (sv)
- 3. Dynamic operational excellence (c)**
 - 3.1 Decentralized Management and leadership organization model (v)
 - 3.1.1 Team work with high motivation (sv)
 - 3.1.1.1 Meaningful work (sv)
 - 3.1.1.2 Good working atmosphere (sv)
 - 3.1.2 Flexible organization model with fair leadership (sv)
 - 3.1.2.1 Global operations with local actions (sv)
 - 3.1.2.2 Cross functional teams (sv)
 - 3.1.2.3 "Tiger" teams (sv)
 - 3.1.3 Fast decision making process (sv)
 - 3.1.4 Right Partners (sv)
 - 3.1.5 Systematic planning process (sv)
 - 3.1.6 Trust (sv)
 - 3.1.6.1 Openness (sv)
 - 3.1.6.2 Empathy (sv)
 - 3.1.6.3 Customer Loyalty (sv)
 - 3.1.6.4 New market segment (sv)
 - 3.2 Systematic tools and operational model (v)
 - 3.2.1 Standardization (sv)
 - 3.2.2 Modularization (sv)
 - 3.2.3 Mass Customization (sv)
 - 3.2.4 Product data management (sv)
 - 3.2.5 Pull control (sv)
 - 3.2.6 High amount of sales variants (sv)
 - 3.2.7 Wide sales channel (sv)
 - 3.2.8 Effective service process (sv)
 - 3.2.9 Continuous improvement system (sv)
 - 3.3 Effective information flow (v)
 - 3.3.1 Cloud computing systems (sv)
 - 3.3.2 Global information sharing and data sourcing system (sv)
 - 3.3.3 Automated data collection systems (sv)
 - 3.3.4 Knowledge service system (sv)
 - 3.4 Activity based costing and corrective actions(v)
 - 3.4.1 Growth tracking (sv)
 - 3.4.2 Profitable tracking (sv)
 - 3.4.3 Finance tracing (sv)
 - 3.4.4 Sustainability resilience (sv)
 - 3.5 Creating, integrating, recombining and releasing resources (sv)
- 4. Intellectual capital (c)**
 - 4.1 Sustaining and disruptive innovations (v)
 - 4.1.1 Process innovativeness (sv)
 - 4.1.2 Product innovativeness (sv)
 - 4.2 Fair Incentive programs (v)
 - 4.2.1 Bonus system based on the Firm's success (sv)
 - 4.2.2 Everyone involved (sv)

- 4.3 Reality company values (v)
 - 4.3.1 Work feedback (sv)
 - 4.3.2 Systematic tools (sv)
 - 4.3.3 Trust (sv)
 - 4.3.4 Fair play (sv)
 - 4.3.5 Firm's spirit based on success (sv)

Conclusion

The dynamic business model was developed in a global and complicated business environment, where products are high tech and there are changes around the firm. The base for the present model was Teece et al.'s definition for dynamic capabilities. This definition indicates that it is the firm's responsibility to integrate, build and reconfigure internal and external competence to address the rapidly changing environments (Teece, Pisano & Shuen 1997).

The dynamic business model of the present thesis consists of more detailed units and describes the major elements and key requirements for the successful firm. The most important actions are related to the major elements as shown in Table 7.

6 DISCUSSION

The present dynamic business model is situational and depends on the firm's life cycle. Globalization level, knowledge, resources and business are company specific, and, therefore it is not possible to highlight the most important elements or key actions. The concepts introduced in the articles are based on experience in limited industry segments and used effectively in the power electronics industry. Examples of the recent discussion, mass customization concept and modular product design are suitable for an environment where both volume and the need to customize products based on the customers' needs exist. If there is no need to customize products, other product platform concepts might be more cost effective to run the company. Most studies on dynamic capabilities focused on the question, "What" are the dynamic capabilities?" The present study focuses on "how", and defines major elements and their relationship to key actions under the dynamic business model in the power electronics industry.

There are benefits when business sectors reconsider and reconfigure their resources, capabilities and concurrent engineering (CE) in their processes. This prepares them for the tough competition in the market. However, this preparation requires versatile competences: technology management, management leadership, organizational strategy and structure, and these should be intertwined (Hakkarainen & Talonen 2006, Matthews 1992). In addition, Ford and Sterman advocate a causal dynamic model that integrates the influences on processes, resources, scope and objectives of the organization (Ford & Sterman 1998). The following discussion responds to the third research question: "How can the key elements be implemented, and what are the main actions"?

There should be a connection between management and organizational strategy, strategic architecture and structure (Mäkinen 1999). This link could be explained as grouped theories about human attitudes and behaviours, managerial actions and policies meant to emphasize these theories and the response of employees with respect to the implemented actions and policies. One of the most significant challenges is how to implement strategies. During the data collection, one of the informants' responded, "*Companies do not have big problems if we take strategy issues away; strategy is the most difficult to implement*". Talonen & Hakkarainen suggest different levels in strategizing. Although this may be the case, the suggested model in the study also confirms that strategy is a challenge.

Importance of dynamical attractors for the customers

The suggested major elements and key actions in this study put management and organizational strategy and structure to the test. Based on the results, the weak test

provides a view of how important management, strategy and organizational structures are. However, the previously listed items go hand in hand with agility and resilience. Holmstrom and Hameri support these views in their study of dynamic behaviour of the supply chain to understand the dynamical attractor for customers, and improve value added (Koskinen, J. & Sahebi, D. 2013). However, there must also be a sound transformational leader to help in the interaction with subordinates (B. M. Bass. 1985).

Dynamic capabilities and team work

As seen earlier in the literature, Garvin (1993) urges team learning for skills and creativity. This develops into strong teamwork, collaboration, and creative thinking. The study reveals that innovation should also encourage the teams involved, and they should become motivated while becoming involved in decision making. This is a very important requirement as seen in the comments shown in Article 7. This in turn delivers speed in information flow and decision-making, quality, flexibility, and responsiveness, all of which are key components of success and agility (Jackson & Johansson 2003).

This dynamic system balances the extremity of the lean ideal and sense and response (Preiss 2005) for the customers' changing needs and trends for long-term client solutions (Pekkarinen, Piironen & Salminen 2012) and customers' needs. (Koskinen et al. 2013), consequently making the firm lean and agile. The dynamic business model in Table 7 also suggests that training and development are associated with performance (Yahya, S. & Goh, W. K. 2002), as well as market share (Schumpeter 1939, Bessant & Francis 1999). However, this study also indicates that fair incentive programs, organizational culture, company spirit, time to market, process and product innovativeness have an impact on competition and market share.

Dynamic capabilities and process improvement including effective R&D

As Table 7 suggests, a good process should be able to improve performance throughout the organization while harbouring motivation directed at the individual in the innovation processes. The replies from the informants suggest this as an inevitable driver for success in global companies. In the early 80s, Cooper viewed process in technology as regards to opportunity, market, proficient internal R&D management, decision making, and logistics (Cooper 1983), and supported rapid changes whilst maintaining the firms' operation. However, it is also necessary to benchmark the firms' internal and external success factors to improve on the performance (Keller 2001b), of cross-functional teams, costs of production develop-

ment (Alemu 2013), NPD times (Yassine, Braha 2003), and time-to-market (Berman, Hagan 2006). Benchmarking could be backed up with Total quality management (TQM) and could benefit the firm's strategy (Mäkinen 1999, Garvin 1984). R&D to market performance is more critical now and in the future. Technology is developing at an accelerated speed, and those companies that are not able to bring new products to the market faster will face difficulties in improving their sales and profitability.

Customer needs and framework

To be successful in today's business environment, management must understand the needs of customers and respond dynamically. Kanter's views on management call for a strong concept with leading-edge ideas and competences. Management must be able to translate ideas into applications (innovation) for customers and connect to other businesses to improve on the value for customers (Kanter 1995). This is not the case for the ideal company, where, there is significant focus on demand targets. In the data collection, some informants were in support of Kanter's views and Mäkinen's suggestion of a theoretical framework on organizational strategy, strategic intent, structure, and processes. It is necessary to have a positivist research with statistical generalization and multiple reliable sites in order to increase the scope of the investigation and degrees of freedom. This study could be used to develop an analytical generalization by imitating the logic of findings to achieve external validity.

Business performance and intellectual capital

It should be noted that due to the interdependency and relation between various tasks and processes that are involved in the construction of the proposed model, challenges are created along the development timeline of the model as well as in its implementation in the power electronic industry. Some of these challenges are associated with time (longer development time) and Yassine and Braha's complex challenges of iteration, parallelism, decomposition and stability (Yassine & Braha 2003). This is due to the fact that these changes are; tactical, strategic, and objective (Brookes & Backhouse 1997), and when introduced in a system, they are meant to improve the overall business performance (Mäkinen 2011). These challenges sometime will increase exponentially depending on the number of "nodes" in the development timeline process. Furthermore, several researchers have argued that concurrent engineering comes with difficulties despite the fact that it has numerous successes (Ford & Serman 1998, Moffat 1998, Clark & Wheelwright 1992). These difficulties and consequent failures may also partially come from

cycle time reduction in the concurrent development process that is also known to increase the complexity of processes in organizations (Krishnan, Eppinger & Whitney 1997). However, excessive focus on cost reduction may create complications by compromising the factors. Sacrificing key competencies is sometimes not appropriate (Stanko, Molina-Castillo & Munuera-Aleman 2012). Conversely, the model may need quantification in order to assess its significance, since the success or failure depends on how functions and sub-system interdependency and relations are integrated to see the overall effects of the model as a system. Managing by improving organizations to become better is a huge challenge. Innovation and learning is difficult to manage in an effective way. Innovative organizations have a strong culture based on goal-oriented actions. Many managers believe that their organizations have high intellectual capital level, but when you delve deeper into the organization levels, too many unsolved problems and challengers are found.

Dynamic business model compared to other business models and frameworks

It is easy to list many business models which are well known in the business life. However, business models are commonly designed to resolve common problems and challenges in an organization. These business models are often on a general level, and at the same time, they are focused on a particular company's processes or problems. Red ocean strategy focuses on competitive markets, while blue ocean strategy focuses on achieving a competitive advantage by giving attention to creating new markets. Lean thinking is also known Toyota's ways of achieving operational excellence in production. Key factors of lean thinking include the removal of "muda", meaning minimizing waste and inefficiencies. Lean is mainly related to effective methods of run production operations.

Six Sigma is a quality-oriented philosophy developed by Motorola. Six Sigma is based on statistical analyses methodology focusing on standard deviation and minimizing the number of defects in a production system. If a firm's production is running six sigma levels, no more than 3.4 defects are allowed in one million opportunities. This can be achieved by reducing the variation of the process and managing it in an effective way.

Kotler's 4P's is a managing model focusing on marketing through product, price, place and promotion. The European Foundation for Quality Management (EFQM) model is a management system that helps managers to build an effective organizational model. The model is result-oriented with a strong customer focus. The main elements are leadership, processes and key performance results. The organization's ability to be better in the future through innovation and learning is crucial. .

6.1 Limitation

This research is focused on the power electronics business industry concentrating on a frequency converter business, which is the study's limitation at the same time. This research helps directors and managers to better understand customer needs and the business environment to think more broadly in order to make better decisions for the success of the company. Research results bring additional value to previous studies regarding dynamic capabilities and flexible business concepts. The dynamic business model works well in an environment where the business is global and the company has a large total volume with many variants. To handle global business in a complex environment is quite common outside of the power electronics industry. Therefore, this model could also be useful in other industries where the challenges are similar to those in the power electronics industry.

6.2 Further studies

Other industries have challenges similar to those in the power electronics industry presented in this study. For further studies, we recommend verifying the model in the start-up companies with high technology products. Other industrial branches, which are technology- and knowledge-driven businesses with many products, delivered in a turbulent business environment might be the target group for the dynamic business model.

7 CONCLUSION

This study suggests a model in Figure 6 that can be used by organizations that are in the power electronics industry to make the companies more successful in a market environment. This model combines the theory of science and methodology. The research methods and the paradigm have an influence on the research problem, and it has been implemented in this research. The contribution achieved from the research could suggest that organizational management should have a competent and unique entrepreneurial strategy.

Fresh ideas are necessary in order to become successful in a changing business environment where firm specific concepts together with software are generally given the most important role, making customization work easier, and creating a wider range of product features. This means that it is possible to increase the revenue very quickly by having no additional investment in the stocks. The dynamic business model created in the study suggests a new way of thinking and makes it easier for management to make the right decisions, both from a company perspective as well as from the customers' point of view. The model combines the most important key elements and links actions to the key elements making it possible to create a more profitable business.

It appears that the firm's size as well as globalization affects the importance of the classes defined above. We can summarize that high technology companies operating on an international level need a wider competence and knowledge platform than local companies. Some of the significant categories are listed below:

- Entrepreneurial strategy
- R&D to market performance
- Dynamic operational excellence
- Intellectual capital

Entrepreneurial strategy, effective processes, innovativeness, and dynamic capabilities, which take environment changes to the account, are one way to develop a more agile customer oriented company. Working in collaboration with customers and partners is crucial. It helps to thoroughly understand the customers' needs and to respond faster to the customers' demands. These are flexible and more agile processes to support the changing customer needs.

The present study provides value added and knowledge to managers in the power electronics industry by modelling a new business model. One key finding inside the model was the importance of effective information flow in a global business. The weight of this in the future will probably increase due to faster technology

development trends. Customers throughout the world do not want to keep stocks anymore. Companies that have dynamic business models with fast delivery time and agile operations with qualified products are most probably the winners in the new business world.

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THE IMPLEMENTATION OF THE BALANCED CRITICAL FACTOR INDEX METHODOLOGY IN THE STRATEGY REDEVELOPMENT PROCESS

Anna Rymaszewska¹, Jari Koskinen¹, Josu Takala¹, Shi Zhao², Yang Chen¹

¹ *University of Vaasa, Finland*

² *Wuhan University of Technology, China*

Corresponding author:

Shi Zhao

School of Management

Wuhan University of Technology

Wuhan, China, 430070

phone: +86-13476271192

e-mail: stevenzhao2005@hotmail.com

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ABSTRACT

Strategic planning and development is a critical yet often overlooked issue in company's operations. The planning of development as well as addressing the distribution of available resources should be done systematically rather than instinctively however, many companies still do not have any reliable method that would facilitate the decision making processes at their disposal.

This article aims at presenting the innovative analytical method- Balanced Critical Factor Index (BCFI) for addressing the need for change in company's operational strategy according to changes in available technology and knowledge. By examining a wide array of indexes, the presented method is expected to suggest the directions of development. The presented method also addresses the challenges of the complex process of decision-making. Moreover, the empirical evidence gathered in the studied case company serves as a source of important feedback regarding the further improvement of the BCFI method.

KEYWORDS

Balanced Critical Factor Index, decision-making, strategy.

Introduction

The careful crafting, development, implementation and ultimately redevelopment of a strategy are crucial elements of company's survival. Although such statement might seem trivial, many companies begin the process of strategy redevelopment only after they find themselves outstripped by competitors, facing no opportunities to grow. Moreover, according to [1] nearly 70 per cent of strategic plans and strategies are never successfully implemented. Companies might perceive the process of examining the existing strategy unnecessary and mundane, failing to see the connection between its elements and day-to-day operations. Nevertheless, nowadays turbulent environment and rapid information flow imposes the requirement of flexibility and high responsiveness. In

order to be able to accomplish the aforementioned, companies should be aware of their critical attributes, technologies as well as the resources that can be assigned to their development. According to [2] strategy is an ongoing process and a certain way of thinking of the whole business based on identification of strengths and weaknesses and the evaluation of opportunities. Therefore, strategy should be seen as an evolution rather than ad hoc activity.

According to [3] strategic decision making is a highly complex process that involves many different variables. The author outlines several characteristics that determine whether a decision is strategic or not. The criteria are as follows:

- Decisions regarding organization's relationships to its environment;
- The whole organization as a unit of analysis;

- Decisions encompassing all the major functions performed by the organization;
- Decisions providing constrained guidance for all of the administrative and operational activities of the organization;
- Critical importance for the long-term success of the organization.

The concept of strategic gap is also mentioned by [3]. The gap is bound with the fact that strategic decisions affect the organization's relationship with external environment. The concept illustrates the discrepancies between organization's current situation and external environment. In other words, it is the difference between where the organization is and where it wants to be. According to [3] the strategic gap can be determined by can be determined by comparing organization's capabilities with the opportunities and threats of the external environment. The author also emphasizes that the situation where there is no strategic gap is almost impossible. Therefore, the organizations should focus on minimizing the strategic gap by exploiting the opportunities while utilizing the internal capabilities as effectively as possible.

The decision-making process and its importance should be perceived through the wide array of its functions. The following were outlined by [3]:

- Determining strategic objectives;
- Exploring, comparing and evaluating alternatives;
- The final act of choosing from the variety of alternatives;
- The implementation of a chosen alternative;
- Controlling and monitoring the results of the decision made.

The functions of the decision-making highlight the complexity of the process. Moreover, in the context of limited time and information available combined with ever changing external business conditions, the importance of making the right decisions in the right time.

Turbulent environment requires quick decision-making processes and therefore this paper suggests the implementation of the Balanced Critical Factor (BCFI) analysis developed by [4]. The paper addresses the question whether the BCFI methodology fulfills the requirement imposed by the dynamic nature of strategy- the frequent monitoring of current situation as well as the awareness of those attributes that are crucial to organization's development. Moreover, by conducting the market-based validation (weak market test) developed by [5] the method is tested in terms of the suggested directions of development and therefore the formulas used for their calculation. The paper aims to contribute to the sci-

entific knowledge within the area of methodologies supporting the strategic decision-making process.

Balanced Critical Factor Index (BCFI) analysis

BCFI analysis was developed by Professor Josu Takala as an improvement to the previously proposed Critical Factor Index analysis. According to [4] both methods can be perceived as measurement tools that are intended to indicate which of the analyzed attributes are critical and which are not and therefore the model can be concerned a useful tool for strategic decision-making. The BCFI analysis has been successfully implemented in e.g. automotive industry [6, 7] or fine gold jewelry export [8].

The stimuli for developing a framework for facilitating the decision-making process and strategic development developed during the earlier empirical research in various companies. Identified was the need for a tool that would fulfill the following criteria:

- Understandable and relatively easy to use in practice;
- Providing valuable insight into company's situation in terms of a various dimensions;
- Providing directions regarding the strategic development in the future;
- Based on quantitative rather than qualitative data and quantified assessment.

The development of the BCFI was initiated in response to the aforementioned requirements. The method will be assessed in terms of being capable of addressing the requirements further in this paper.

The BCFI analysis utilizes the survey structure which, according to [4], is an efficient approach to reaching the desired response. The main challenge of the questionnaire creation is the selection of the attributes that would best represent company's operations.

Based on the simple statistical measures and more complex calculations developed by [6] and [4] the BCFI analysis allows for the identification of critical attributes which, in turn, supports managers in the decision-making process.

The research presented in this paper utilized two types of questionnaires in order to gain a more complex understanding of company's operations. The first Balanced Scorecard Questionnaire (BSC) refers to the attributes such as:

- External structure;
- Internal processes;
- Learning and growth;
- Trust;
- Business performance.

The second type of questionnaire- Operational Performance (OP) refers to the operational attributes such as:

- Knowledge and technology management;
- Processes and work flows;
- Organizational systems;
- Information systems.

Respondents were asked to evaluate the present situation within their organizations as well as to refer to their future expectations regarding the same attributes. Respondents were also asked to evaluate the same set of attributes in comparison with competitors. The scale for evaluation stretches from 1 (worst) to 10 (best) and respondents were given certain freedom in interpreting the meaning of values they were assigning to the attributes. Questionnaires also refer to the classification of the attributes in terms of their importance for the development of a company. A division into three groups was implemented and the respondents were asked to divide 100 per cent into the following:

- Basic;
- Core;
- Spearhead.

Attributes classified as spearheads are those that determine the future development of an organization while basic and core capabilities are those typically well-developed that drive the current operations.

The final value of BCFI analysis was calculated by based on the Eq. (1) developed by [6].

$$\frac{SD \text{ expc I} * SD \text{ expr I} * PI}{II * GI * DDI}, \quad (1)$$

where SD expc I – standard deviation expectation index, SD expr I – standard deviation experience index, PI – performance index, II – importance index, GI – gap index, DDI – direction of development index.

The development of the BCFI model has its roots in the need for addressing the complexity of decision making process as well as the multi-dimensional nature of strategies. Moreover, the Balanced Scorecard has been identified as one the most inspiring concepts in the process of BCFI development.

Balanced Scorecard

According to [7] the Balanced Scorecard framework was created based on a need for a multidimensional performance measurement system. The framework provides a holistic perspective on performance measurement that encompasses the following four perspectives:

- Customer;
- Financial;

- Internal business process;
- Learning and growth.

The perspectives are viewed as a set of interlinked relations and the company's strategy should underline the overall concept of the scorecard. According to [7] the significant benefit of the method is the possibility to simultaneously control key performance areas with the help of the key performance indicators characterized by cause and effect relationships. The author emphasizes that the Balanced Scorecard contributed to the way companies are being managed by promoting a holistic approach and simultaneous consideration of dissimilar perspectives. Furthermore, the author claims that the method facilitates the process of reaching consensus in terms of outlining the strategic objectives as well as communication of the chosen strategy. Wu et al. [7] also mention the concept of strategy maps which provide graphical presentation of the results achieved while implementing the Balanced Scorecard. Strategy map represents the process of value creation by connecting the different strategic objectives and assigning them into the aforementioned BSC perspectives. Moreover, strategy maps aim at presenting a macro view of an organization's strategy.

According to [7] the main strengths of the BSC tools comprise of the following:

- Simplicity;
- Interdisciplinary;
- Potential to enhance understanding of the business as well as the cause-effect relationships;
- Aligning intangible assets with company's strategy;
- Supporting corporate restructuring, goal setting, compensation, resource allocation and performance improvement.

According to [7] the major drawbacks of the method are as follows:

The major drawbacks of the BSC framework as mentioned by [7] refer to the weaknesses in design and the implementation failures. Other identified drawbacks concern the insufficient explanation of causality as well as unclear relationships between measures. The framework is also being criticized for its failure to address system dynamics and inability to refer to the time lapse between cause and effect. Another important limitation refers to the small number of indicators. The aim of maintaining the simplicity of the framework should not be compromised however, the key to success is the focus on measuring the "right things".

Despite aforementioned drawbacks the BSC framework can still be described as a beneficial method based on correct and rational assumptions.

The development of the BCFI method aims at adopting the similar logic and creating a tool that would provide an all-encompassing view of organization's situation as well as direct the future development.

The case company

The company chosen for this study develops, manufactures, markets and services low voltage AC drives in the power range of 0.2–5,000 kW, from the simplest to the most demanding applications. The case company's headquarters is located in Vaasa, Finland and it has sales offices and R&D departments in 27 countries in three different continents. The organization aims at building its competitive advantage upon global presence, multiple sales channels, exceptional know-how and innovativeness. Since winning the leadership within the AC drives business requires providing customers with innovative solutions, the company focuses in particular on the research and development as well as shortening the distance to the customer by locating its units worldwide.

The company aims to be a leader supplier of AC (alternating current) drives therefore the strategic choices comprise of product leadership, total focus on AC drives, multi-channel sales network and global presence. The overall ambitious goal of being a leading AC drives imposes investments in research and development as well as maintaining a well-developed customer interface.

The company is constantly facing the challenges that stem from operating in a turbulent environment as well as the growing competition. Moreover, maintaining and coordinating operations worldwide imposes additional challenges in company's operations. Therefore, the process of strategy redevelopment was initiated.

The respondents chosen for the study represent the top management level. For the convenience of analysis they were divided into two groups out of which one represented of "strategy developers" (executive officers, vice presidents) and the "strategy implementers" (directors responsible for the main operations- logistics, global sourcing, business controlling, production testing). The main reason for such division was to examine whether the outlined groups differ in their perception of current situation as well as the expectations regarding the future.

Methodology and research background

Case study approach was implemented in order to address the aforementioned research aims. Single

case approach was chosen in order to address the depth rather than the breadth. Nithisathian et al. [8] suggest that single cases are generally recommended for gaining an in-depth and detailed understanding. The study presented in this paper comprises of data collection through a detailed survey. The emphasis was put on gathering quantitative evidence as well as providing description both of the situation in a given point of time and the expected development in the future.

The research presented in this report was based on the survey conducted in the company. The representatives of different management levels were selected for the research and all together 14 responses were gathered. The responses were divided into two following groups:

- group 1 (employees responsible for strategy crafting; 5 answers in total),
- group 2 (employees responsible for strategy execution; 6 answers in total).

Weak market test

The weak market test was conducted in order to validate the results of the empirical research as well as to determine whether the model would require any corrections. The results of the weak market test revealed certain discrepancies between the suggested directions of development and the perception of the company's president. Therefore, the method should be given additional attention especially in terms of calculating the formulas and the meaning of statistical measures.

The weak market test was conducted with the president of the company. The interviewee was asked to comment on the proposed directions of development. As it can be observed from the tabular summaries there is a significant resistance towards the proposed increase of attributes. Such results suggest that there might be some weaknesses in the method in terms of the construct of questionnaire or the formulas.

Presentation and interpretation of the results

The empirical data gathering was accomplished through a survey distributed among employees of the case company. The respondents were asked to express their opinions on the aforementioned attributes in terms of both present and their future development. To facilitate the process of data analysis the respondents were asked to express their opinions by assigning values from 1 (lowest, the worst) to 10 (highest,

the best) to their opinions.

The aim of the presented research was, apart from providing guidelines for the case company, testing the method for its potential flaws and weaknesses. In particular, the weak market test was expected to provide a valuable insight into rethinking the method.

Figures 1 and 2 presents the results of BCFI (OP and BSC questionnaires) calculations for group 1. Figures 3 and 4 present the same calculations for group 2. Graphs present the tendencies for the past and the future (experiences and expectations).

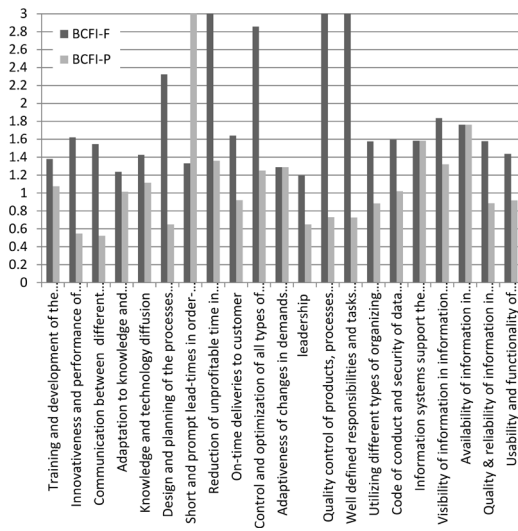


Fig. 1. BCFI calculations for group 1 (OP questionnaire).

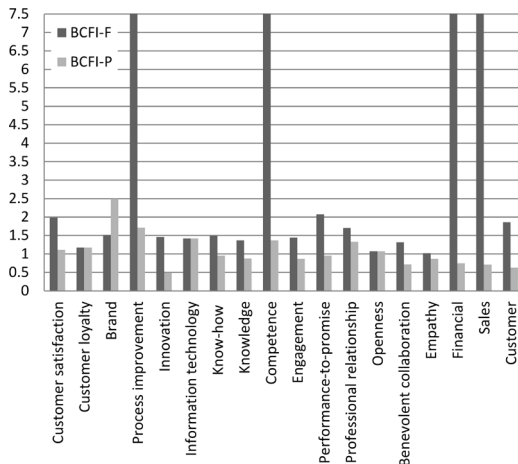


Fig. 2. BCFI calculations for group 1 (BSC questionnaire).

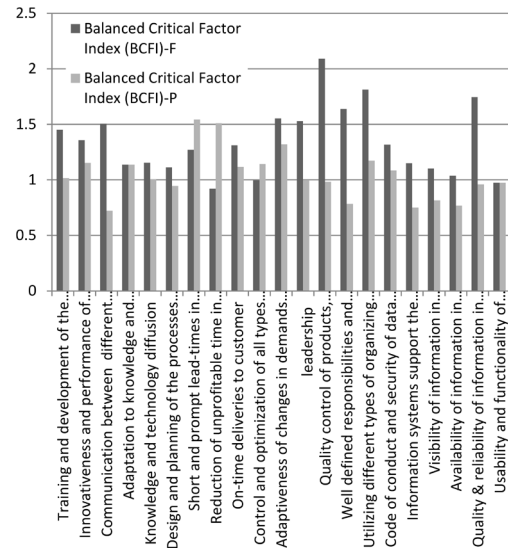


Fig. 3. BCFI calculations for group 2 (OP questionnaire).

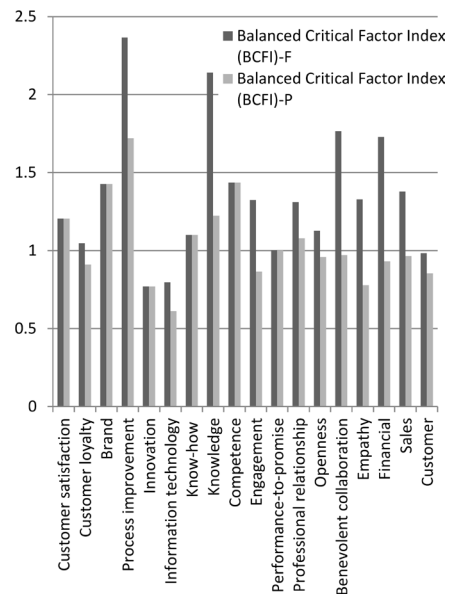


Fig. 4. BCFI calculations for group 2 (BSC questionnaire).

Based on the values of the calculated BCFIs the attributes were divided into critical (requiring immediate action), green ones (not requiring immediate action however, should be monitored), and yellow ones (unclear in their meaning). Based on the numerical values calculated for every attribute the division was made and suggestions for the future de-

velopment were outlined. Tables 1 and 2 present the suggestions contrasted with the results of the weak market test during which the company's president commented on the proposed improvements (agree or disagree).

Table 1
Directions of development and the results of the weak market test (group 1)

attribute	suggestion	comments
Adaptation to knowledge and technology	increase	agree
Adaptiveness of changes in demands and order backlog	increase	agree
Empathy	increase	agree
Openness	increase	agree
Customer loyalty	increase	agree

Table 2
Directions of development and the results of the weak market test (group 2)

attribute	suggestion	comments
Control and optimization of all types of inventories	increase	agree
Usability and functionality of information systems	increase	agree
Innovation	increase	agree
Information technology	increase	agree
Communication between different departments and hierarchy levels	increase	disagree

Improvement suggestions were presented in terms of the attributes that require attention or, in other words, need to be increased. It is assumed that available resources are limited and therefore, more resources allocated into certain areas might imply that the development of other potentially important areas would have to be at least temporarily abandoned. Since such a tradeoff is challenging to address, this paper does not provide clear suggestions regarding the decrease of certain attributes. The further development of the model will be focused on sharpening the suggestions regarding the decrease. Currently, the results provided by the model are not reliable enough to serve as basis for outlining the managerial implications.

Conclusions

The empirical study was intended to examine a set of attributes divided into two separate question-

naires. Based on simple statistics and more complicated calculations the attributes were examined in terms of their criticality. According to [4] the final value of the Balanced Critical Factor Index (BCFI) can serve as a basis for division into critical, not critical or unknown. The factors influencing the final value of BCFI are: standard deviation index (relating to past and future), performance index, importance index, gap index, and direction of development index. The indexes rely on the values of standard deviation and therefore the number of respondents is critical and should preferably be at least five. The number of respondents for this empirical research was 11 which support the validity of results. The process of coding the responses did not reveal any serious mistakes or misunderstanding therefore all the responses were considered usable.

The weak market test was conducted in order to validate the results of the analysis and its results revealed several challenges regarding the interpretation of the suggested directions of development. Therefore, the question of the reliability of the final formula appeared. One of the opportunities for the future research is redesigning the final BCFI equation or its components in order to avoid extremely high values caused by the variance in responses.

The final values of BCFI served as a reference for determining whether a given attribute is critical or not. Determining the criticality of attributes was followed by the suggestions regarding the resource allocation (assign more resources, assign less resources or restrain from any actions). Therefore, the method not only beneficial for the critical evaluation of company's current situation by also of is directly useful in the decision-making process and supports the understanding the organization's situation in terms critical attributes.

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The 'mini factory' concept: how to access market fast in china by using dynamic capabilities in production

Jari Koskinen

Department of Production,
Faculty of Technology,
University of Vaasa,
P.O. Box 700, FI-65101, Vaasa, Finland
E-mail: jari.koskinen@gmail.com

Abstract: The purpose of this case study is to deepen understanding of dynamic capabilities in production and to explain a solution; how to use dynamic capability in business life. Most research on dynamic capabilities has focused on the question 'what' defines dynamic capabilities; this article focuses on 'how'. Dynamic capabilities can be used successfully for improving company's efficiency. The case company work in the field of power electronics, and they decided to set up a factory in China. The case company developed their own concept called a 'mini factory'. The mini factory is a factory with a high flexibility and speed.

Keywords: dynamic capabilities; innovation; learning; the mini factory concept; mass customisation; networking production; modular product structure.

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Biographical notes: Jari Koskinen has a wide experience on leadership, information technology and manufacturing. He has more than 20 years knowledge in industry. He works as a Business Controller, and later in production as the Vice President of global factory operations. He has also experience on Chinese culture and business life, lived in China several years and works there as a Managing Director, after which he has been Chairman of the Board of that company. His research interests are related to strategies, research and dynamic capabilities.

1 Introduction

Due to increasing competition and the customer's changing needs it is a fact that companies should be more innovative to be competitive in the future. Therefore companies should organise their operations in such a way that they could react fast to the changes in the business environment. This covers all of the company's processes, including product creation, production, and logistics. Company's organisational creativity is an important factor of organisational innovation (Gupta, 2011). The innovation processes has changed little, although business environment has changed plenty (Wind

and Mahajan, 1997). For the companies it is challenging to set up a strong empirical link between innovation and performance (Tidd, 2001).

Information sharing is an important factor to reach results and to get the needed products to the marketplace. Strong integration between research and marketing is important to ensure that market requirements are included in technological development (Ayers et al., 2001).

Information sharing and team communication are important factors to improve organisation innovativeness (Chatterjee, 2012; Parjanen, 2012). There are several studies focusing on information flow and importance of co-operations between divisions and departments (Griffin and Hauser, 1996; Burroughs et al., 2011).

Customers' needs are changing and we can identify the following increasing trends: the number of product variants, product features, and quality requirements are all increasing. At the same time companies want to decrease inventories. The situation is difficult because of high amounts of product features and product variants are pushing the value of inventory up, instead of decreasing material buffers. To be competitive in such an environment, companies should organise its operations in a way that they would have fast responses to the changes in the market.

Dynamic capabilities are the organisational and strategic routines by which firms achieve new resource configuration as the market situation changes (Eisenhardt and Martin, 2000). The discussion on dynamic capabilities strongly recommends that companies should have the capability to learn quickly and organisations should react fast to the changes. The case company in the present study developed its own concept: the mini factory. The mini factory concept is invented by the writer of this article, and is based on two main elements: module factory production and variation production. The module factory production is based on the modular product structure and variation production is based on the customisation. The first part of the production is made in Europe. The second part is made in China. The power of the concept is that it makes it possible to minimise the stock levels, and at the same time, offers a high mix of product offerings to the local customers with a very fast lead time.

The present study answers the question: how did the case company act differently in order to succeed in China compared to its competitors? The purpose of the study is to understand the case company's ways of working from the dynamic capabilities' point of view.

2 The mini factory concept definition

The terms 'mini factory', 'module factory' and 'main factory' are used by the case company in production. The main factory is a factory which includes both module factory production and mini factory production. In the main factory there could also be a 'make to order' production done mainly for OEM (original equipment manufacturer) customers or for old products. Module factory production is based on 'mass volume' principles and effectiveness. There are only a few variants, and typically the production volumes are very high. The production type is called 'low mix' and 'high volume' production. There are effective automated or semi-automated production lines and testing systems. Material handling is based on demand driven buffers and Kanban containers are used to serve materials to production lines.

The 'mini factory' concept

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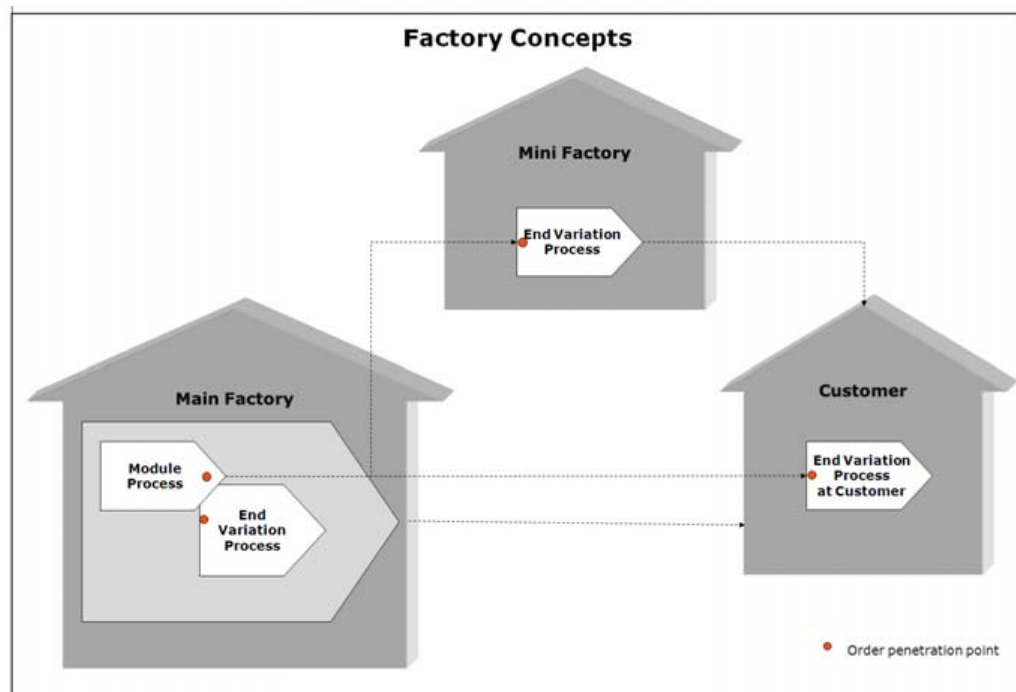
The mini factory is a factory with high flexibility and speed. The mini factory contains similar operations as a normal factory; operations are just in a smaller scale.. Typically, activities are production loading, material handling, testing, simple production lines or production tables and tracking system. The mini factory is using ready assembled and ready tested modules in its production process. That is the reason why it is called mini factory. It is like a 'logistic hub', where the end variation work is done very fast and in an effective way.

The idea is that there is no double testing. Only those modules, which have been connected together, will be checked. The interface of modules that have been brought together are tested and checked that communication between different layers are working fluently. A mini factory can be on the same premises as a module factory. If this is the case, the company calls the factory a main factory. A mini factory can also be near the customer, in another part of the world than the main factory.

To get products to the market fast, the case company divides its production process into three separate processes. These three different production processes are module process, end variation process and make to order process. In the beginning module production process was set up to make high efficiency by having high volume with limited number of variants. The customisation is done in variation process by connecting ready assembled and ready tested modules together ('Lego block' thinking).

The make to order process is made for products where customisation begins from the first assembled parts. This process is mainly for dedicated OEM customers or for the old products, which have not been developed with mass customisation principles. The most effective way to do customisation work is to use the module process and the end variation process.

Figure 1 Factory concepts and factory processes (see online version for colours)

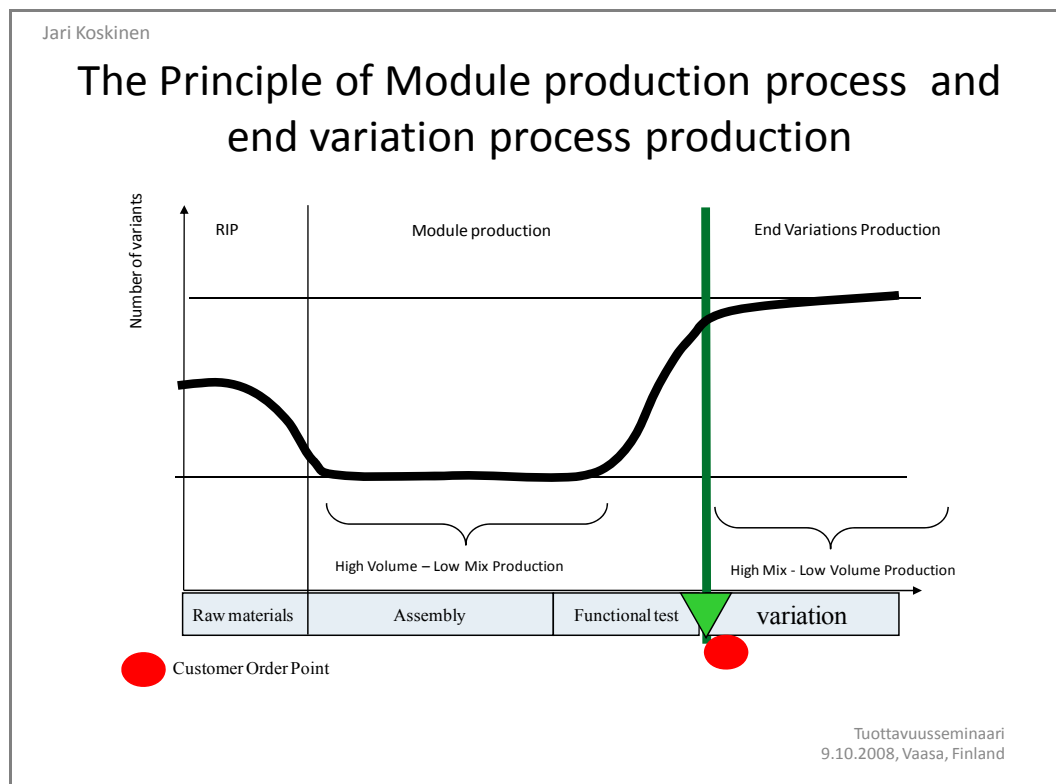


The mini factory concept includes variation process and all the tools that are needed to run the process. Typically these are IT tools, production tools and testing systems. Figure 1 shows that in theory, it is possible to carry end variation process to the customer premises and improve the performance of the company.

Currently, the case company has mini factories in four different countries. In the future there might be more mini factories to achieve better customer service all over the world. The company has reported that the mini factory concept is one way to be greater in global competition and will even boost better business success in the future.

Figure 2 shows the principle of module production process and end variation process. The time is on the X-axis and on the Y-axis we can find the number of variants. In the first step raw materials are in process, in which the material is collected to the products.

Figure 2 The principle of module production process and end variation process production (see online version for colours)



Source: Koskinen (2008)

Module production is the main part of the work that will be done on the product. The key is that the number of variants should be limited. During this part, testing of the final module will be done. The production is running based on the pull control. The modules will be produced to the buffer and there is no customer order addressed to the module. Company's strategy is networking production and they network together with suppliers, which company is calling partners. They have created effective supplier network, where special focus has given to the information flows.

The impulse to start the end variation is a customer order. This is the part where product is customised based on the order. A customer can have specific software, own

labels and even own printed circuit boards. During the end variation process, the final product can also be modified by control board (there are several different levels of motor controls boards), I/O boards, IP-enclosure, EMC level, Panel board, etc.

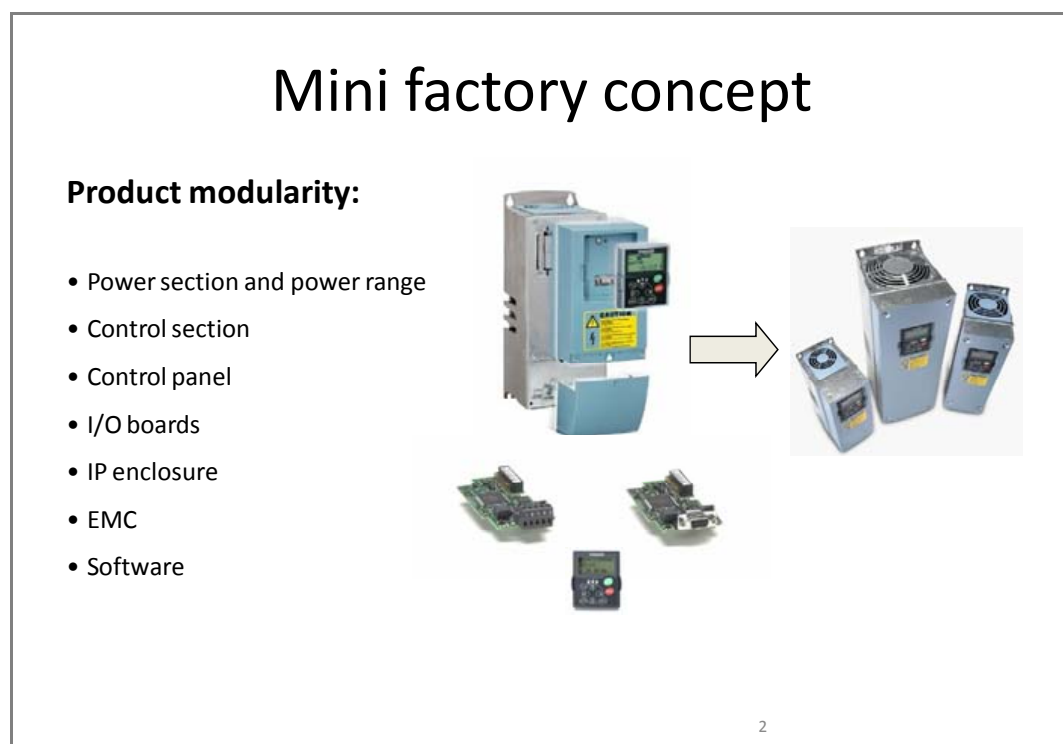
In 2008, a productivity seminar was held in Vaasa, Finland. The principles of module production and end variation production were presented by Jari Koskinen, shown in Figure 2.

Figure 3, explains the connection between the product and the mini factory concept. It is extremely important that the product structure supports the production concept. The concept needs to have modularity product structure, so that independent modules can be connected together.

This means that production people and the people, who are working in the research and development department should have close cooperation to get new products which fits the concept's requirements.

In general, mass Customisation needs products that consist of independent modules that can be easily connected together into different forms (Radder and Louw, 1999).

Figure 3 The mini factory concept and product modularity (see online version for colours)



3 Example of other 'mini factory' type of solutions

In a fast changing business environment, companies should find new ways of working and encourage people to be innovative in order to find new solutions. In turbulent business environments, the importance of innovativeness will increase, and knowledge is one of the most critical inputs to innovation process (Zheng et al., 2011). Dynamic capabilities such as high flexibility and speed enable for firms to create such capabilities.

It provides firms to create and protect intellectual capital, which supports firms to be successful in a long term business (Teece, 2007). Innovativeness is one of the key elements, when firms create their own solutions to become more competitive in a market place. For competitors it is difficult to understand and create similar solution, because dynamic capabilities are internal to the company's operations.

The mini factory concept is an example of innovation to solve the problem: how to get the fast ramp up for the products. The benefits of the mini factory concept are fast market access by using other factories' module production, capability to handle high mix and low volume production, fast product deliveries for local customers and to minimise the stock level.

We can find solutions similar to mini factory concept in other companies. Hewlett-Packard made a solution for their DeskJet printer where they customised their printers at distribution centres for the local market (Feitzinger and Lee, 1996).

Automotive companies have used a flexible production concept where modifications are done in a systematic way with sharing widely used modules in different car models (Suh et al., 2007).

The mini factory concept is suitable for an environment where there are both volumes and the need to individualise products based on the customer needs. If there is no need to customise products; other production concepts might be more cost effective to run the production.

4 Case study methodology

This work is a case study, which is based on the notes of the managing director, who worked for the case company in China during the years 2005 to 2007. The studied data also includes project documents, presentation slides, minutes of the board meetings and minutes of the management team meetings. This study is topical and important because it contributes to identifying and explaining the requirements of entrepreneurship in a changing business environment where companies have to find new ways of working and encourage people to do things in a different way. This helps managers to understand the power of dynamic capabilities and motivates them to improve their companies operations in a systematic way. The case company developed the 'mini factory' concept to gain faster access to the Chinese market. The mini factory concept is company specific; it is based on the mass customisation and modular product structure principles.

Mass customisation is connected to flexibility and fast responsiveness, where the company gives to its customers exactly what they want (Pine et al., 1993). Mass Customisation is thus the mass production of individually customised goods and services. A key element of mass customisation is product modularity, connected to customisable aspects (Anderson and Pine, 1997). This means that product development, production and company's marketing should work together to get this concept to work. The criterion for selecting the case company was to study its way of production, and to understand the connection to operational performance.

5 Production strategy of the case company

The case company was selected because of its performance in the frequency converter market. In this context performance means capability to increase market share faster than main competitors.

The case company has more than 1,300 employees and the revenue in 2011 was more than EUR 380 million. The company has an aggressive growth target. The goal is to achieve revenue of EUR 500 million with an operative profit of 14% in 2014.

The case company has solely focused on frequency converters (AC drives). Frequency converters provide stepless control of rotation speed of the electronic motors.

Frequency converters have many technical and environmental benefits including the following:

- saving considerable amount of energy in electric motor applications
- reducing carbon dioxide emissions
- reducing the load on the electricity network
- reducing the mechanical stress on machinery when starting an electric motor
- making it easy to connect electric motors to automation systems.

The case company develop, manufacture, market and service low voltage AC drives in the power range of 0.2–5,000 kW, from the simplest to the most demanding application.

The case company is a good example of a firm, which has followed its strategy very successfully and developed its operations to be more agile. The company has seen profitable growth rate that is two to three times higher than the market growth rate in China.

Companies need new approaches for strategising and organising their operations. This means a new style of leadership and new methods to leave slower competitors behind (Doz and Kosonen, 2008).

The case company is focusing on core competencies including drives know-how (products and applications), mass Customisation, product development, customer relationship management and logistics. The company provides AC drives to original equipment manufacturers, end users, brand label customers, distributors, wholesalers, value added resellers and system integrators throughout the world.

The production provides added value to company's customers by creating efficient networks, which combine end-to-end logistics, fast delivery time, high levels of quality and fast time to market.

The production focuses on its core competencies (mass customisation, flow technology, global sourcing and quality) and networking with its partners. Together they develop processes and procedures that guarantee a high level of quality, flexibility and a very cost-effective logistics network.

The company has an aggressive profitable growth rate strategy. The goal is to grow two to three times faster than markets are growing. Production is based on networking and partnering. The production operations which are in house are only final assembly and testing. The principle is that the company is networking with its partners. The main part of the production work is done by the suppliers. This means that the whole supplier

chain, should know the company's volume target to reach upcoming volumes and to serve the common end customers' need in the best possible way.

The company's goal is to provide a wide range of products and product features to the customers. The performance should correspond to the mass production efficiency. The company is using mass customisation principle on its operations. They started using the concept since 2001 and firstly the company focused on the product development and supplier network co-operations. The company has received the total inventory turnover, which is more than 20 turns in a year. The best production lines are running their material operations with more than 60 turns in a year, including the materials that are available on the production line. Material control is based on the Kanban system and effective cooperation with supplier partners.

6 Chinese frequency converter market

The Chinese frequency converter market growth rate is one of the highest in the whole world. Previous year's market growth rate has been calculated with two digits and it has been estimated that this positive trend will continue by more than 10% annually (Beijing Market Avenue Consulting Co., Ltd. Scale of China's FC Market 2004–2008). Currently, foreign players have dominated the market, while the local players are mainly small and middle sized companies.

Over the last years, domestic companies have won the market shares. Chinese companies have improved their service support for local customers. Chinese players have also improved their product portfolio to develop higher power range area, to get better market coverage for their products. In spite of high market growth rate, the customer prices for the final products have decreased year by year (Gongkong, 2011).

In developing countries, it is rather common that companies are lacking investment money and due to that the product price is more important than in the developed countries. Due to the high competition situation, companies that want to grow faster than the market grows should find new capabilities to secure the profitability and high growth rate. New innovation requires first class researchers and inspired entrepreneurs also in China (Xu, 2012).

7 Reason for develop 'mini factory' concept

Frequency of changes in the business environment is increasing and big international firms are highly pressured to get profitable operations all over the world. The case company's target was to provide frequency converters to the Chinese clients with large power range area and faster than competitors. The case company started its production in 2005 in Suzhou, China. Before that, the products were manufactured in Europe and exported to China.

The main reason to set up a factory in China, was that local Chinese key customers started arguing that they wanted to get service and customer support in the local language. The challenge was, during that time that the volumes were quite small and it was clear that new customers and higher volumes were needed in order to make the new factory profitable. The huge challenge in the beginning was to start production from zero and to build local supplier network for the whole power range area, which normally takes

The 'mini factory' concept

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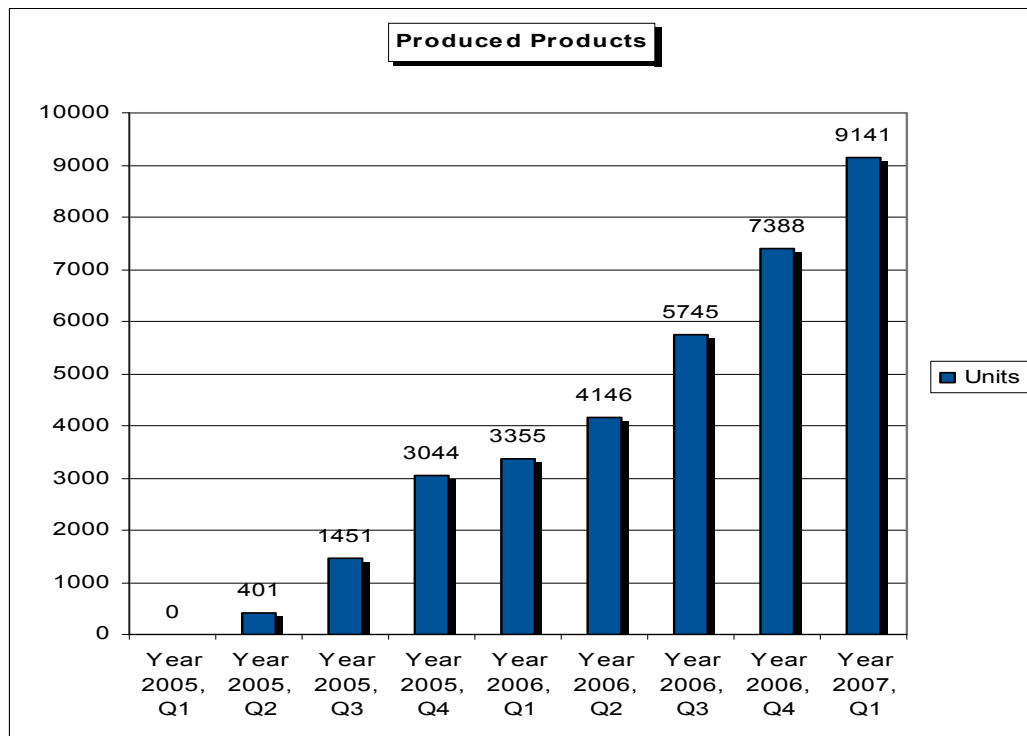
several years. *The mini factory concept was developed to get faster market access to the local customers by using existing product modules and supplier network.*

In practice, the mini factory concept was implemented using the principles of mass customisation and flow technology concepts. The mini factory concept has two main elements; module factory production and the end variation production. The module factory production was made outside of China and readymade and ready tested modules were imported to China.

8 Results

The case company went into a new market with the new concept. The main challenge was to make the factory profitable as soon as possible in a situation, where customer behaviour is unknown. It was almost impossible to estimate the local customers' volumes and needs, because of thousands of product variants. The case company developed a mini factory concept, which is flexible and can fulfil the customers' needs. The company reduced process time in China by 80% compared to normal process time which they had during that time. The reason behind this was that modules were already produced in another factory. The concept was developed in the market where the demand for the products was difficult to estimate. The case company wanted to provide the most comprehensive market coverage with its products, to get fast ramp up and success. To get critical volumes for the products, the key issue was to reach the breakeven point as soon as possible. The concept was developed and implemented in China. Today, the concept is in a global use. It is working all over the world where the concept is needed.

Figure 4 Produced products to customers by quarters (see online version for colours)



The volume growth is illustrated in Figure 4. The case company started its production in quarter two 2005. During the next four quarters the company increased its deliveries more than ten times compared to the starting quarter. If we analyse volumes during a six month period between quarters three 2006 and first quarter 2007, we find that the growth rate has been almost 60%.

At the same time profitability increased dramatically. The reason behind the positive result was mainly the mini factory concept. The concept permits to offer large product variants to Chinese customers rapidly. During that time there were only a few companies with product offerings which were at the same level.

9 Conclusions

The company can list several benefits to being near its local customers through mini factory concept. Firstly, the company has better customer support by having a mini factory near the local customer. In the mini factory they keep ready tested, readymade modules. After the customisation work is done in the mini factory, the typical lead time could be only one day from customer order to delivery. Better on time delivery rate can be noticed. Secondly, good cash flow is a benefit thanks to the concept, which makes it possible to have effective material operations. Thirdly, because materials are flowing through the mini factory continuously, all modules and parts are 'up to date' and of the latest revision in the mini factory.

The company has run the mini factory concept now for several years and the benefits are clear. The company started its factory operations in China during 2005. One year later, the company was profitable in China. Later the case company expanded the concept to the global market. Today, it is a global concept and mini factories are located in Italy, USA, Finland and China.

Based on the earlier experience and the case company study, the writer of this article suggests that there are few key elements that make firms performance better compared to their competitors. These elements are entrepreneurial strategy, innovativeness, decentralised decision making organisation model and effective processes.

Some of the previous studies support these opinions, for instance Burroughs et al. (2011) tested the proposition that reward and creativity training given for employees are increasing creativity of new product design. They found that product creativity was highest when the reward was linked with creative training technique.

Automobile companies have done significant improvements for time to market by integrating modular product structure and standardisation to their process (Suh et al., 2007).

Ayers et al. (2001) propose that better performance is achieved by decentralising decision making process early on in new product development project phase. They found that it is possible to create special atmosphere that promote participative for effective decision making.

Roberts (1995) has identified three stakeholders that affect the performance of the new product development: end customers, senior officers, who link technology strategy to corporate strategy and thirdly manufacturing. He has listed three major factors that influence time to market.

Firstly, the use of multi-functional teams; they have the highest statistical impact to get new products fast to the market. Secondly, qualified project managers and thirdly, support of senior management sponsors.

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Modular product design for dynamic capabilities of manufacturing organisations: a case study

Jari Koskinen

Department of Production/Industrial Management,
University of Vaasa,
P.O. Box 700, FI-65101, Vaasa, Finland
E-mail: jari.sakari.koskinen@gmail.com

Abstract: Importance of flexibility and responsiveness in the 21st century of global business is growing. Different strategies, techniques and tools have been used for achieving agility in an organisation. One of such strategies is the modular product design. Modular product design has not been studied widely, despite the importance of this subject. Considering this, an attempt has been made to improve organisation performance by using other concepts like generic product development process. The purpose of the case study is to deepen understanding of the requirements for and implementation of modular product design and its benefits to customer relations. This paper supports the view that modular product design can be used successfully for improving company efficiency in power electronics industry.

Keywords: modular product structure; dynamic capabilities; mass customisation; mini factory; product life cycle; modular product design; innovation.

Reference to this paper should be made as follows: Koskinen, J. (xxxx) 'Modular product design for dynamic capabilities of manufacturing organisations: a case study', *Int. J. Business Innovation and Research*, Vol. X, No. Y, pp.000–000.

Biographical notes: Jari Koskinen has a wide experience on strategy, leadership, information technology and manufacturing. He has more than 20 years knowledge in industry. He worked as a Business Controller, and later in production as Vice President in global factory operations. He has also experience on Chinese culture and business life, he lived in China several years and worked there as a Managing Director. He also has experience on board of directors, working as a chairman of the board of several companies. His research interests are related to strategies, manufacturing and dynamic capabilities.

1 Introduction

In consequence of global completion, shorter product life cycles and the customer's changing needs, it is a fact that companies should be more innovative than before to be competitive in the future. Therefore firms should organise their operations in such a way that they can react extremely fast to the changes taking place in the operational environment of the company. This covers all of the company's processes, including

product creation, production and supplier network. The former requires communication between firm's global teams to be effectively organised between mentioned elements. Winter (2012) contends that there is only little empirical evidence that network effects the market success of new products. To be fast in the market place means that firm's organisation should react fast to market changes. An agile firm is capable of working in a competitive environment and utilise the market opportunities (Pan and Nagi, 2013). Roh et al. (2008) have recognised importance of supplier network while the company culture is less clear in a rapid changing business environment.

Customers' needs are changing and we can identify following increasing trends: the number of product variants, product features and quality requirements are increasing. At the same time companies want to decrease net assets. The situation is difficult because high amount of product features and product variants are pushing the value of inventory up instead of decreasing material buffers. To be competitive in such an environment, companies should organise its operations in a way that they would have a fast response to the changes in the market. Many industrial producers want to have deeper cooperation with their customers and firms are changing their business models into the long-term client solution (Pekkarinen et al., 2012). Especially companies, which are operating in a new technology area should develop their business model and platforms (Zheng, 2012).

Christensen states in his speech at open business conference held March 2004 in San Francisco, that the product modularity enables product differentiation and fast market access for companies. He gives an example: especially automobile industry and software companies are using modular product design based on the business benefits. The present study focuses on power electronic industry, which is new industry segment, compared to automobile industry or software companies, and there are no wide resource work done in this industry segment.

There is a broad consensus in the research literature that dynamic capabilities contrast with ordinary capabilities by being concerned with change. Product modularity is one of the key elements to increase the speed of the company; we can incorporate modularity to be part of corporate dynamic capabilities. Modularity in organisation can simplify the creation and development of dynamic capabilities (Ravishankar and Pan, 2013). Dynamic capabilities are the organisational and strategic routines by which firms achieve new resource configuration as market situation changes (Eisenhardt and Martin, 2000). Based on this definition companies should have the capability to learn quickly and organisations should react fast to the changes in the market.

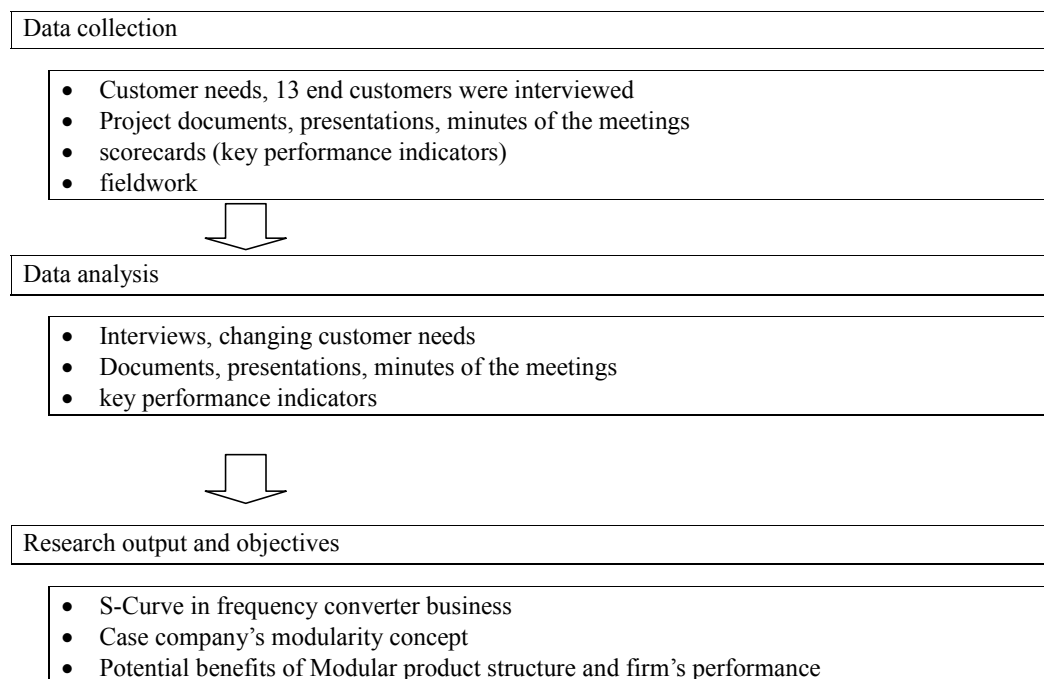
This paper addresses the relationship between the product life cycle and modular product design. The question of how the product life cycle is linked to modular product design and what are the benefits by using modular product concept in a fast changing environment. This issue is examined in three steps. The first step is to understand the mega trends and key success factors from production point of view. The second step is to clarify the meaning and construction of modular product design. In the second step the author focuses on S-Curve and product life cycle, and their connection to the modular products. In the third step, to increase the quality of resource work, the author studies the case company's modularity concept to understand the existing situation. The study supports the view that modular product design and mass customisation concept can be

power of modular product design. Innovation is a key element to improve the performance of the company, although the link between technological innovation and business performance is not widely studied. Annavarjula et al. (2012) have studied relationship between firm's technological innovation capabilities and its international performance.

2 Research objectives and methodology

This paper is a case study, which is based on the case company's operations and challenges to improve firm's efficiency including R&D, production and customer service. The objective of the study is to clarify S-curve in frequency converter business and to find the potential benefits of modular product structure. Several interviews have been conducted and analysed. Also project documents, score cards, presentation slides, and minutes of the project meetings have also been studied. This is also based on the notes of researcher's fieldwork observation collected by the author, who worked for this case company in since 1994.

Figure 1 Data collection and research objectives



The case company decided to start mass customisation and modular product design project in March 2001. The case company developed an original concept called 'mini factory' based on the mass customisation and modular product principles. The mini factory is a factory with a high flexibility and contains similar operations as a 'normal' factory. The flexibility is done by using mass customisation and modular products. The mini factory concept is the base of agility and invented by the author of this article, it is based on two main elements: module product design and mass customisation production

The reason to select an empirical research methodology was to facilitate understanding of complex issues in power electronics business. The case company was selected because of its long experience on modular product design. The aim was to study the way of making global product development work and to understand the modular product design and its connection to the operational performance. The background motives also included finding better world-class modular product design process for a company that has global operations.

3 Literature review

In a fast changing business environment, companies should find new ways of working and encourage people to be innovative in order to find new solutions. This is an issue that is widely discussed in contemporary studies of industrial-based development. In turbulent business environments, the importance of innovation will increase and knowledge is one of the most critical inputs to innovation process (Zheng et al., 2011). The management of the new product development process defines a firm's capability to introduce new products, which qualify the company's competitiveness in global marketplace (Jenkins et al., 1997). According to Winter (2012) product advantages matters and are important factor. Firms' organisational structure has effects on innovation level and performance of R&D. According to a study, global firms with multi-divisional operations can be great innovators measured in terms of output of products per unit and new patents (Cardinal and Opler, 1995).

Mass customisation concept and modular product design are accompanied by other issues. Christensen (1997) has split technology development to sustaining technologies and disruptive technologies. Sustaining technologies focused on improving product performance, when disruptive technologies offer something new that existing technology cannot fulfil.

Information sharing, E-commerce and agile methods are important factors to understand customer needs and to get right products to the marketplace (Hannola et al., 2013; Tajeddini and Tajeddini, 2012; Jehangir et al., 2012). Strong integration between R&D and marketing is important to ensure that market requirements are included in technological development (Ayers et al., 2001). Several studies focus on information flow and importance of cooperations between divisions and departments (Griffin and Hauser, 1996; Vagneur, 1996; Burroughs et al., 2011).

Information sharing and decision making in a global company is not necessarily easy to handle. Hewlett-Packard decided to develop DeskJet printers for the European and Asia market by using mass customisation principles. The reason to develop and use end variation concept near the customer was that forecasting the mix of options that customers will order is difficult. This decision needed people from at least five areas of a company: marketing, R&D, manufacturing, distribution, and finance (Feitzinger and Lee, 1997).

Many recent studies have paid attention to the fact that several automotive companies are using product platform design process where they handle information very systematic way. The challenge is that market needs are changing all the time and it is difficult to estimate customer behaviour. Flexible product platform concept has been developed to solve this complex problem. Flexible product platform concept helps to handle product

variations and modifications are done in a systematic way with sharing widely used modules in different car models (Suh et al., 2007).

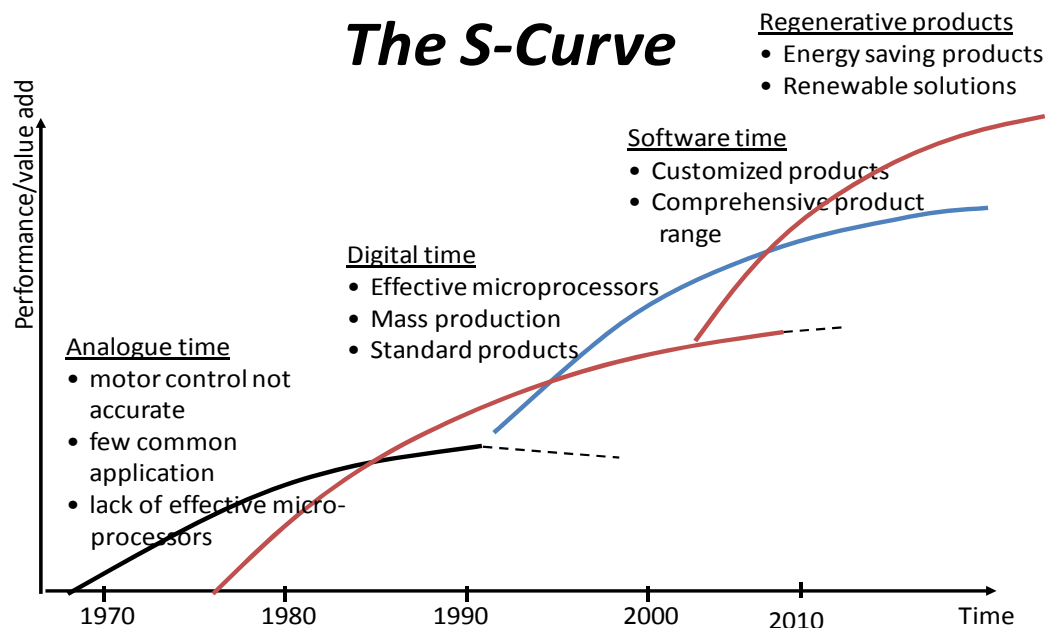
Based on these examples of the recent discussion, mass customisation concept and modular product design are suitable for an environment where both volumes and the need to individualise products based on the customer needs exist. If there is no need to customise products, other product platform concepts might be more cost effective to run the company.

4 Customer needs in frequency converter market

4.1 Changing customer needs

Based on unpublished research (will be published later by the author) illustrates that customer needs are constantly changing. The number of product features, customer's quality requirements and number of product variants are increasing. On the other hand, customer's requirements are that sales prices should decrease and delivery time should decrease as well. This means, that manufacturing units should constantly develop their operations to be more competitive. An additional big challenge is to decrease through put time in an environment where the numbers of product features are increasing and production process will be more and more complex. Automotive industry has solved this problem by using modular product design. Modularity helps manufacturing units to control the production process effective way, also supplier network is more easily to control.

Figure 2 S-curve in frequency converter business (see online version for colours)

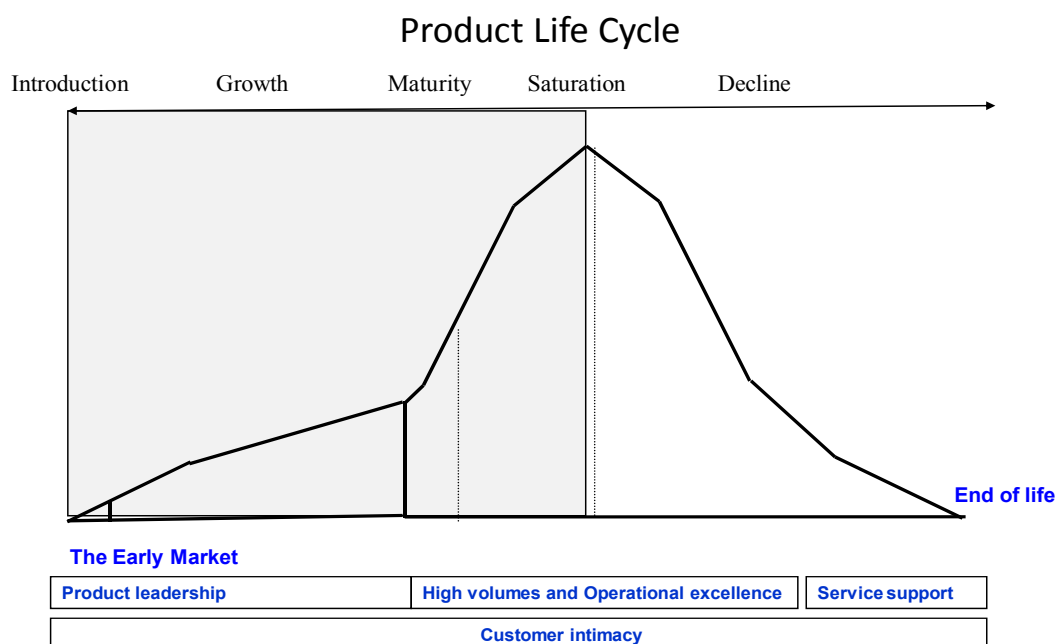


4.2 *The main technologies and trends on time scale*

Figure 2 shows the technologies trend in frequency converter business. The first commercial applications of frequency converters came in the 70's. At that time, company called Strömberg was pioneer in technology development area. One of the significant frequency converter solutions in the world was Helsinki metro project in Finland. During analogue time technology offered a very rough motor control, and applicability was very limited. During 80 century digital technology made breakthrough via better manageability, based on the processor technology. The Japanese companies invade market shares and completion game more global. During that time, frequency converters were difficult to use and needed special skill to install product for new solutions. In the 1990s, software started to be used more commonly. User interfaces came more user friendly, and special applications came more common. The motor control was more accurate and precision products came to market place. Penetration rate increased and market growth rate was calculated with two digits. Regenerative products are products which can supply energy back to the net. These kind of new solutions are used by, for example, elevator solutions. When elevator comes down the energy can be supplied back to the net. These kinds of solutions save energy dramatically.

Figure 3 illustrate typical generic product life cycle, which consists of five different phases: introduction, growth, maturity, saturation and decline. During the introduction phase typically lead time from concept to availability is typically critical. Once the product is more reliable and entered to the market, growth phase will take place. In saturation phased, volumes are at highest and operational capability is important. During the saturation phase, technology is well known and typically low cost country production is wide. Finally, when volumes start to decrease normally service activities will be most profitable business. In this decline phase, new technology enters to the market.

Figure 3 Product life cycle (see online version for colours)



In different phases business roles and customer needs are changing in a whole production chain, from supplier via manufacturing unit to the customer. Today, supply chains should be flexible and match the requirement in a different life cycle phases (Aitken et al., 2003).

5 A framework for modular product design

Modular product design has many benefits including the following: for production final assembly work is easier and faster to perform, because there are fewer components to assembly. During the R&D process modularity gives more flexibility and allows more versatility, which save money. Ulrich and Tung's (1991) study shows that modularity enables the following benefits: component economies of scale, easy of product updating, increase product variety, decreased order lead time and ease of design and testing.

Gershenson et al. (1999) states that the four-step measure systems is as follows:

- 1 generating a component tree
- 2 generating process graphs
- 3 construction of the matrix
- 4 calculation of the relative modularity using the modularity evaluation matrix.

Modular product design gives many benefits mentioned above. For this reason companies should consider to integrate modular product design principles to the product development process. Next chapter explains generic product development process.

5.1 Generic product development process

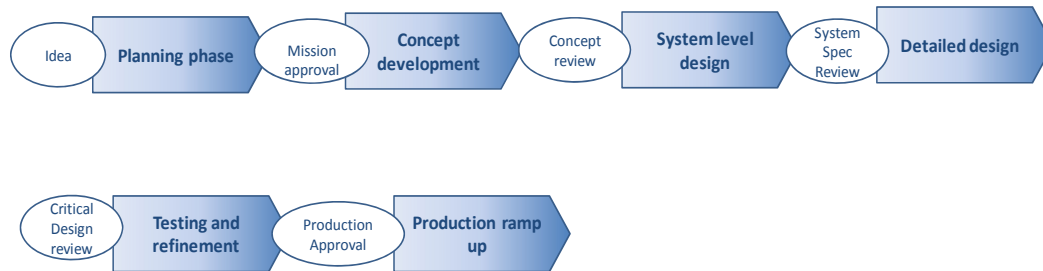
Generic product development has been divided to six phases shown in Figure 1. Planning phase is the phase that begins with the firm's target and strategy. This is the phase where whole project is accepted. Second phase is concept development phase where the need of target market segments is identified and competitors' products are analysed. During the system level design phase definition of the product architecture is specified as well as make or buy decision is made. Component list, tools and the final assembly system for the production are defined. It also includes a preliminary process flow chart and the description of final assembly process. Detailed design phase is the fourth phase. In this phase complete specification of materials, parts, and supplier network is specified. Prototypes are tested to be sure that product is covering customer needs; documentation is also done during this phase. Fifth phase is testing and refinement phase. This phase involves the construction and evaluation several preproduction versions of product. Later version called beta prototypes are built to with parts supplied by the intended suppliers. This phase is the start up phase for suppliers to start ramp-up process. Product performance and reliability are tested and typically customer tests are also used. The last phase is production ramp-up. This phase includes production testing concept and training employees. The product is made using the intended IT-applications and production systems.

Generic product development process is widely used. One challenge in this model is that especially in a global company's information flow between the project group and

other division might be limited. Knowledge service will help in this problem to give same information for everyone who is involved in the project, more effective IT tools helps designers for their working process. Computer aided design (CAD) systems are coming general tools to handle product design more faster and more cost effective way (Park et al., 2012).

Generic product development process has gates that products and operations should meet before project can shift to next step. The power of this concept is that it is a systematic method for managing product development projects. In Figure 1, we can state project phases and gates between phases. The author of the paper proposes that modular product design should be part of the generic product development process to get best possible end result.

Figure 4 Generic product development process (see online version for colours)



To be cost competitive companies should focus on information flows. Companies should ask how the available data can be used effectively during the R&D process. The shift from independent data handling system to a comprehensive information handling system has been taken place rapidly. During the last 20 years companies' employees work has changed dramatically. Today employees have a huge amount of data and the flow of information is massive. However, it is still problem to find all necessary information at the right time for running product development process effective way. Cloud computing systems help people to communicate and handle information globally.

Over the last years, global companies have developed their information systems. Global companies have improved their R&D effectiveness and service support for their customers. Global players have also improved their product portfolio to develop wider product ranges and product performance to get better market coverage for their products.

The current technology enables automated data collection systems. In the future these kinds of new solutions will be more common. The case company is using this kind of system for service purpose to collect the engine data to get better customer support.

5.2 *Sustaining and disruptive technologies in frequency converter business*

According to Christensen (1997) sustaining technologies focus on improving product performance mainly for mainstream customers. According to Christensen, sustaining technologies are normally most profitable business for the companies. He has stated that sustaining technologies can be divided into discontinuous and continuous technologies (Christensen, 1997). Disruptive technologies are technologies that bring very different value proposition and something totally new compared to sustaining technologies. Based on Christensen definition we can state that all technological steps shown in Figure 2

belongs to sustaining technologies except frequency technology itself. The reason is that frequency converter technology is still quite new technology in industrial business segment and in that sense is disruptive.

6 The case study

The case company has more than 1,300 employees and the revenue last year was more than 380 million euro. The company has an aggressive growth target. The goal is to achieve revenue of 500 million euro and to get an operative profit of 14% in 2014.

The case company has a 100 percentage focus on frequency converters (AC drives). Frequency converters provide stepless control of rotation speed of electronic motors. Frequency converters have many benefits, for example:

- saving considerable amount of energy in electric motor applications
- reducing carbon dioxide emissions
- reducing the load on the electricity network
- reducing the mechanical stress on machinery when starting an electric motor
- making it easy to connect electric motors to automation systems.

The case company develop, manufacture, market and service low voltage AC drives in the power range of 0.2–5,000 kW, from the simplest to the most demanding application.

The case company is a good example of a company, which has followed its strategy very successfully and developed its operations to be more agile. The company focus is 100% on frequency converters and it has seen profitable growth since 1996, only one year after when they started to produce frequency converters.

The frequency converter is a product used for controlling the speed of electric motor. The unit converts the fixed frequency and fixed voltage coming from supply network into a variable frequency and voltage in order to control the speed of motor.

The company's goal is to provide a wide range of products and product features to customers of efficiency corresponding to the mass production efficiency. Mass customisation needs products that consist of independent modules that can be easily connected together into different forms (Radder and Louw, 1999).

The company is using mass customisation principle on its operations. Mass Customisation is connected to flexibility and fast responsiveness where the company gives to its customers exactly what they want (Pine et al., 1999).

Currently, the case company has product development centres and factories in Finland, China, USA and Italy. The company is growing very fast and it might be possible to see more factories in the future.

6.1 *The modularity concept at the case company*

Modules of frequency converter can be divided to four main functional elements:

- 1 Power module, which has the appropriate voltage and current rating for the intended use. It contains all the power semiconductor switches, bus bars, filters and cooling components built into a mechanical frame. The power module is one of the major

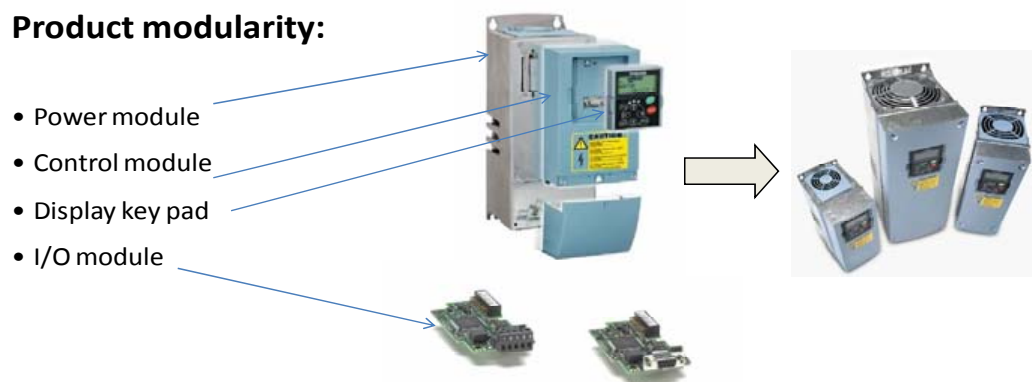
10 *J. Koskinen*

part for whole frequency converter, according to block diagram, inside the power unit there are only passive components.

- 2 Control module, which contains micro controllers, software and all the intelligence components needed to control the switches of the power unit in order to fulfil the interfaces to the surrounding environment.
- 3 Display keypad is the interface between the unit and user. Through the key pad user can change the parameters and solutions.
- 4 I/O modules are additional parts, which enables to connect the unit to the automation systems.

In the Figure 5 all these parts are separated to visualise the concept. Firstly power module, which is heaviest module. Control module is consisting mainly with electronics components covered by die casting or sheet metal. There are several different kinds of display keypads: alphanumeric, graphical panel or text panel. I/O modules consist of electronics components assemblies to the printed circuit board. I/O board are mainly used in field bus purposes connected to large automation systems.

Figure 5 The modularity concept (see online version for colours)



6.2 Results and analyses

The case company has targeted to use mass customisation concept and modular product design since 2001. Existing products are more modularity compared to old generation products. Typical product life cycle time in frequency converter business is more than ten years. We can notice several technologies trends: analogue time, digital time, software time and regenerative units. It is expected, that in the future product life cycle time will be shortening. Due to new players and intensifying competition new products will be launched faster to the market by competitors. The power electronics industry is not using very systematic way of designing modularity and typically existing modules are made very high level. In the future it is recommended that power electronics companies will start to use more systematic tools and methods. This is important because frequency converter includes a lot of electronic components and the trend is that integration levels of electronic components are increasing and the price per performance is decreasing. This means, that those competitors who have capability to launch new products faster than competitors will have cost benefit.

There are also new solutions whose volumes are growing very fast. This means that emerging market areas are important for frequency converter manufactures. For example China is the biggest wind mill market globally, frequency converter is one of the key components in that area. Indian government has stated that it will support renewable business including solar and wind mill production. The next big market areas are most probably countries with large populations focusing on energy friendly energy production.

Modular product structure enables many benefits for the company. In Table 1 the key performance indicators and trend from the year 2001 to 2011 are illustrated. Company's revenues and produced products have increased more than three times and at the same time product variants has increase significantly. Delivery accuracy has increased 7%. First pass yield is a KPI that reflects the quality assurance capability. First pass yield indicate the number of units that pass the tests. Quality level has improved 79%, meaning that production process and product quality has improved significantly during the observation period. Inventory turnover is more than two times faster in 2011 compared to the year 2001.

Table 1 Key performance indicators in years 2001 and 2011

<i>KPI</i>	<i>Year 2001, Index</i>	<i>Year 2011, Index</i>	<i>Change</i>
Revenue	100	333	3,33
Produced products	100	353	3,53
Delivery accuracy	100	107	1,07
First pass yield	100	21	0,79
Inventory turnover	100	238	2,38

7 Conclusions

Due to intensifying completion and the customer's changing needs it is a fact that companies should be more innovative in their product development operations to be more competitive in the future. The innovation processes has changed relatively little although business environment has changed a lot (Wind and Mahajan, 1997). For companies, it is often difficult to set up a strong causal link between innovation and performance (Tidd, 2001).

To answer the main research question of this paper, software enables higher volumes and customised products with comprehensive product range. To handle the production effective way in such an environment means to have modular products. The case company can list several benefits by using modular product design. First, the company can serve a large amount of customers by having more products through modular product concept. Second, the typical lead time is only few days from customer order to delivery. Third, more effective material flow and better cash flow has been noticed.

It seems that those companies, which have dynamic capabilities to react to the changes in the market place, are the winners in the future. This is also the way to connect product life cycle to the customer relations and modular product design.

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CUSTOMER NEEDS LINKED TO PRODUCTION STRATEGY AND FIRM'S DYNAMIC CAPABILITIES

Jari Koskinen, Daniel Sahebi

University of Vaasa, Finland

Corresponding author:

Jari Koskinen

Department of Production

Faculty of Technology

University of Vaasa

P.O. Box 700, FI-65101, Vaasa Finland

phone: +358408371217

e-mail: jari.sakari.koskinen@gmail.com

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ABSTRACT

This study identifies and analyzes the key factors of an efficient customer oriented production strategy. The paper supports the view that dynamic capabilities can be used successfully for improving company's efficiency. This research is a case study research related to production strategy. In a case company, totally 31 interviews were made from 16 subsidiaries and 13 from end customers. The present paper focuses more on end customers' than internal customers. Key findings can be identified as follows: effective information flow, flexibility, speed and responsiveness need more focus in the study of dynamic capabilities. Delivery accuracy is the key, while short delivery time is a competitive factor. This research is focused to power electronics business segment which is research limitation. To make wider conclusions, more empirical studies are needed. As a Practical implications, this research helps firms to improve their strategy process by understanding real customer needs. The research results bring additional value to the previous studies regarding company strategy, business environment, innovativeness and operational excellence.

KEYWORDS

production strategy, innovativeness, effective information flow, flexible production system, dynamic capabilities.

Introduction

Due to tightening competition and business turbulence as well as changing customer's needs, firms need new capabilities in the future to be competitiveness. Customer's needs should be more deeply understood, and firms should react faster to the changes around the company. Firms need to be more innovative, that requires more than just cheap labour force [1], and such a new advantage could be dynamic capabilities. Teece (2012) defines dynamic capabilities as ability to integrate, build, and reconfigure internal and external resources and competences in a rapidly changing business environment [2].

Although the link between organizational performance and firm performance is well researched, and these are typically connected to the strategy struc-

ture performance, only little empirical research has been conducted, how customer needs can be linked to the firm's dynamic capabilities and strategy process. Porter (1985) contends that there are two types of competitive advantage: cost leadership and differentiation [3]. This study focuses on the end customers and the elements, which are important for them in a tightening completion. Wilden et al. (2013), propose that dynamic capabilities framework consist of three major elements: organizational structure, organizational performance and competitive intensity [4]. Based on their definition, dynamic capabilities, organizational structure and organizational performance are internal and competitive intensity is external. Companies, that want to follow an operational excellence strategy need competitive product price, customer perceived quality and lead time, and

on time delivery for purchasing [5]. By working different way than competitors, companies can create success, Ravishankar et al. (2012), suggest that this could be for example modular production linked to the strategic making abilities [6].

Companies should organize their operations so that they can make fast changes in their own organization as well as in their partnership network, to react to the changes in the business environment. This includes very widely company's processes, for example product creation, production and supplier network. The former requires more resource work to understand the connection between mentioned elements. Winter (2012) has noticed that there is only little empirical evidence that network effects the market success of new products [7].

To be competitive in such turbulent environment, companies should organize their operations so that they have a fast response to the changes in the market. Many industrial producers are changing their business models into the long-term client solution [8].

There is a broad unanimity in the literature that dynamic capabilities contrast with ordinary capabilities by being concerned with change.

This research addresses questions related to delivery time, delivery accuracy, and scope of offering, product technology, and availability of information, product customization, product performance and quality. The central research question of this paper is as follows, what are the main elements, in customer's point of view, that company should take into account in the strategy? The paper discusses this main question in three steps. The first step is to understand the key elements which are important for the customer. The second step is to analyze reliability of the answers. The third step analyzes the correlation between satisfaction of products and satisfaction of services. This step answers the following sub question; what kind of relationship is there between satisfaction of products and satisfaction of services?

Research methodology

This paper is a case study, which is based on the interviews conducted in the case company's sales conference 2011, at Cancun, Mexico. Four people made the interviews during the three days sessions. Two of interviewers were working in the case company and two other interviewers were from Consultant Company. Totally 31 persons were interviewed from 19 different countries. End customers were in 7 different countries, including 13 interviewees. Figure 1 described the data collection process, from getting

people to the same place to the conclusion of the results. Corresponding author of this paper took part to the Cancun sales conference.

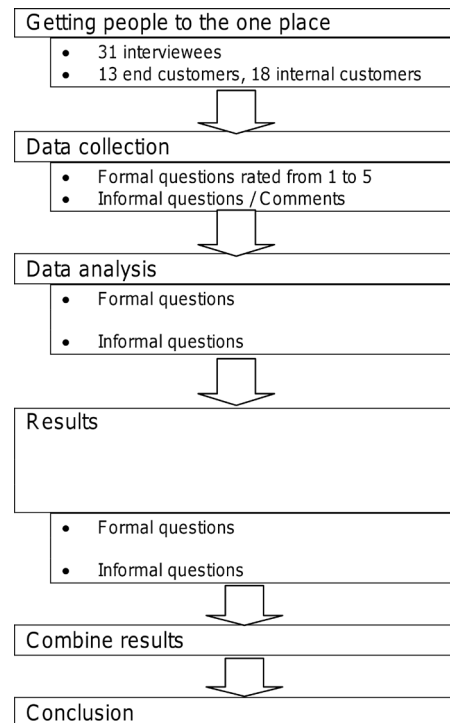


Fig. 1. Data collection process.

The case company has more than 1400 employees and the revenue is more than 400 million euro. The company has an aggressive growth and profit target. Firm's aim is to achieve revenue of 500 million euro and to get an operative profit of 14% in 2014. The case company focuses on frequency converter business. Frequency converters provide stepless control of rotation speed of electronic motors.

This paper focuses on the end customers because strong "customer voice" was the main focus of the research, also internal customers opinions were noticed during the research work.

The main motive for the paper is to study customers' needs in a fast changing business environment and connect that information to the company strategy. To have right information directly coming from end customers helps managers and project team members to understand the power of customers interest and to do right improvement actions in next coming period.

Innovation is one of the key elements in enhancing the efficiency of the firm, although the link be-

tween technological innovation and business performance is not widely studied. Annavarjula, et. al. (2012) have studied relationship between firm's technological innovation capabilities and its international performance [9].

The reason to select interviewing as research methodology was to get understanding of complex issues in power electronics business. The reason to select the case company was their long experience on power electronics business and opportunity to study customers' opinions extensively and from different countries. The aim was to study real customer needs, to understand the positioning in a market and to improve case company's operations in the future. For global operated company it is extremely important to make right actions in a fast changing business environment.

Literature review

Recent discussion on dynamic capabilities focuses on changes happening around the company. In a fast changing business environment, companies should find new ways of working and encourage people to be innovative in order to find new solutions. In turbulent business environments, the importance of innovation will increase and knowledge is one of the most critical inputs to innovation process [10].

Information sharing is important factor to reach results and right products to the marketplace. Ayers et al. (2001) test a model that suggest that new product success is a function of the relational norms and integration between marketing and R&D [11]. The research group stated that new product development success was related to the presence and strength of relational norms. Their study also found that positive relationship between collaborative relationship between R&D and marketing. There are many studies that focuses on information flow and importance of co-operations between divisions and departments [12–14].

Information sharing and decision making in a global company is complex issue to handle. Several automotive companies are using product platform design process where they handle information very systematic way. The challenge is that market needs are changing all the time and it is difficult to estimate customer behavior. Flexible product platform concept has been developed to solve this complex problem. Flexible product platform concept helps to handle product variations and modifications are done in a systematic way with sharing widely used modules in different car models [15].

In summary, it can be concluded that for an environment where there are many changes like volumes variation and the need to individualize products according to customer need, information sharing and co-operation between different teams are crucial.

Results

Variability coefficient

By calculating the mean and the standard deviation of the ratings in all the questioners, we calculated the variability coefficient in excel. One should always consider the variability coefficients which are below one for the ratings to be accurate. In our case all the variability coefficient turned out to be below one, indicating that they all stand accurate for the given ratings. Figure 2 shows the graph of these efficiencies.

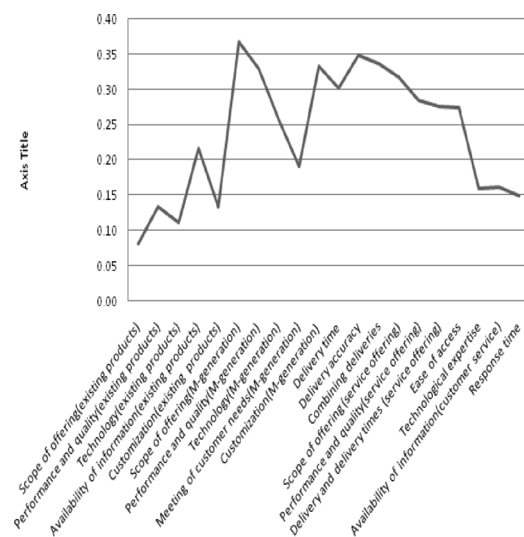


Fig. 2. Variability coefficient.

The X-axis lists all the factors indicated in the questioners by the case company and the Y-axis contains the number of the variability coefficients.

Satisfaction between products and services

Based on the analysis of the interviews, we can see a certain type of pattern or relation between the satisfaction of the customers with the products and their satisfaction with service level. This rate of satisfaction can be measured or shown in accordance with the regression graph standards. Figure 3 shows the regression graph of this relation between the quality of the products and their services in general.

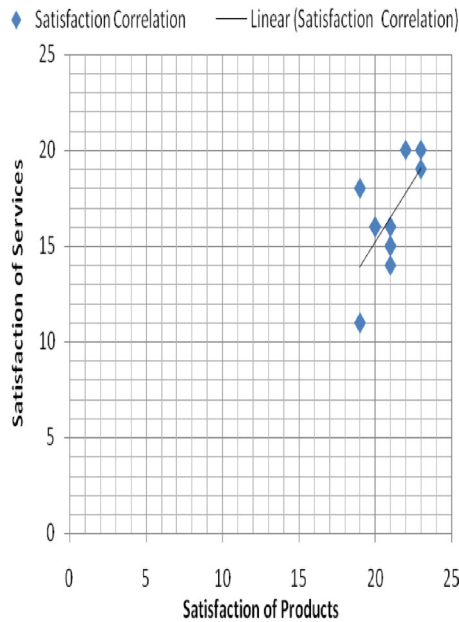


Fig. 3. Satisfaction correlation between product and service.

As we can observe from the above mentioned graph (Fig. 3), there is an upwards sloping line to the right, forming the regression relation between the satisfaction of products and satisfaction of services. The chart shows us that there is a medium positive relation between these two factors. Consequently, as the rate of the satisfaction from the quality of the items goes higher, the satisfaction from the services follows accordingly, hence increase in satisfaction of the customers from the items results in the increase of the satisfaction from the services.

Correlation between the technology of existing products and the availability of information

The Fig. 4 is considering the correlation between the technology of existing products and the availability of information. As we can see from the graph, there is a very small correlation between these two factors. This happens to be a slight negative correlation between technology of existing products and the availability of information. Generally one can always claim that the slope of the curve is so small that the factors practically have no relations with one another. Hence we can conclude that regardless of the technology in existing products, availability of information remains to be independently a very crucial and important factor.

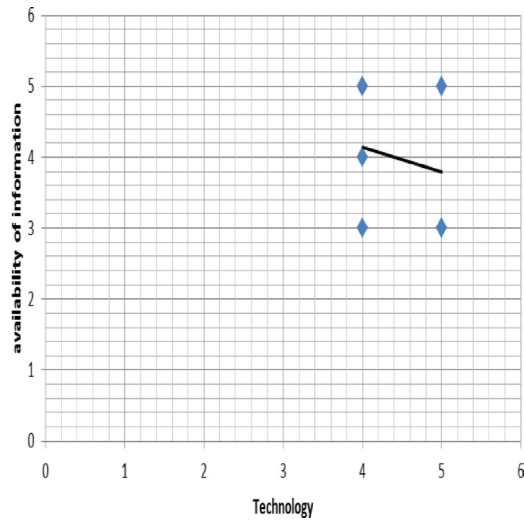


Fig. 4. Correlation between the technologies of existing products and the availability of information.

The free comment analysis

The Table 1 below consists of a number of operations and factors taking place in the case company. The right column belongs to the free comments or feedback which was given by the customers. Some comments indicated a lack of communication between the marketing and R&D. The delivery times were one of the main concerns of almost every feedback, indicating that the company needs to work more on their delivery times. New generation seemed to be attracting quite a bit of negative attention due to its quality problems and low price competitiveness in comparison to Japanese products. Moreover, it was indicated by many customers that some of the new generation products have been launched rather too early.

Figure 5 shows that customer needs are changing all the time. The number of product features, customer's quality requirements and number of product variants are increasing. On the other hand customer's requirements are that sales prices should decrease and delivery time should decrease as well. This means, that manufacturing units should develop their operations all the time to be more competitive. One big challenge is to decrease lead time in an environment where the numbers of product features are increasing and production process is more complex. Automotive industry has solved this challenge by using modular product design. Modularity helps manufacturing units to control the production process effective way, also supplier network is more easily to control.

Table 1
Key findings.

Key findings	Number of being referred to
Technology – Case company is keeping up with the new technologies – Company does not have the leading edge yet but is one of the best ones in the market – IEC 611 31 tools was mentioned to be the main reason of cooperation with the case company – More product features and product solutions are needed	Technology – All thirteen feedback givers were satisfied with the level of existing technology – Need for fieldbus was mentioned to by 1 customer – IEC 611 31 tools were mentioned by 1 customer – More product features and solution mentioned by four customers
Performance and quality – New generation product was mentioned to be an unsure topic (information flow) for a number of the customers – New generation product (small units) need price improvement to be competitive with Japanese products – Some of the products have minor problems with speed of communication	Performance and quality – New generation product was mentioned to be 10th the expected price by 1 customer – Uncertainty (information flow) about new generation was mentioned by 3 customers also quality improvements are needed in the future – New generation product (small units) price issues and compatibility was mentioned by 2 customers
Delivery and service – Improvements in delivery time and accuracy is one of the key issues – Combining delivery need to improve	Delivery and service – Combining delivery was mentioned to be needed by one customer – All thirteen of the customers wanted to have more faster or accurate delivery times – Delivery of the smaller spare parts for the purpose of service was said to be more accurate than the bigger parts by 3 customers
Availability of information – Finding specific information in some specific cases (hard data) is rather difficult – The availability of information and the quality of need to improve	Availability of information – Existing products: information and communication need to improve mentioned by 7 customers – Service information: need to improve mentioned by 3

Customer needs in power electronics business

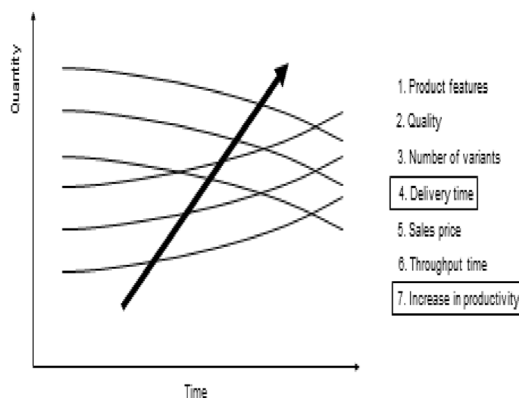


Fig. 5. Main elements in a power electronics business environment.

Business environment can change very fast, in power electronics business there are elements which effects to the company’s customer performance. We can identify following increasing trends: the number of product variants, product features and quality requirements are increasing (Fig. 5).

Production strategy

Based on study made and earlier studies as well as experience of the business segment, the case company launched strategy (see Fig. 6) which is focuses on:

- giving more customer value through effective network (including material flow and information flow),
- fast delivery time,
- high level of quality,
- cost efficiency,
- fast time to market for new products.

Global factory operations strategy

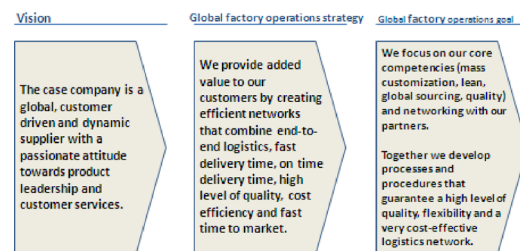


Fig. 6. Connection to production strategy.

Effective information flow

The latest IT technology is significantly advanced and therefore enables extended automated data collection systems. However, usually there are no existing solutions or systems to exploit this ability. In the future these kinds of new solutions will be more common. Based on the study, the case company should build up this kind of system for business purpose, to collect, share and distribute the data, to get better customer support. Previous can be provided to improve information handling towards knowledge management system. The corresponding writer of this article proposes that the trend of data processing can be divided into the three waves shown in the Fig. 7.

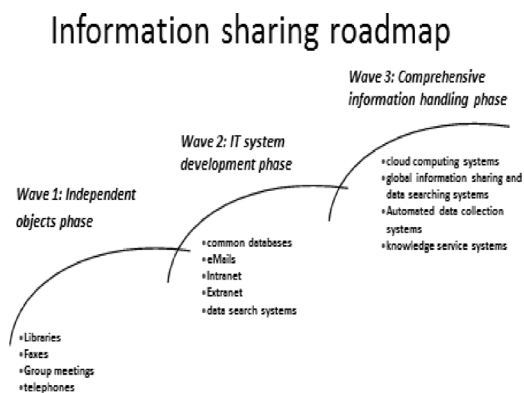


Fig. 7. Information sharing roadmap.

We have defined that the *knowledge service* by being a service/ideology which provides versatile ability to access and create information throughout the whole community. The service commonly uses dedicated IT systems and software as an interface towards the user. These systems are tailored to fit their purpose by the service owner. These systems then make use generally the majority of the databases created in the community.

Conclusions

Entrepreneurial strategy, effective processes, innovativeness and dynamic capabilities which take environment changes to the account are one way to develop a more agile customer oriented company. Working in collaboration with customer and partners, it is possible to understand customer needs more deeply and to achieve more faster, flexible, and more agile processes to support the changing customer needs. The aim of this study was to understand and to analyze factors that are most important

to the customers in a power electronic business industry. One of the key findings was the importance of effective information flow in a global business. This is related to the communication of technical, delivery, installations and service matters.

It seems globalization level effects to the quality of information and speed of the information flow. We can summarize that effective information flow, flexibility, speed and responsiveness need more focus in the firm's strategy. Delivery accuracy is the key, while short delivery time is a competitive factor.

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IMPROVEMENT OF SERVICE OFFERING CONNECTED TO CUSTOMER SATISFACTION IN THE POWER ELECTRONICS FIELD

Jari Koskinen¹, Daniel Sahebi¹, Hassan Nikookar¹, Wang Zhan²

¹ University of Vaasa, Department of Production/Industrial management, Finland

² The Key Laboratory of Contemporary Design and Integrated Manufacturing Technology, Ministry of Education, Northwestern Polytechnical University, China

Corresponding author:

Jari Koskinen

Department of Production

Faculty of Technology

University of Vaasa

P.O. Box 700, FI-65101, Vaasa Finland

phone: +358408371217

e-mail: jari.sakari.koskinen@gmail.com

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ABSTRACT

This research is a case study research related to customer satisfaction, focuses on more effective service improvement and changes in regards with meeting the customer needs. Through empirical approach and related enterprises investigation, based on employees' perspective and end-user' perspective, it designs a questionnaire system to collect data. In a case company, totally 31 interviews were made from 18 subsidiaries and 13 from end customers. Finally, we use statistical analysis to analysis the collection data and draw a conclusion. The outcomes of analysis show that communication and effective information flow, as well as effective service processes are the key while technical knowhow is the basic requirements. Throughout the body of the research, we can observe that there are significant differences between the internal and external customers perspective. These differences should be taken into consideration when the service improvement is the main objective. This research helps manufacturing firms to improve their value added services in addition to operating closer to their global customers.

KEYWORDS

customer satisfaction, industrial service offering, services quality improvement, dynamic capabilities.

Introduction

In the past few years, the challenge to raise the profit level has increased in many companies. Companies are striving to extend the value-added chain and work closed to the customers [1]. Currently, the service programs are of an immense importance in various manufacturing sectors. Stressing on customers' point of view related to service quality is crucial to increase the customers' satisfaction and to enhance the company's value added. With the improvement in customer's business situation, their requirements are changing from mass production to customization, with high regards to quality

and flexibility levels. Therefore, it is important to improve firms dynamic capabilities by understanding the customer requirements and provide them with products and services they need, reduce the total cost and continually increase the customer's satisfaction.

Various manufacturing companies deliver their products along with offering after-sales services. One should always bear in mind that improving the operation strategy leads to an improve in the firm's efficiency globally. It also positively affects the after-sale services. Hence, manufacturing firms aim to market their products while endeavoring for a better relationship with the end customers through pro-

viding higher quality after-sales service. After-sales services do indeed have a very important role in manufacturing firms, this is due to the fact that the trend of technology is exponentially growing and after-sales services enable the manufacturers to gain feedbacks about their product and service from customers. This is because of information flow from the customers back to the producers has drastic effects on the improvement for the quality of the items being produced. In the past few decades this method has been mainly used by the service department, however, with the advancement of technology in competitive markets, the manufacturing firms are also taking advantage of this method by the aim of improving the production quality as a whole.

Nowadays, customer loyalty as well as creating growth opportunities in markets are as important as selling the products. Under the circumstances of product technology and quality, after-sales services have become a more important factor affecting customer satisfaction degree. Currently, many manufacturing firms concentrate on improving customer satisfaction via deeper cooperation via after-sales service [2]. It is crucial to understand the needs of different customers and to improve company's after sales performance.

Various researches on customer satisfaction have focused on elements of quality and services. It is obvious that industrial services can have a large variety of demand characteristics with regards to volume, and that can affect the service design to be either centralized or decentralized. There is a need for more and better detailed investigation on analyzing industrial services offered by manufacturing companies.

This research paper is a case study, concentrating on more effective service improvement and changes with regards to meeting the customer needs and their satisfaction in the power electronics field.

The answer to the following questions is the main objective of our study:

Q1: Can there be correlation between the below listed factors affecting the overall satisfaction?

- Existing products;
- New generation products;
- Delivery;
- Service offering;
- Customer service.

Q2: To what percentage each of the above mentioned factors are affecting the overall customer satisfaction?

Q3: Are communication and service processes crucial in overall customer satisfaction?

Literature review

Customer satisfaction and service quality

Customer satisfaction is a direct result of providing goods and services as well as qualified information, which meet and exceed customers' needs. Many of the reclamations are related to company's Total Quality Management (TQM). It is worth mentioning that TQM had been widely used during the past few decades and is recently replaced by more advanced methods such as Mass Customization and Lean Production. Meeting customers' requirements, and consequently assuring customer satisfaction, are ultimately the responsibility and the main task of the manufacturing firms.

During the last decades the researchers have collected a number of studies on customer satisfaction and service quality. This case study focuses on the following dimensions:

(1) Focuses on the literature to explain the importance and necessity of customer satisfaction.

Bearden and Fornell, for instance, pointed out that customer satisfaction is directly linked to be resulted from repeat sales, positive spread of information, and customer loyalty [4, 5]. Higher market share and profit can be driven from high customer satisfaction rate, which leads to a much stronger compatibility and competitive advantage [6]. Consequently one can claim that improvement in service quality, value perceived, and customer satisfaction results to more success and competitive advantage [7–11]. It is quite obvious that the customer satisfaction turns out to be the main objective of various manufacturing corporations.

(2) Discussion of various elements influencing customer satisfaction.

Anderson, Fomell, and Lehmann, believed that service value is one of the most crucial factors when it comes to customer satisfaction [2]. Zeithaml and Bitner found that customer satisfaction can be strongly affected by the following factors [12]:

- Service quality;
- Product quality;
- Price;
- Personal and situational factors.

Croninet et al. and Kristensen pointed out that customer satisfaction is heavily influenced by service quality [13, 14]. Similar conclusions have been argued in the studies of website and online shopping [15–20]. These studies supported the view that service quality affects customer satisfaction in a somewhat positive way.

(3) Highlighting various methods for evaluating customer satisfaction and service quality.

Meuter, Ostrom, Roundtree, and Bitner introduced diverse methods of customized service enhancements with the aim of increasing the customer satisfaction rate [21]. Christian and Bettina have introduced a scale to measure industrial customers' satisfaction. That scale can be used in different situations and various product categories [3].

Relevant method for data analyzing

Customer surveys are powerful tools for assessing customer satisfaction. These surveys put forward valuable data enabling a company to compare its performance with its competitors.

Statistical analysis method can be an effective tool for data analyses [22, 23]. However, it is the fact that many items in the questionnaire for customer satisfaction surveys were unable of quantitative evaluation. Binshan Lin noticed that the main problem needs bringing deeper attention in customer satisfaction surveys [24]. When in accurate analyses are used, results may not be valid, and misleading conclusions may be drawn. In this case, incorrect conclusions could result in wrong decisions made by management.

Research methodology

Figure 1 shows that the research process and methodology in this paper, from questionnaire design to the conclusion of the results.

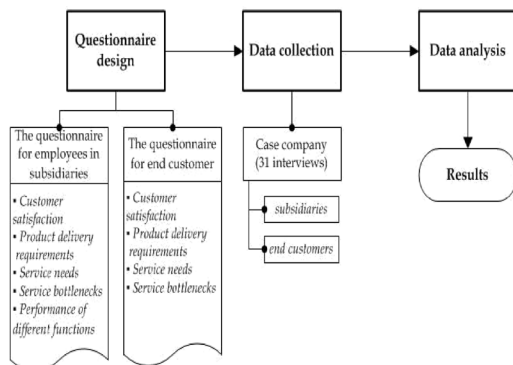


Fig. 1. Research process and methodology.

Questionnaire design

Customer satisfaction surveys have been used to measure the level of customer satisfaction. It is a fact that questionnaires are used as a common technique for assessing customer satisfaction.

The questionnaire has been developed by a consulting company and the case company's experts.

Data was collected in a global sales meeting that was held in Mexico in the year 2011.

The questionnaire contained two parts. The first part includes standard questions scaled from one to five where 1=“low” and 5=“high”. The second part was dedicated to individual free comments given by respondents.

The questionnaire was designed for two groups. One is for managers and experts as internal customers in different subsidiaries, and one is for ultimate customers. The items of the questionnaire for internal customers are existing products, new generation products, delivery, service offering, and customer service. The items of the questionnaire for external customer are the same as internal ones.

Data collection

The case company is one of the biggest on its own business field in the world. Totally thirty one persons have been questioned consisting of 18 from subsidiaries and 13 from end customers.

Data analysis

SPSS has been the main tool for analyzing the statistical data collected from the questionnaire. The main methods used for analyzing the data were through the correlation and regression analysis. In this study we have used five following factors: existing products, new generation products, delivery, service offering and customer service (see Fig. 2) to measure customer satisfaction and calculated the mean value of them. Additionally, we noticed two extra

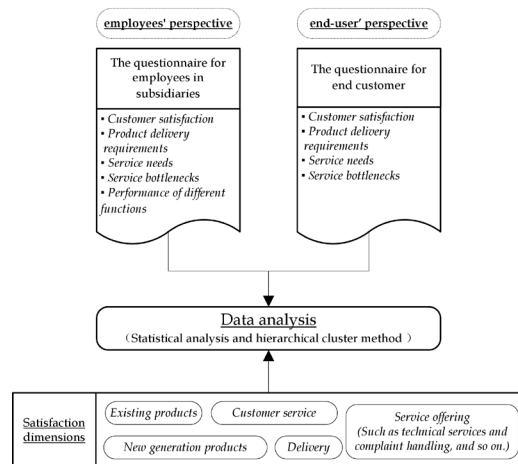


Fig. 2. Satisfaction dimensions use in the data analysis process.

important factors which affected the customer satisfaction immensely. These two factors are effective communication and rapid service processes. Those areas can be counted as the key service processes to manufacturing firms. The results can help manufacturing firms to improve their value added services in addition to operating closer to their global customers.

Results

The found data from each and every questionnaire had been entered into SPSS and the correlation along with the regression between the main factors of the questionnaire had been calculated. It is worth mentioning that the main factors of the questionnaires are as following: existing products, new generation products, delivery, service offering and customer service. As we already know our questionnaires has been divided to two groups of external and internal customers. The following analysis and results are presented respectively.

Correlation of the external customers

Table 1 belongs to the correlation analysis of the questionnaires answered by the external customers. 12 questionnaires out of 13 were qualified enough to be analyzed. This is due to the fact that one of the questionnaires did not contain enough answers to be used by the SPSS program. From the Table 1 we can

observe that which one of the factors are correlated with each other.

The numbers containing ** indicate that the correlation between factors is 99 percent accurate. However if the sign above a number is * it is indicating that the existing correlation is 95 percent accurate. For instance there is a 72 percent correlation between the existing products and the new generation products.

Regression analysis of the external customers

As we can see from the Table 2, all the factors are significant, meaning that the regression analysis do indeed stand up amongst all the factors. It should however be mentioned that an extra factor has been created as the independent factor which is called the Overall Customer Satisfaction. The numbers in this factor are result of the mean of the values in all the other factors. One should note that the five other factors are indeed dependent factors. The beta column in the Table 2 shows the percentage, belonging to every factor and the role it has on the overall customer satisfaction. The percentage belonging to each factor is as following (refer to Fig. 3):

- Existing products 10%;
- New generation products 15%;
- Delivery 32%;
- Service offering 44%;
- Customer service 27%.

Table 1
Correlations; external customers.

		Existing products	New generation products	Delivery	Service offering	Customer service
Existing products	Pearson Correlation	1	.722**	.312	.623*	.658*
	Sig. (2-tailed)		.008	.323	.030	.020
	N	12	12	12	12	12
New generation products	Pearson Correlation	.722**	1	-.152	.409	.207
	Sig. (2-tailed)	.008		.638	.187	.519
	N	12	12	12	12	12
Delivery	Pearson Correlation	.312	-.152	1	.550	.623*
	Sig. (2-tailed)	.323	.638		.064	.031
	N	12	12	12	12	12
Service offering	Pearson Correlation	.623*	.409	.550	1	.559
	Sig. (2-tailed)	.030	.187	.064		.059
	N	12	12	12	12	12
Customer service	Pearson Correlation	.658*	.207	.623*	.559	1
	Sig. (2-tailed)	.020	.519	.031	.059	
	N	12	12	12	12	12

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 2
Coefficients.

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	-8.327E-15	.000		.000	1.000
Existing products	.200	.000	.101	8.937E6	.000
New generation products	.200	.000	.149	1.569E7	.000
Delivery_	.200	.000	.323	4.029E7	.000
Service offering	.200	.000	.444	5.904E7	.000
Customer service	.200	.000	.272	3.221E7	.000

a. Dependent Variable: Overall satisfaction

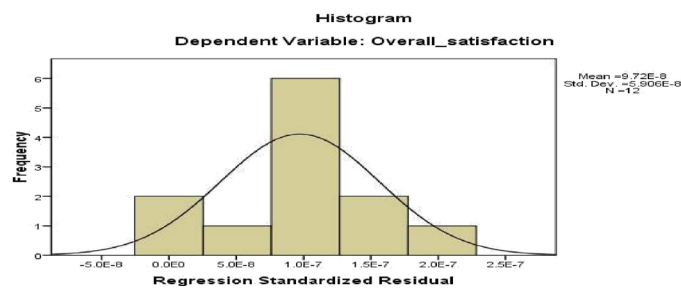


Fig. 3. Dependent variables of external customer satisfaction.

Correlation of the internal customers

The Table 3 belongs to the correlation analysis of the questionnaires belonging to the internal customers. 17 questionnaires out of 18 were qualified enough to be analyzed. This is due to the fact that one of the questionnaires did not contain enough answers to be used by the SPSS program. From the

Table 3 we can observe that which one of the factors are correlated with each other. The numbers containing ** indicate that the correlation between factors is 99 percent accurate. However if the sign above a number is * it is indicating that the existing correlation is 95 percent accurate. However according to SPSS analysis for the internal customers, there is no correlation amongst any of the factors.

Table 3
Correlations; internal customers.

		Existing products	New generation products	Delivery	Service offering	Customer service
Existing products	Pearson Correlation	1	.722**	.312	.623*	.658*
	Sig. (2-tailed)		.008	.323	.030	.020
	N	17	17	17	17	17
New generation products	Pearson Correlation	.512**	1	-.134	.632	.207
	Sig. (2-tailed)	.008		.638	.154	.519
	N	17	17	17	17	17
Delivery_	Pearson Correlation	.312	-.152	1	.550	.623*
	Sig. (2-tailed)	.323	.638		.064	.031
	N	17	17	17	17	17
Service offering	Pearson Correlation	.673*	.534	.542	1	.508
	Sig. (2-tailed)	.030	.187	.064		.059
	N	17	17	17	17	17
Customer service	Pearson Correlation	.678*	.265	.623*	.559	1
	Sig. (2-tailed)	.013	.532	.051	.063	
	N	17	17	17	17	17

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Regression analysis the internal customers

As we can see from the Table 4, all the factors are significant, meaning that the regression analysis do indeed stand up amongst all the factors. Once again an extra factor has been created as the independent factor which is called the Overall Customer Satisfaction. The numbers in this factor are result of the mean of the values in all the other factors. One should note that the five other factors are indeed de-

pendent factors. The beta column in the table below shows the percentage, belonging to every factor and the role it has on the overall customer satisfaction. The percentage belonging to each factor is as following(refer to Fig. 4):

- Existing products 18%;
- New generation products 25%;
- Delivery 34%;
- Service offering 43%;
- Customer service 30%.

Table 4
Coefficients.

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	6.661E-16	.000		.000	1.000
Existing products	.200	.000	.180	5.155E7	.000
New generation products	.200	.000	.256	8.160E7	.000
Delivery_	.200	.000	.342	1.048E8	.000
Service offering	.200	.000	.434	1.131E8	.000
Customer service	.200	.000	.305	6.776E7	.000

a. Dependent Variable: Overall satisfaction

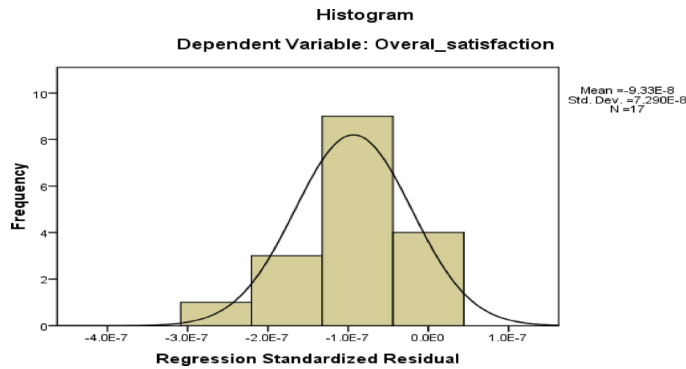


Fig. 4. Dependent variables of internal customer satisfaction.

Table 5
Free comments.

Comments on Service offering and Customer service	Internal	End Customer	Total
Communication improvement <ul style="list-style-type: none"> • Responsiveness • Difficult to contact • Information flow • Information availability • 24/7 reachable 	8	10	18
Service process improvement <ul style="list-style-type: none"> • Paper work/reports • Tools • Service portfolio • Documentation 	12	3	15
More resources are needed	5	2	7
Faster lead time is needed	2	5	7
Training improvements	1	1	2
Total	28	21	49

According to results of the analysis is SPSS, The delivery factor had a negative correlation with the new generation products. This is why Fig. 4 has only four columns.

According to the Table 5, the communication and service process improvement are extremely important for companies functioning on international scale. As we can see from Table 5, the communication factor happens to be the most important factor for the end customers. This is due to the fact that getting 24/7 customer service is very valuable for end customers all over the world, in case a problem occurs unexpectedly. However according to the internal customers service process improvement happens to be the most important factor. This might be because of the fact that more documentation and tools are needed in the subsidiaries for supporting the customers at the best positive way.

Discussion and conclusion

Our study has certain limitations due to the fact that only one company was taken into consideration, with a limited amount of customer respondents. Further research is needed on the rapid service process improvement as a consequence of its crucial role on enhancing the company capabilities for dealing with various customer demands.

As we could see throughout the article, the main objective of this case study has been revolving around the factors which can affect the customer satisfaction. This could be valuable when companies prepare their service strategies. The process of gathering information has been taken care of by the use of questionnaires which have mainly covered the five main concern of our analysis. These main concerns or groups were as following:

- Existing products;
- New generation products;
- Delivery;
- Service offering;
- Customer service.

During the analysis of the gathered data a specific statistical data processing program, named SPSS, was used to sort out the data and help us with finding the correlation between the factors and the concepts affecting the customer satisfaction. During the studies, the main concern of the research had been finding out how and to what degree the service offering can affect and be linked to customer satisfaction. During our analysis we found out that according to the external customers there is indeed a correlation between the main five factors of the questionnaire

(refer to Table 1 and 3). However, the internal customers believed that there is no positive correlation between mentioned factors. This might be due to the new generation products, being made of complete new components and the product development is based on new innovations. As it was stated in the body of this article, the respond to the questionnaire came from two different groups. One group of respondents was the internal customers who were the managers and experts of the daughter companies in various countries. The other group of respondents belonged to the end customers. It is worth mentioning once again that the five stated above factors were taken into consideration according to the influence they have on the overall customer satisfaction.

The internal customers ranked service offering to be the most important factor affecting the overall customer satisfaction. According to our data analysis from the internal customers, service offering affected the customer satisfaction by 43%. In accordance with the calculations we made about the role of service offering according to the external customers, it affects the overall customer satisfaction by 44%. It is also worth mentioning that the biggest percentage out of five was belonging to service offering itself.

Based on the analysis from Table 5, we can conclude that effective communication and rapid service processes have positive effects on the dynamic capabilities of the company.

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VALIDATING KNOWLEDGE AND TECHNOLOGY EFFECTS TO OPERATIVE SUSTAINABLE COMPETITIVE ADVANTAGE

Josu Takala¹, Jari Koskinen¹, Yang Liu¹, Mehmet Serif Tas¹, Matti Muhos²

¹ University of Vaasa, Department of Production, Finland

² University of Oulu, Oulu Southern Institute, Finland

Corresponding author:

Josu Takala

Department of Production/Industrial management

Po. box 700, FI-65101, Vaasa, Finland

phone: +358-6-3248 448

e-mail: josu.takala@uwasa.fi

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ABSTRACT

Purpose: This paper aims to present a fresh idea on how to model and examine the level of sustainable competitive advantage (SCA) with and without knowledge and /technology (K/T) effects in a case company's operation by taking the manufacturing strategy's development directions and the efficiency of resource allocation among its attributes into consideration.

Design/Methodology/approach: In this paper, questionnaires are filled by two different managerial groups, company's management team (G1) and company's global directors (G2). The analyses based on G1, G2 and G1-G2 (mixed results) are performed and examined as well as the effect of knowledge and /technology rankings to observe the differences on how they effect on company's operations strategy and what kind of strategy type that decision makers might follow. Besides, the effects of knowledge/technology rankings on SCA risk levels are examined on different case companies to perceive the similarities and differences with our case company. In this case study, the objectives are achieved based on several methodologies: manufacturing strategy index (MSI) [1] and sense and respond (S&R) methodology [2].

Findings: The achieved results through the model are found to be promising corresponding to the feedback from the respondents.

Research limitations/implications: The model is applied only in a big sized B2B global company that produces power electronics products. Therefore, further tests need to be applied to the model in case of multiple companies from different sizes and areas to figure out the best formula in case of validation of strategic direction (MAPE, RSME or MAD).

Practical implications: As a result of its wide applicability and its ease in arrangement the model has an enormous potential for strategic decision-making process and strategic analysis.

Originality/Value: The model can provide a more dependable possibility of sustainable improvement to the corporate operational excellence and strategy.

KEYWORDS

Sustainable competitive advantage (SCA), knowledge and /technology rankings, manufacturing strategy, sense and respond (S&R), operational excellence, operations management, dynamic capabilities.

Introduction

The growing role of technology cannot be underestimated nowadays as it brings vast number of opportunities for business development, growth and strengthen of the competitive advantages [3]. The advanced technology is the source of profit and competitiveness to enterprises, and at the same time, it

is also an important support which helps enterprises adapt market changes. Along with the unceasing renovation of technology of industry, enterprises must continually adapt to the technical requirements of the market.

Although, SCA was not formally defined at the beginning it is first aroused by Porter [4] that the firms of basic types of competitive strategies can be

possessed of achieving SCA. Barney [5] has made a closer definition by uttering as a: “A firm is said to have a sustained competitive advantage when it is implementing a value creating strategy not simultaneously being implemented by any current or potential competitors and when these other firms are unable to duplicate the benefits of this strategy (italics in original)” (p. 102). By the SCA values, one may observe how much the resource allocation supports the company’s strategy. Liu states that the main idea lies behind the implementation of SCA is to find the critical attributes in resource allocation through sense and respond methodology (S&R) and make the improvements that provides to perform dynamic adjustments to enhance the company’s strategy in turn [6]. In a fast changing business environment, companies should have a clear focus to find new and more innovative ways of working. They shall encourage firm’s employees to be innovative in order to come up with new solutions. In turbulent business environments, the importance of focusing on right things is more important. New models and tools as well as dynamic capabilities support firms to achieve success in a long term business.

The view of an organization based on the resource allocation is started by the theoretical reference basis of competitiveness in manufacturing operations [7]. It is aimed to understand whether the right direction of development is selected to make certain that the selected strategy is followed by the corporation by employing resource allocation with dynamic capabilities’ point of view. Accordingly, manufacturing strategy index (MSI) [1] and the method of detection of a company’s preferable strategy type through utilization of sense and respond (S&R) methodology [2] methodologies are used for the validation.

In this paper, all analyzes are performed based on 11 interviews with vice presidents and global directors in global operation strategies in global company that produces power electronics products. In its business area, the case company is one of the biggest players focusing on profitable growth.

In this paper, the analyses based on the level of SCA is modeled and examined with and without the effects of K/T in our case company’s operation by involving MSI and S&R. Here, two research questions are aroused. First one is how to evaluate K/T effects to SCA and the second one is how valid different SCA models to evaluate K/T effects to SCA are in practice. In the literature review part, great background information is provided for the reader to have a good understanding of the process and in the follow-

ing part, the required equations are given for the modeling of SCA. Subsequently, analyses are performed and the results are discussed and concluded.

Literature review

Manufacturing strategy

Johnson describes strategy as ‘the direction and scope of an organization over the long-term, which achieves advantage in a changing environment through its configuration of resources with the aim of fulfilling stakeholder expectations’ [8]. Mintzberg states that strategy is organization’s future plan, a position in specific markets, a pattern of its performance and a tactic to left behind its competitors [9].

Miles and Snow topology [10] is a dominant framework of the strategy types. They have developed a comprehensive framework which states that the strategy type can be detected depending on the fixed proportions between RAL Model elements (Quality, Cost, Time/Delivery, and Flexibility). By this framework strategy types are considered to be four different groups, prospectors, defenders, analyzers and reactors. Decision makers stick to one of these strategies at certain times depending on the market condition to avoid crisis from turbulent business environment. Prospector strategy has a definite focus on quality and it endlessly seeks for new market opportunities, defender strategy aims achieving an advantage in cost to create a stable market share and analyzer strategy is considered to be an intermediate one as it focuses on balancing between quality, cost and time.

Strategy detection

Each attribute in the list (Table 1) is numbered and analyzed in graphs with respect to the order (Fig. 1). In the last column (Table 1), the attributes from OP (Operations) questionnaire are assigned to one of the multiple key categories of RAL model Quality (Q), Cost (C), Time/Delivery (T) and Flexibility (F), depending on their most significant effect [3]. These categorizations are performed to integrate Miles & Snow topology into Sense and Respond methodology. According to Thomas L. Saaty: “To make a decision we need to know the problem, the need and purpose of the decision, the criteria of the decision, their sub-criteria, stakeholders and groups affected and the alternative actions to take” [11].

Table 1
The list of attributes used in Sense and Respond questionnaire.

Attributes		
Knowledge & Technology Management		
1	Training and development of the company's personnel	←Flexibility
2	Innovativeness and performance of research and development	←Cost
3	Communication between different departments and hierarchy levels	←Time
4	Adaptation to knowledge and technology	←Flexibility
5	Knowledge and technology diffusion	←Cost
6	Design and planning of the processes and products	←Time
Processes & Work flows		
7	Short and prompt lead-times in order-fulfillment process	←Flexibility
8	Reduction of unprofitable time in processes	←Cost
9	On-time deliveries to customer	←Quality
10	Control and optimization of all types of inventories	←Quality
11	Adaptiveness of changes in demands and in order backlog	←Flexibility
Organizational systems		
12	Leadership and management systems of the company	←Cost
13	Quality control of products, processes and operations	←Quality
14	Well defined responsibilities and tasks for each operation	←Flexibility
15	Utilizing different types of organizing systems	←Flexibility
16	Code of conduct and security of data and information	←Cost
Information systems		
17	Information systems support the business processes	←Time
18	Visibility of information in information systems	←Time
19	Availability of information in information systems	←Time
20	Quality & reliability of information in information systems	←Quality
21	Usability and functionality of information systems	←Quality

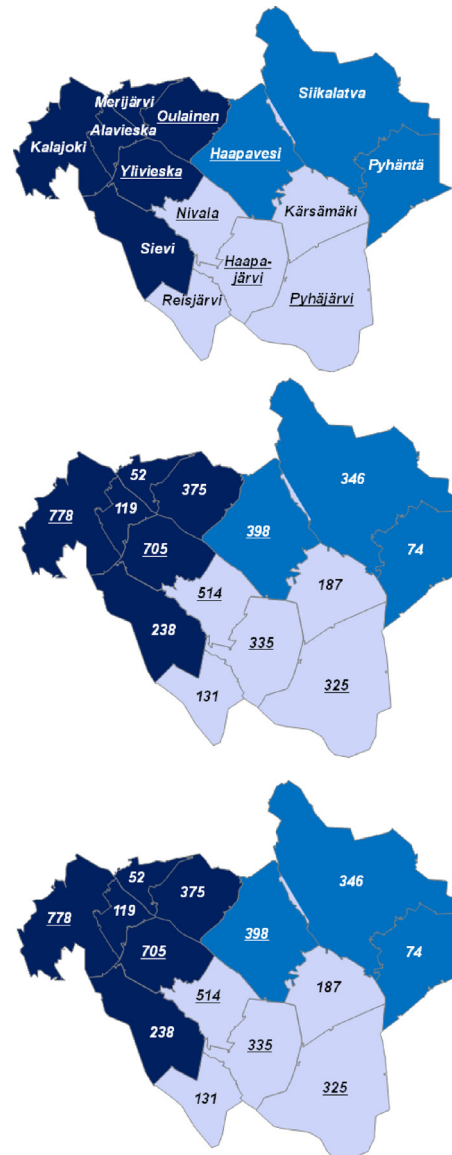


Fig. 1. Oulu South municipalities and numbers of companies.

Sense and respond

Sense and respond (S&R) is a comprehensively customizable industrial operational strategy to deal with current turbulent business environment. The main idea of 'Sense & Response' philosophy is the execution of the best practices in a turbulent business

environment by detecting changes (sensing) and reacting to them properly (responding), in other words, converting threats into opportunities and drawbacks into strengths. Bradley and Nolan [12] developed dynamic business strategies with respect to the S&R thinking. In case of facing frequently changing environmental conditions, companies are able to sense,

adapt and rapidly respond due to these dynamic business strategies. The S&R was utilized by Ranta and Takala [13] to develop the operative management system by introducing critical factor index (CFI). Since then, the S&R model has gone through three stages of development, which are called CFI model, BCFI model, and SCFI model [6].

Knowledge and technology rankings

Technology provides the opportunity of competitive advantage to a firm and decision makers should integrate this opportunity with their strategy [14]. Knowledge/and technology requirement section has been added to the Sense and Response questionnaire to gather information about the companies' knowledge/and technology rankings. Respondents are required to evaluate each attribute in terms of basic, core and spearhead technologies in percentages while keeping the summation of these three terms to 100%.

Basic technology is referring to technologies commonly used and that can be purchased or outsourced while core technology is referring to company's current competitive technologies and spearhead technology is referring to the technologies focused on the future.

The importance of different technological levels (Basic, Core or Spearhead), in technology-based businesses, affects a lot the strategy implementation by the knowledge required, and supports the company's success in the competitive category chosen. The information is useful as it helps to understand additional ways of performance control and improvement for every listed attribute [3].

The method of judgment on critical attributes

There are three different colors defined for the resource allocation of the attributes; red, yellow and green which represent whether an attribute is under resourced, over resourced or balanced. Here the resource allocation of the attributes is considered to be

ideal if it is equally distributed. The whole resource is counted to be 100% and it is divided to the total number of attributes. By this division the average resource level is defined. An attribute is counted to be balanced and takes the green color if BCFI value is between the range of 1/3 and 2/3 of average resource level. For the rest, any attribute which has a lower BCFI value than 1/3 of average resource level is counted to be under resourced and takes the red color, and any attribute which has higher BCFI value than 2/3 of average resource level is counted to be over resourced and takes the yellow color [2].

Derivation of BCFI K/T

Right after applying the method of judging under resourced and over resourced attributes, the next step is to calculate the values of BCFI K/T for each attribute, depending on the formulas provided below (Table 2). First, the color of the attribute is taken into consideration then the dominating technology for that attribute. The dominating technology is one with a value more than 43%; in case all of the technology levels are less than 43% the one with the highest value is dominating [3].

Oulu South Region (OEI)

Oulu South Area is located in Northern Ostrobothnia in the southern part of the province of Oulu. It has three sub-region area of cooperation.

Number of firms = 4597, Micro entities 95%, Small and medium sized enterprises 5%, Large companies 0.1%.

The area includes a total of 14 municipalities with a total population of just under 90 000, or about a quarter of the Northern Ostrobothnia population. In 2001, Oulu Southern Regional Ministry of the Interior approved the regional center program three sub-region network-type cooperation areas. The region's development strategy has been prepared in Oulu South 2015 agreement. The contract shall be entered in the main area of development in 2007–2015.

Table 2
Technology Rankings: General formulas.

	RED attributes	YELLOW attributes	GREEN attributes
<i>Basic</i>	$(B)CFI / (B\% / 100)$	$(B)CFI * (B\% / 100)$	$(B)CFI / (B\% / 100)$
<i>Core</i>	$(B)CFI * (C\% / 100)^2$	$(B)CFI / (C\% / 100)$	$(B)CFI * (C\% / 100)^2$
<i>Spearhead</i>	$(B)CFI * (SH\% / 100)^3$	$(B)CFI / (SH\% / 100)^2$	$(B)CFI * (SH\% / 100)^3$

Oulu South is one of the main agricultural areas – the area can be characterized as an industrialized in rural areas, because the region offers a significant extent, the manufacturing industry jobs. The largest industries are agriculture, metals, wood products industry, and information and communication technology (ICT). The regional unemployment rate is among the lowest in northern Finland and the age structure of the population is young. This differentiates from other Finnish Oulu Southern rural areas. Oulu South is a business-friendly area where currently about 4,600 active companies. Of these, about 95% of companies are micro-enterprises. More than a hundred of enterprises with a range of less than 20 Oulu South map numbers of companies and municipalities is shown in following picture.

The implementation of SCA

For the calculation of the operational competitiveness rankings of the case companies in different groups, prospector, analyzer and defender, the analytical models are used for manufacturing strategy (MSI) [10]. Takala [1] states that the theory of analytical models are supported by the RAL (Responsiveness, Agility and Leanness) model by taking four main criteria into consideration, cost (C), quality (Q), time/delivery (T) and flexibility (F). The development of the analytical models is held from over 100 companies in the GMSS research group. Therefore, they have good transferability and they will provide competitiveness ranking of the case companies in this paper.

The equations below (1–4) stand for the calculations of normalized weights of four main criteria in the analytical models.

$$Q\% = \frac{Q}{Q + C + T}, \quad (1)$$

$$C\% = \frac{C}{Q + C + T}, \quad (2)$$

$$T\% = \frac{T}{Q + C + T}, \quad (3)$$

$$F\% = \frac{F}{Q + C + T + F}. \quad (4)$$

The equations (5)–(7) stand for the analytical models that provide the calculations of MSI of operational competitiveness in each group.

The MSI model for prospector group:

$$\emptyset \sim 1 - \left(1 - Q\%^{1/3}\right) (1 - 0.9 * T\%) (1 - 0.9 * C\%) * F\%^{1/3}. \quad (5)$$

The MSI model for analyzer group:

$$\lambda \sim 1 - (1 - F\%) \left[\frac{[ABS[(0.95 * Q\% - 0.285) * (0.95 * T\% - 0.285) * (0.95 * C\% - 0.285)]]}{10} \right]^{1/3}. \quad (6)$$

The MSI model for defender group:

$$\varphi \sim 1 - \left(1 - C\%^{1/3}\right) (1 - 0.9 * T\%) (1 - 0.9 * C\%) * F\%^{1/3}. \quad (7)$$

Ranta and Takala [13] have introduced critical factor index (CFI) into the operative management system to shape sense and respond (S&R) theory. By this way, the critical criteria of strategic adjustment that may support the strategic decision-making phase is interpreted and evaluated. The following model, BCFI, was developed by taking the principle of CFI theory into consideration. Later, Liu et al. [2] developed the SCFI model that accurately models the S&R theory.

The following equations are used in the calculations of CFI, BCFI and SCFI models (8)–(11).

$$Importance\ index = \frac{Average\ of\ expectation}{10}, \quad (8)$$

$$Gap\ index = \frac{Average\ of\ expectation - Average\ of\ experience}{10} - 1, \quad (9)$$

$$Development\ index = |(better - worse) * 0.9 - 1| \quad (10)$$

$$Performance\ index = \frac{Average\ of\ experience}{10}. \quad (11)$$

The equations of CFI, BCFI and SCFI models are listed as follows:

$$CFI = \frac{std\{experience\} * std\{expectation\}}{Importance\ index * Gap\ index * Development\ index} - 1, \quad (12)$$

$$SD\ expectation\ index = \frac{std\{expectation\}}{10} + 1, \quad (13)$$

$$SD\ experience\ index = \frac{std\{experience\}}{10} + 1, \quad (14)$$

$$BCFI = \frac{a^*}{b^*} - 1, \quad (15)$$

where

$$a^* = SD\ expectation\ index * SD\ experience\ index * Performance\ index,$$

$$b^* = Importance\ index * Gap\ index * Development\ index,$$

$$SCFI = \frac{c^*}{d^*}, \quad (16)$$

where

$$c^* = \sqrt{\frac{1}{n} \sum_{i=1}^n (\text{experience}(i) - 1)^2}$$

$$* \sqrt{\frac{1}{n} \sum_{i=1}^n (\text{expectation}(i) - 10)^2}$$

*Performance indes,

$$d^* = \text{Importance index} * \text{Gap index}$$

*Development indes.

By the SCA values, one may observe how much the resource allocation supports the company's strategy. As the SCA value approaches to 1 the consistency between resource allocation and strategy becomes stronger.

MAPE (absolute percentage error):

$$SCA = 1 - \sum_{\alpha, \beta, \gamma} \left| \frac{BS - BR}{BS} \right|. \quad (17)$$

RMSE (root means squared error):

$$SCA = 1 - \sqrt{\sum_{\alpha, \beta, \gamma} \left(\frac{BS - BR}{BS} \right)^2}. \quad (18)$$

MAD (maximum deviation):

$$SCA = 1 - \max_{\alpha, \beta, \gamma} \left| \frac{BS - BR}{BS} \right|. \quad (19)$$

Case study

In this case study, MSI and S&R data are collected from a multinational Finnish company in two phases, 2 years in the past (P) and 2 years in the future (F). The collected S&R data is examined in three groups, G1, G2 and G1&G2, to analyze their distributed and normalized values in terms of quality, cost, time and flexibility as can be observed from the following tables. The values of the multiple key categories of RAL model (Q, C, T and F) are calculated separately based on CFIs values of the classified attributes (Tables 3–5).

Table 3
Results of informants G1.

	Quality	Cost	Time	Flexibility
CFI(P)	4.52	5.19	11.05	13.31
CFI(P) Normalized	0.13	0.15	0.32	0.39
CFI(F)	12.34	10.86	19.59	10.30
CFI(F) Normalized	0.23	0.20	0.37	0.19
BCFI(P)	4.82	4.75	5.88	9.66
BCFI(P) Normalized	0.19	0.19	0.23	0.38
BCFI(F)	15.22	9.08	9.19	9.95
BCFI(F) Normalized	0.35	0.21	0.21	0.23
SCFI(P)	61.37	78.01	105.72	192.53
SCFI(P) Normalized	0.14	0.18	0.24	0.44
SCFI(F)	174.24	140.76	148.54	174.76
SCFI(F) Normalized	0.27	0.22	0.23	0.27
BCFI TK(F)	15.50	5.94	13.98	17.34
BCFI TK(F) Normalized	0.29	0.11	0.27	0.33

Table 4
Results of informants G2.

	Quality	Cost	Time	Flexibility
CFI(P)	9.16	13.38	9.15	10.21
CFI(P) Normalized	0.22	0.32	0.22	0.24
CFI(F)	12.72	15.95	13.64	14.29
CFI(F) Normalized	0.22	0.28	0.24	0.25
BCFI(P)	5.20	5.73	4.05	6.97
BCFI(P) Normalized	0.24	0.26	0.18	0.32
BCFI(F)	7.17	6.25	5.98	8.87
BCFI(F) Normalized	0.25	0.22	0.21	0.31
SCFI(P)	131.84	161.99	102.55	211.67
SCFI(P) Normalized	0.22	0.27	0.17	0.35
SCFI(F)	175.99	182.29	150.21	269.47
SCFI(F) Normalized	0.23	0.23	0.19	0.35
BCFI TK(F)	9.62	5.40	9.39	16.37
BCFI TK(F) Normalized	0.24	0.13	0.23	0.40

Table 5
Results of informants G1&G2.

	Quality	Cost	Time	Flexibility
CFI(P)	8.47	11.28	11.92	13.30
CFI(P) Normalized	0.19	0.25	0.27	0.30
CFI(F)	13.97	15.48	18.37	17.40
CFI(F) Normalized	0.21	0.24	0.28	0.27
BCFI(P)	5.05	5.30	4.61	7.67
BCFI(P) Normalized	0.22	0.23	0.20	0.34
BCFI(F)	8.73	6.90	7.06	9.34
BCFI(F) Normalized	0.27	0.22	0.22	0.29
SCFI(P)	200.11	241.18	197.88	380.53
SCFI(P) Normalized	0.20	0.24	0.19	0.37
SCFI(F)	328.80	323.92	296.76	453.05
SCFI(F) Normalized	0.23	0.23	0.21	0.32
BCFI TK(F)	17.14	6.34	10.33	16.19
BCFI TK(F) Normalized	0.34	0.13	0.21	0.32

Results of K/T rankings from informants G1

Company’s current competitive technologies (Core) seem to be around 35%, the technologies commonly used (Basic) differ from 25% to 50% and the technologies focused on the future (Spearhead) is observed to be roughly around 20% in average (Fig. 2). From the technology rankings point of view the company is found to be somehow competitive; however, spearhead ranking shows that company do not aim to invest on the technologies focused on the future.

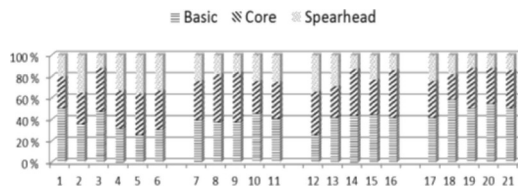


Fig. 2. Knowledge and Technology rankings.

From the technology point of view, most of the attributes are going to be critical by lack of resource allocation and the attribute number 14 is going to be over resourced (Fig. 3). Considering the K/T effects, it may be observed that while it enhances some attributes it makes it worse for others as the dominating technology ranking differs for attributes. Company may concentrate more on the right type of technologies for each attribute to keep them in balanced zone (3.17–6.35). Although, the overall situation is observed to be critical K/T effect has provide a positive impact in general.

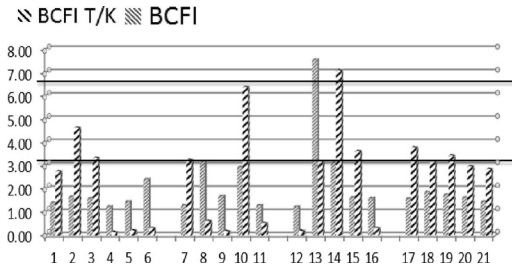


Fig. 3. BCFI (F) vs BCFI K/T (F).

Results of K/T rankings from informants G2

Technology rankings for the attributes of G2 are seen to be slightly different compared to the answers from G1 (Fig. 2, Fig. 4). Here, participants from G2 values basic technologies more than spearhead technologies while they keep the core technologies in same level with G1. Although, there are small changes between G1 and G2 in technology rankings, the change in dominating technology will effect on the enhancement of the attributes by K/T effects.

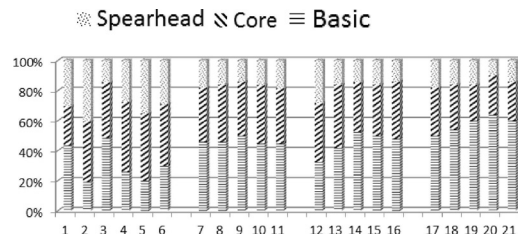


Fig. 4. BCFI (F) vs BCFI K/T (F).

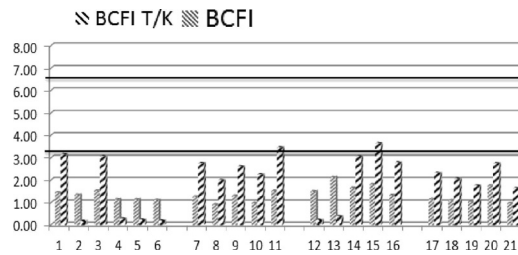


Fig. 5. BCFI (F) vs BCFI K/T (F).

Except the attributes number 1, 11 and 15, all the attributes are going to be critical by lack of resource allocation from the technology point of view (Fig. 5). The improvement done by K/T effects on BCFI in G1 is not observed well for the BCFI K/T values in G2 which means that K/T rankings consideration from G2 is not as effective as in G1 in general. Company should put more effort for under

resourced attributes and decide on the right type of the dominating technology for each attribute.

Results of K/T rankings from informants G2

By analyzing the data from both groups' participants, company's core technologies seem to be around 35%. Basic technologies differ from 25% to 60% and the technologies focused on the future (Spearhead) are observed to be roughly around 20% in average (Fig. 6). It may be very clearly observed that the basic technologies are generally the dominating technology type for most of the attributes which implies that the company is not considered or going to be competitive from the technology point of view, although core technologies are around 35%.

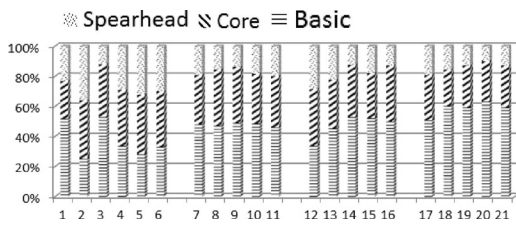


Fig. 6. Knowledge and Technology rankings.

Except the attribute number 13, almost all the attributes are going to be critical by lack of resource allocation and the attribute number 13 is going to be over resourced with a small number (Fig. 7). General situation in this figure does not seem a very bad one. Although, most of the attributes are not in the balanced zone they are quite near to be pulled to the balanced zone.

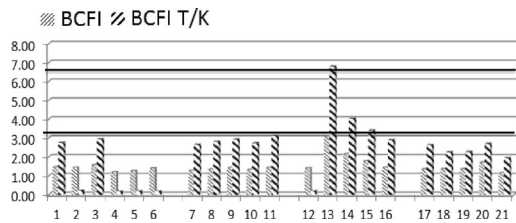


Fig. 7. BCFI (F) vs BCFI K/T (F).

Strategy type

Analyzer and defender strategy types are seen to be almost equally the most preferred strategy types for the company in the past case. Although, company aims to keep its operational strategy type unchanged analyzer strategy type is slightly less dominant for the future case but defender strategy type is the most dominant one (Table 6). It is well understood that the company is aiming to follow defender

strategy type in the future case with and without K/T involvement; however, somehow it is also going to have analyzer strategy type characteristics as well in the future.

Table 6
Strategy type calculations.

	Prospector	Analyzer	Defender
G1 BCFI (P)	0.92	0.95	0.96
G1 BCFI (F)	0.78	0.87	0.89
G1 BCFI TK (F)	0.81	0.88	0.90
G2 BCFI (P)	0.95	0.97	0.97
G2 BCFI (F)	0.74	0.84	0.88
G2 BCFI TK (F)	0.77	0.86	0.89
G1-G2 BCFI (P)	0.94	0.96	0.97
G1-G2 BCFI (F)	0.74	0.84	0.88
G1-G2 BCFI TK (F)	0.76	0.86	0.89

SCA analyzes and Weak Market Test (WMT)

The calculated SCA values for the past case are seen to be relatively very high compared to the SCA values that are calculated for the future case (Table 7). In this scenario, it can be concluded that the resource allocation for attributes were partially supporting the operational strategy better; however, the resource allocation for the future scenario seems to be inadequate which means weak sustainability is unavoidable in the future operation strategies. Therefore, the decision makers are suggested to concentrate more on well distributed resource allocation between attributes.

One other point observed from Table 7 is the enhancement of K/T effects on SCA risk levels. Involving the K/T effect into the consideration shows a small improvement in SCA values for G2 and G1&G2 analyzes which simply indicates an automatic improvement in resource allocation. At this point it is highly suggested for the decision makers to adjust their technology rankings accordingly to improve the critically allocated resource for each attribute.

Validation of SCA formulas seem to work properly based on WMT. OEI case companies do not stand against the SCA risk levels; they approve the results with the practice. The same situation may be said for our case company, the practical SCA risk level is exactly same compared to MAPE and %2-3 higher risk level compared to RMSE and MAD in the past case. Although, there is a high risk level between WMT and MAPE the risk level is quite small in comparison of WMT and MAD in the future case. In this scenario, WMT data does not exactly fit to any of the SCA formulas. Therefore, there is a need to conduct more case studies to make a decision on which SCA formula would be more realistic.

Table 7
Calculated SCA results.

	α	β	γ	MAPE	RMSE	MAD	WMT
G1 BCFI(P)	1.08	0.99	1.08	0.92	0.95	0.96	
G1 BCFI(F)	1.06	1.01	1.07	0.78	0.87	0.90	
G1 BCFI TK (F)	1.04	1.03	1.07	0.74	0.84	0.88	
G2 BCFI (P)	1.07	1.01	1.07	0.95	0.97	0.97	
G2 BCFI (F)	1.07	0.99	1.08	0.74	0.84	0.88	
G2 BCFI TK (F)	1.06	1.01	1.08	0.76	0.86	0.89	
G1-G2 BCFI (P)	1.07	0.99	1.07	0.94	0.96	0.97	0.94
G1-G2 BCFI (F)	1.07	0.99	1.08	0.74	0.84	0.88	
G1-G2 BCFI TK (F)	1.05	1.01	1.08	0.76	0.86	0.89	0.91

K/T effects comparison with other OEI case companies

As the effects of K/T to SCA has also been examined for OEI case companies (OEI.1- OEI.7) a comparison between the results from these companies and our case company is performed. While the effect of K/T has a small enhancement, (1-3) %, to SCA values for our case company in case of G1&G2, it increases the risk level for the other OEI case companies except OEI.1 (Fig. 8). The derived results imply that these companies cannot take the effect of K/T into account as they use weak or wrong type of the technology for most of their attributes.

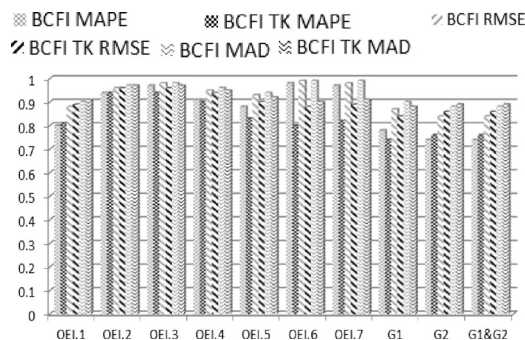


Fig. 8. BCFI (F) vs BCFI K/T (F).

Discussions

In this paper, the operations SCA evaluation may be considered as the risk probability. By achieving the SCA value, decision makers may decide on an operation strategy (among prospector, analyzer and defender operational strategy types) which causes least risk. The presented SCA method provides better sustainability, sensitivity and flexibility for the company. Moreover, it enhances its competitiveness and performance. The model provides possibility:

- To observe the right type of the operations strategies that may provide better performance for the company.
- To make the adjustments in case of the general strategy and take better strategic actions by operation with supplementary information.
- To investigate whether each unit in company follows the general strategy or not, in case of analyses for each unit separately. In case a unit is not following the general strategy, the attributes in that unit may be adjusted to converge with the company's general strategy.

Our international case company does not seem to be a competitive one in case of K/T rankings. Therefore, the enhancement of K/T to SCA values is not significantly seen in this study. The usage of the core technologies is around 35% and it might seem relatively sufficient; however, it is observed that the basic technology type is dominant for the most of the attributes. This situation shows that company is not planning to invest on the future type technologies efficiently.

Although, the model introduced in this paper provides an extensive potential and adequate practical value in case of strategic analyses and strategic decision making process it is found to be in need to be tested with higher number of organizations in different type and size in order to find the best formula to validate the strategic decision (MAPE, RSME or MAP).

Managerial implications

In addition to the theoretical contributions of this paper, this study provides new ways for more robust operation strategies. Although, it has been the first validation that is based on WMT for OEI and our case companies the models proposed for the calculation of K/T effects to SCA risk levels seem to work properly in practice. By taking the results

gained through the models proposed into consideration, managers may observe and avoid weak sustainability in operation strategies.

Conclusion

The main role of this paper is to validate the effect of K/T to SCA in operations by taking the firm's strategy development directions and the efficiency of resource allocation into consideration. In case study section, the analyses are performed and the recommendations are provided for the decision makers. Moreover, the analytical model presented in this paper could be considered as a great source to observe the weaknesses and strengths of the company's operations and accordingly to take required actions to keep up the sustainability of the company's development.

Although, the effect of K/T to SCA is observed to be significantly small the enhancement of K/T is not negligible in case of using right type of the dominating technology. K/T effects to SCA do not increase the risk levels and WMT is very close to the calculated SCA values in case of our case company. Therefore, K/T rankings model seems to be a valid one as it enhances resource allocation; however, more case studies need to be conducted to provide a stronger validation of K/T rankings and SCA models.

This study has reached its aim and shown noteworthy results; however, it is well accepted that there are some limitations and shortcomings. First of all, the study is based on our multinational company and several OEI companies. Therefore, there should be more similar studies conducted to prove the validation of SCA models with K/T rankings. Second, the population of the participants is not that large. Collecting data from more participants might lead to steadier results. Third, the data is collected based on 3 years in the past and 3 years in the future perhaps this time duration should have been extended or data should have been collected based on different times in the past and in the future. For these reasons, the future studies will be conducted accordingly to have a stronger validation of the models introduced and to achieve better results.

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DYNAMIC BUSINESS MODEL BASED ON RESEARCH IN POWER ELECTRONICS INDUSTRY

Jari Koskinen, Josu Takala, Joseph Sebuwufu Awali

University of Vaasa, Department of Production / Industrial management, Finland

Corresponding author:

Jari Koskinen

Department of production

Faculty of Technology

University of Vaasa

P.O. Box 700, FI-65101, Vaasa Finland

phone: +358408371217

e-mail: jari.sakari.koskinen@gmail.com

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ABSTRACT

The recent global economic crisis has caused an uncertain and challenging business environment and has battered managements that are running businesses all over the world. This paper focuses on new capabilities that can be used successfully in a fast changing business environment for improving firms' efficiency.

This research utilizes constructive approach including interviews and case studies. The relevant findings of the study are the elements of the key success factors: entrepreneurial strategy, R&D to market performance, dynamic operational excellence and innovativeness with links to the key actions which have led to new business model called dynamic business model (DBC). This research focuses on power electronics business industry which at the same time is a limitation. This research helps directors and managers to think more widely and make better decisions for the success of the company. This research results bring additional value of the previous studies regarding a firm's key success factors and dynamic capabilities.

KEYWORDS

dynamic capabilities, entrepreneurship strategy, operational excellence, innovation, agility.

Introduction

Firms need to be more agile and resilient in their business sector due to the tightening market competition. The need of this agility is to make the firm more fit for the prevailing competition of the market. However, the resilience should be in line with their resources, capabilities, and readiness of the firm. Firms should reconsider and reconfigure their capabilities. This reconsideration and reconfiguration should also be agile and resilient in order to cope up with the dynamic market.

Conversely, Garvin argues [1] that a learning organization gets more skilled at creating, acquiring, and transferring knowledge which in turn helps it to adapt to new knowledge, interaction behaviour and insights. This interaction and communication will allow for peer learning, teamwork building, col-

laboration, and creative thinking. This creativeness becomes innovative knowledge and technology that helps in problem solving; i.e., overall performance of the organization [2]. However, while businesses are in this innovation process, they face challenges like threats and also changes in the company's actions or actors in the business environment.

For that matter, it is necessary for business to have different strategic architecture for different purposes that do not inhibit the flexibility of the firms or strategy. This architecture should have core competence in the business operations, as well as strategic intent; objective of the firm designed to capture the winning position [3]. Bessant argues that training and development are associated with increasing market share and growth [4]. There is need and importance for firms to keep up with the training and organization learning with and within the strategies.

Such knowledge could be extended further to global operations or large-scale operations.

In addition, the management should be innovative, encourage subordinate to be creative and make new innovative proposals as well as empowering them to make decisions. This should be done in a flexible but agile manner. The decision making process in the organization should be decentralized in fast changing technology environments in order to speed up the implementation of the new ideas [5]. Furthermore, the process should be efficient; covers all firms' processes primarily marketing, Research and Development (R&D) performance, Key performance indicators (KPIs) and production processes. These capabilities are necessary to sustain superiority in performance of an enterprise in a turbulent global market with rapid innovation and scattered sources of manufacturing capability, innovation, and invention [6]. This calls for agile use of dynamic capabilities as suggested by Teece [7]. The managerial nature and objective should be of entrepreneurial and with managerial sustainable competitive advantage activities that are more than just mere authority in order to capture value from its actions [8].

The central research questions of the present paper are:

1. Is it possible to create an efficient business model for power electronics firms which have operations in a turbulence business environment?
2. What are the key elements of such a model?
3. How could the key elements be implemented?

Research methodology

This paper collects previous case studies processed by the corresponding author of this article based on the interviews and data collections in the case companies collected in 2011, 2012 and 2013 and published in 2013 (some of articles are still forthcoming). Based on the previous studies focusing on dynamic capabilities and new business framework; weak market test was done and results are shown in the results and conclusion chapter.

Furthermore, the paper focuses on the domain of global electronics enterprises which have turbulence and complex business environment. Research work target is to test a new business model which includes dynamic capabilities and agility in a main role. The main motive for the paper is to create a framework with key success factors and define classes and slots for the selected domain.

Most research on dynamic capabilities has focused on the question "what" defines dynamic ca-

pabilities; this study focuses also on the "how" side. As for the practical implications, the new model helps firms to create processes that are more effective and to serve their customer better way in the future.

In total, the six interviewees have almost 200 years of experience in global business. Their experience is from high-level organisational position such as; board of the directors, management directors, vice presidents and global business directors (Table 1). They have worked in a global business, and each of them has had global director experience, two of them are women and four are men. Respondents overall experience in global director positions consist of R&D director, marketing director, factory director, logistics director, business development director and human research director experiences. This study tests the model of the key factors of successful company under the dynamic capabilities and agile concept.

Table 1
Working experience of respondents.

	Chairman of the board	Managing director	Management team member	Global director	Work experience
01-respondent	X	X	X	x	=>40
02-respondent	X	X	X	X	=>35
03-respondent	X	X	X	X	=>30
04-respondent	X	X	X	X	=>35
05-respondent			X	X	=>20
06-respondent			X	X	=>25

Theoretical construction of the model

The model is built based on own articles, previous articles, interviews mentioned in Fig. 1.

The Fig. 2 illustrates the flexibility and responsiveness of the model that is used in the research. The theoretical construction supports the dynamic capabilities framework that is also comprised of three primary elements: organizational structure, organizational performance, and competitive intensity [15].

In the following sections the five key elements of the model are introduced and linked to the theoretical view.

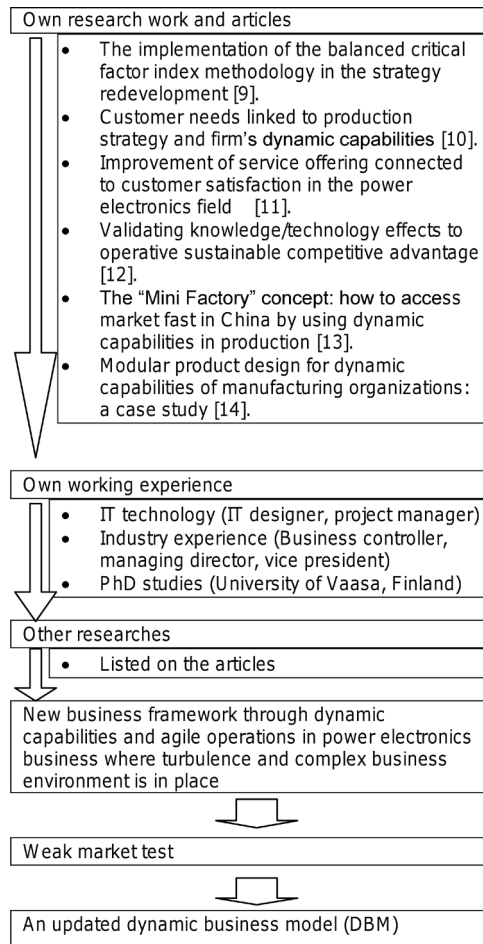


Fig. 1. Data collection process.

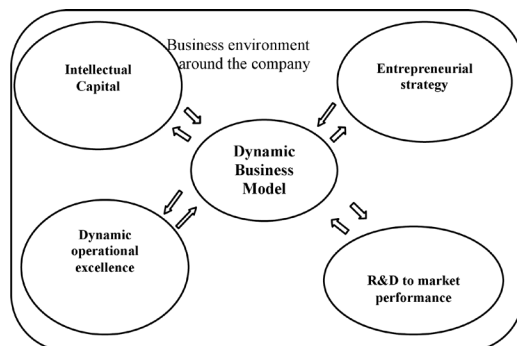


Fig. 2. Theoretical construction of the model.

(1) Entrepreneurial strategy

In entrepreneurial strategy, there should not be a gap between business management and technology,

but rather be intertwined [16]. Business and technology strategies are dualistic viewpoints to a mutual strategy. The model in the study is designed in a way that it considers technology as a key player of the strategies. Strategy, in a business, organizes the firms' resources to position its self to win [6].

(2) Intellectual capital

For accelerated innovation as a whole, there is a need for open innovation. It focuses on ease of knowledge and technologies flow, interactive processes outwards through firm boundaries. This is due to the fact that, open innovation concept considers invention and innovation, but they should not necessarily happen at the same location of transformation. However, outside-in open innovation should also be encouraged since it creates an "innovative semi-permeable membrane" [17].

(3) Decentralized decision making organization model

Study made by Bourgault et al., (2008), on decision-making processes in New Product Development (NPD) linked to team autonomy, revealed that, formal decision making process is even more necessary for distributed teams that are highly dispersed. In addition, team autonomy is very important for the success of dispersed teams while formalization will add value to teamwork, most especially when team distribution is on the increase.

(4) Effective processes

How should industries new product manager take to improve new product performance? Ulrich and Tung's argued that it is also valuable to have modularity in an effective process [18]. Some of the benefits may include, flexibility, easier and faster task to perform at the end of an assembly [19–21] and even more effective material flow through the factory [14].

(5) R&D to market performance

Cross-functional teams are one option to handle the cross-functional responsibility as well as interfacing departments to promote better new product performance [22]. Porter's competitive forces have changed high-technology organizations to adopt cross-functional project group as in the deployment of new products and processes [23].

Results

Key success words in next five years period

Below (Fig. 3) is the graph of the answers to the question; what are key words that describe the requirements for success in next five years period?

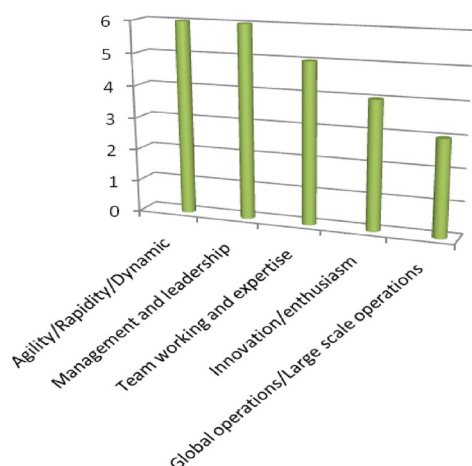


Fig. 3. Key success words.

The X-axis lists all the categories, which are mentioned most often. The Y-axis shows the number of answers in each category. On the graph, we can see that all of the interviewee said that, in the future most important issues are the reaction fastness to the changes around the company as well as management and leadership skills. This is especially for high tech companies where technology develops rapidly; it is the lifeline for companies to be fast and agile.

Researcher made weak market test for the proposed key success factors. The tested factors are:

1. Entrepreneurial strategy;
2. Innovativeness;
3. Decentralized decision making organisation model;
4. Effective processes;
5. R&D performance.

The free comment analysis

One respondent, who has long experience in mar-

keting, managing director and chairman of the board, replied to the question of key success factors as follows:

The bold strategy is number one, innovation is needed, and the strategy framework provides the accountability and gives power for firm’s management team. Decentralized decision-making organization is needed; profit centre leaders should have decision-making power. Some operations should be common for whole company group like; marketing and brand management, accounting systems, ways of thinking, values, rewards, travel and other general items. Employees who are not working to give value add for the customers, are people who normally secure their opinions, and therefore they are dangerous for the company. Product development must support customer commissioning. Selling persons should have a face, it is important for them to communicate with the customers and solve their problems. Product development people need more courage to go to see the customers; trade fair is good for them. Employees who do not have fresh ideas are not good for the company. Company vision is important to have but it is not enough. Company vision should make in teams and process to common company vision.

Weak Market test

Weak market test was done to test the key elements of the model. Next five parameters were tested based on the Table 2:

1. Entrepreneurial strategy;
2. Innovativeness;
3. Decentralized decision making organization model;
4. Effective processes;
5. R&D performance.

Everyone agree that for international company which have operations in many countries and firm’s product is based on high technology, the given drivers are most important for the future success of the company. Table 2 shows the results of weak market test.

Table 2
Weak market test.

Key element	Key driver	n:o of respondents	agree	disagree
Entrepreneurial strategy	Company strategy is unique	6	6	0
Innovativeness	The firm encourages people	6	6	0
Decentralized decision making model	Profit units have decisions power	6	6	0
Effective processes	covers all firm’s processes	6	6	0
R&D performance	covers all firm’s processes	6	6	0

For entrepreneurial strategy five additional comments was given:

1. *Companies need to do things better, to do things in a different way from your competitors (see the blue ocean strategy).*

2. *If you copy the others, your company is an average level company and will not be able to be the best. Firm specific concepts are important from success point of view.*

3. *A successful firm needs entrepreneurship strategy. Start up company needs to have "business angel" who has a financial interest and is stabilizer the road with the Equalizer in strategic terms. When the business is going up and down, it implies that the company is not going through the easiest point when the problems grows - the risk is that the firm will lose its whole strategy.*

4. *A bold strategy drives forward. Mirroring the strategy means that firm' operations are not developed. Bold strategy means that the company is ahead of its competitors. In addition, the strategy must be credible, simple and feasible (not castles in the air, the objectives should be of a kind that it is possible to get to them).*

5. *It is important as well to do things different from your competitors.*

For innovativeness, six comments were given:

1. *Innovation is important as well as the speed to win. Processes and innovation are two different things, and do not compete with each other, both are needed.*

2. *It is important to get straightforward and direct management to encourage people in their daily contacts. To provide ideas to develop functions and processes, as well as company's tools. Companies do not have big problems in general if you take out a strategy. Parts manufacturing fell from 31 days to five days removed from the 7000 issue, which were problem, any new machines do not invested, people liked to develop processes.*

3. *Agree, this is extremely important for "star ups" and for fast growing companies. Incentive programs increase the innovativeness. Employees should lead the way that they know where the company is going to and where the firm wants to go in the future.*

4. *This is working well - this is the key - not an easy thing - you should use all the possible tools that drive great results.*

5. *Companies that are copying others ideas can only be of an average level. Own ways of doing things are important.*

6. *R&D organization is particularly important. Employees' involvement is important as well as the*

company's culture support of processes and operations (corporate culture = mother's milk).

Decentralized decision making organization model

Everyone reported that a decentralized organization model is necessary. One respondent out of six said that decentralized organization model need also some centralized operations. The power should be decentralized. This is due to the fact that, people who are responding to operational business have budget responsibility. However, part of the operations is more efficient when centralized – this kind of activities is common for the whole company group and is like a platform design and human resources. Information flow between different organisation levels is crucial. The problem of matrix organization model was reported to be slow decision-making process and ambiguity that who is responsible for making decisions.

The following comments were reported from respondents:

1. *Decentralized decision-making organization model is the best. In addition, the value based Leadership and management is important. People need to be given the freedom and the power of high-speed decisions to look at the values of the company where one can get support for decisions. Hierarchical management is suitable for static business, more dynamic business environment need leadership which is based on visions and values.*

2. *The profit centre needs to have the power to make decisions on the results of the issues that are needed. It is important to have underlying control strategies and other ways to keep the company in the right track. It is dangerous to lose the strategy of the companies. Compared to one restaurant, their special plate were at the beginning three kinds of meat, which were very good, then the restaurant started to save money and whole restaurant lost its competitive advantage.*

3. *Some of the firm's operations should be centralized, just like a platform design.*

4. *In a crisis situation, centralized model is better. In normal circumstances, a decentralized model is better. The matrix model is not good because people may be buried in the matrix and it may kill innovation; this is not my personal view but a typical response. Some of the customers are in matrix, mainly through auditing points because small offices can look good through the matrix organization. Matrix organization is needed when there is a sufficiently large organization; the matrix should be light and allows the cooperation.*

5. *It is valuable to have decentralized organization model, for example, our Indian organization should decide what to produce in India for the local market. Light centralized model is needed to get a clear global decision making model. The aim is to be fast.*

6. *Authorization is important. Management model should be clear and communicated to everyone. This enables the efficiency and good communication. Decentralized organization model is good, but there should be some operations that are centralized. Centralized should be platform design and HR for example. Operating procedures should be a common platform (mode of operation).*

Effective processes

Process development is one of the key drivers to global companies. Effective processes also motivate firm's employees to work harder and they are proud of the company that they working for.

The following comments were given related to effective processes:

1. *Efficient logistics and sales processes are extremely important. The importance depends on the business in which one is. Standardization is to a certain extent a good thing. Routines should be incorporated in the process. Firms should give enough time for innovation. Process management is a must! A successful business cannot be imagined without the processes.*

2. *Process development should be done in order to keep people motivated and to involve people in the firm's issues.*

3. *Important sub elements are: product data management (hardware & software), modularisation, standardization and mass customization.*

4. *Organization must have rules of the "game," work events must be standardized, and purchases must have standardized ways of working. The process should work in a same way in every sector (Standardized production, purchasing, office, etc). It is also a management issue because this makes it possible to develop and lead. In addition, it also allows space for innovation because people do not have to fight daily routines and "fires"*

5. *Processes should be effective.*

6. *It depends on the company's size. If you are a big company such as our company, it is extremely important that the processes are defined, they are implemented and develop.*

R&D to market performance

When company have high technology product and are working in product business, R&D perfor-

mance is one of the key driver for success. Biggest business success is coming through technology push, product leadership is important because it makes possible to get profitable growth. Respondents gave following comments:

1. *In the product business, this is essential. Leading in a large group is the key; otherwise people are doing mistakes, and they do not know what the best is for the company; "the initial R & D phase (the prestudy phase) is most important". For great success, it is important to have the capability of anticipating the future needs of the customer that the customer cannot self-identify.*

2. *Definitely, this is the key driver.*

3. *Company should have clear instructions and operational models.*

4. *The more good products the company has - the better situation for the company. Good products drive better situation in a market place, assuming, of course, the products are what market needs. "Market pull" as well as time-to-market is essential. Right product range is essential.*

5. *The product leadership is essential because it achieves profitable growth.*

Ideal company in employee's point of view

Employee's motivation to reach the firm's target is one of the key drivers to reach high results. For that matter, respondents had to answer the question on; specify idea company employee's point of view.

Figure 4 show that most significant issues for interviewee were demanding business target. Previously, it included; challenge goals, demanding working tasks, process improvement to reach the target. Second most important issues were flexible and well working organization model with fair leadership. Respondents reported that freedom and power to make decisions are important as well as an organization culture, which does not have tight organizational boundaries. Third important issue pointed out includes four categories, which were at the same level:

1. Team work and high motivation.
2. Innovations where everyone are involved.
3. Meaningful work and good working atmosphere.
4. High technology products.

Innovation and positive way of thinking as well as a good product technology were highlighted.

Last categories are company culture and international business concept, which both got two answers with comments; company cultures where people are important and company respect employees are important.

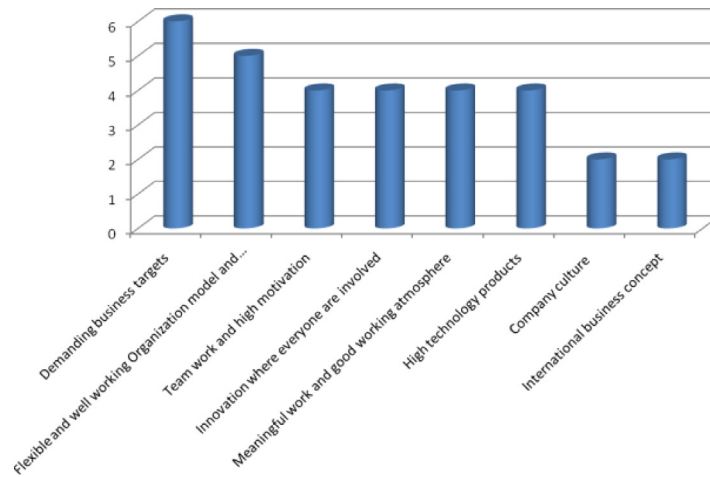


Fig. 4. Ideal company profiles.

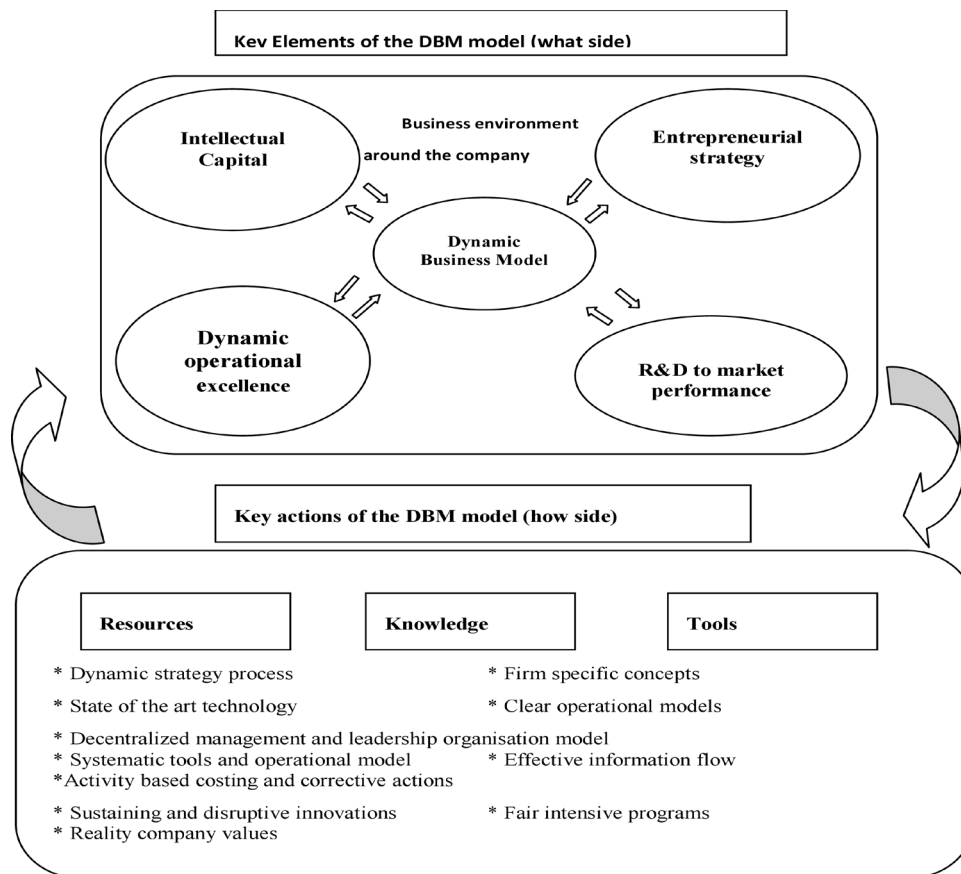


Fig. 5. Simplified Dynamic Business Model .

Dynamic capabilities in high technology power electronics field

Based on the analyses, previous studies, and interviews that were made, we can summarize following simplified model shown on the Fig. 5. First part of the figure shows the key elements and the second part shows actions that a firm should do to the key elements. The Fig. 5 also answers the first research question;

1st Qn; is it possible to create an efficient business model for power electronics firms which have operations in a turbulence business environment?

Company should have resources, knowledge and tools to make possible those mentioned actions to see the day light. Resources are people, finances, knowledge, and tools, which are needed so that employees can do the right things in the right way.

Figure 5 shows the most significant high-level actions while more detailed model is introduced later in this section including the links between the key elements and values as well as sub values.

The model has been developed for power electronics industry in a turbulent complex environment with global business. The Fig. 5 shows how the model is working at a higher level.

This model further described in a detailed list description of success factors or classes under the dynamic business concept, which are considered to be the most important factors in high technology power electronics field. In bold words are classes and subclasses are marked with “sc”, values marked with “v”, and sub values marked as “sv”. These letters are answering to the question on “what” and “how”. The ontology list below answers to the second and third research questions:

2nd Qn; What are the key elements of the model?

3rd Qn; How could the key elements be implemented?

Dynamic Business Model (DBM)**1.0 Entrepreneurial Strategy (c)**1.1 Dynamic strategy process (v)

1.1.1 Demanding business target (sv)

1.1.2 Company specific (sv)

1.1.3 International business concept (sv)

1.1.4 Networking (sv)

1.1.5 Continuous Improvement (sv)

1.2 Firm specific concept (v)

1.2.1 Credible, Simple, Feasible (sv)

1.2.2 Product concept (sv)

1.2.3 Process concept (sv)

2.0 R&D to market performance (c)2.1 State of the art technology (v)

2.1.1 Technology push products (sv)

2.1.2 Market Pull products (sv)

2.1.3 Appropriate product portfolio (sv)

2.1.4 Modular product platform (sv)

2.2 Clear operational model (v)

2.2.1 Concurrent engineering (v)

2.2.2 Cross functional “tiger” teams (v)

2.2.3 Fast time to market operations (v)

3.0 Dynamic operational excellence (c)3.1 Decentralized Management and leadershiporganisation model (v)

3.1.1 Team work with high motivation (sv)

3.1.1.1 Meaningful work (sv)

3.1.1.2 Good working atmosphere (sv)

3.1.2 Flexible organization model with fair leadership (sv)

3.1.2.1 Global operations with local actions (sv)

3.1.2.2 Cross functional teams (sv)

3.1.2.3 “Tiger” teams (sv)

3.1.3 Fast decision making process (sv)

3.1.4 Right Partners (sv)

3.1.5 Systematic planning process (sv)

3.1.6 Trust (sv)

3.1.6.1 Openness (sv)

3.1.6.2 Empathy (sv)

3.1.6.3 Customer Loyalty (v)

3.1.6.4 New market segment (v)

3.2 Systematic tools and operational model (v)

3.2.1_Standardization (sv)

3.2.2_Modularization (sv)

3.2.3 Mass Customization (sv)

3.2.4 Product data management (sv)

3.2.5 Pull control (sv)

3.2.6 High amount of sales variants (sv)

3.2.7 Wide sales channel (sv)

3.2.8 Effective service process (sv)

3.2.9 Continuous improvement system (v)

3.3 Effective information flow (v)

3.3.1 Cloud computing systems (sv)

3.3.2_Global information sharing and data sourcing system (sv)

3.3.3 Automated data collection systems (sv)

3.3.4_Knowledge service system (sv)

3.4 Activity based costing and corrective actions(v)

3.4.1 Growth tracking (v)

3.4.2 Profitable tracking (v)

3.4.3_Financing tracing (v)

3.4.4_Sustainability resilience (v)

3.5 Creating, integrating, recombining and releasing resources (sc)**4.0 Intellectual capital (c)**4.1 Sustaining and disruptive innovations (v)

4.1.1_Process innovativeness (sv)

4.1.2_Product innovativeness (sv)

4.2 Fair Incentive programs (v)

4.2.1 Bonus system based on Firm’s success (sv)

- 4.2.2 Everyone involved (sv)
- 4.3 Reality company values (v)
- 4.3.1 Work feedback (v)
- 4.3.2 Systematic tools (v)
- 4.3.3 Trust (v)
- 4.3.4 Fair play (v)
- 4.3.5 Firm's spirit based on success

Conclusion

The study in this paper suggests a model in Fig. 5 that can be used by organisations that are in power electronics industry, to be successful in a turbulent market environment. This model combines the theory of science and methodology. The models' methods and its paradigm have an influence on the research problem, and it is implemented in this research. The contribution achieved from the research, could suggest that, organisational management should have a competent entrepreneurial strategy that is unique.

Fresh ideas are necessary to be successful in changing business environment where, firm specific concepts together with software are generally running the most important role, making customization work easier, and creating a wider amount of product features. This means that it is possible to increase the revenue very fast by having no additional investment to the stocks. The Dynamic business model represent in the study suggests a new way of thinking and making it easier for managements to make the right decision in company perspective as well as customers' view. The model combines most important key elements, links actions to the key elements making it possible to create a more profitable business.

It appears that firm's size as well as globalization affects the importance of classes defined above. We can summarize that high technology companies operating on an international level need wider competence and knowledge platform than local companies. Some of the significant categories are listed below:

- Entrepreneurial strategy;
- R&D to market performance;
- Dynamic operational excellence;
- Intellectual capital.

Entrepreneurial strategy, effective processes, innovativeness, and dynamic capabilities, which take environment changes to the account, are one way to develop a more agile customer oriented company. Working in collaboration with customers and partners is crucial. It helps to understand the customer needs more deeply and to respond to the customers' demand faster; flexible, and more agile processes to support the changing customer needs. The aim of this study was to develop a business model and to

analyze factors that are most significant in power electronic business industry. One of the key findings inside the model was the importance of efficient information flow in a global business.

Many other industries have similar challenges like power electronics industry presented in the study. For further studies, we recommend verifying the model in the start ups companies as well as within other industrial branches, which are technology and knowledge driven businesses with many products, delivered in a turbulence business environment.

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