Mode switching from component manufacturer to system supplier - requirements, opportunities and best practices. A resource-based reflection on R&D.

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Declaration

This is to certify that, except where specific reference is made, the work described in this thesis is the result of the candidate. Neither this thesis, nor any part of it, has been presented, or is currently submitted, in candidature for any degree at any other University.

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07.01.2014, Matthias Karl Wilhelm Bandorf

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This thesis is dedicated to my father who left this beautiful place much too soon.

Abstract

Manufacturing industry is facing a dramatic transition; many enterprises find themselves caught in rapidly changing and intensified competition structures with increasing pressure to develop innovative solutions in ever shorter cycles. This issue presents a massive threat for component manufacturers today, as it suggests that excellence of technical components is no longer a guarantee of maintaining market position. One way of addressing this challenge, which is investigated within this study is mode switching - evolution into the next product hierarchy, namely moving from the development and manufacturing of sole components, towards the supply of more complex systems.

An initial review of the extant literature revealed a gap. To date no research had examined mode switching into an advanced product hierarchy, highlighting best practice or key considerations, from a real life business perspective. Moreover, the understanding of component, module and system had not been defined consistently in the current literature.

To address this gap, this research focused on providing a professional real life view, representing a comprehensive perspective of *´mode switching from component manufacturer to system supplier´*. In addition, this research applied a practical approach in developing a conceptual framework to support companies that are evolving to the next product hierarchy, while also compiling a novel definition of component and system in an applied context. A qualitative multiple case study approach was adopted based on interviews. In total, 24 face-to face semi-structured interviews were conducted to glean senior management views from original equipment manufacturers, component manufacturers, system suppliers, academia, and business consultants.

This thesis contributes to knowledge and practice in four ways: *fundamental, methodological, normative and conceptual*. The *fundamental* contribution is a knowledge matrix, which is an extensive information base concerning mode switching to an advanced product hierarchy. The *methodological* contribution is an aspect model and the advancement of the 4Ps innovation model. The *normative* contribution to knowledge and practice provides new understanding with reference to product hierarchy and its subdivision into component and system. The *conceptual* contribution of this thesis is the development of a conceptual framework which will provide a significant and effective resource for companies concerned evolving into the next product hierarchy.

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List of Acronyms

Acronym	Description
ASA	American Sociological Association
Bp x	Best Practice Case No. x
BPS	British Psychological Society
BSA	British Sociological Association
BYD	Build Your Dream
CEO	Chief Executive Officer
CMMI	Capability Maturity Model Integration
CO_2	Carbon dioxide
CTO	Chief Technology Officer
Cx	Case No. x
DEC	Digital Equipment Corporation
DVD	Digital Versatile Disc / Digital Video Disc
ERRC	Eliminate-Reduce-Raise-Create
ESRC	Economic and Social Research Council
Exx	Expert No. xx
FAIR	Fairly - Autonomy - Integrity - Results
FMEA	Failure Mode and Effects Analysis
ibid	in the same place
IBV	Institution-Based View
IEEE	Institute of Electrical and Electronics Engineering
JiT	Just in Time
MBV	Market-Based View
MGI	McKinsey Global Institute
OECD	Organisation for Economic Cooperation and Development
OEM	Original Equipment Manufacturer
PARC	Palo Alto Research Centre
PC	Personal Computer
QFD	Quality Function Deployment
Qx	Interview question No. x
R&D	Research and Development
R-A	Resource-Advantage
RBV	Resource-Based View
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RQx	Research Question No. x
SBU	Strategic business unit
SME	Small and Medium-Sized Enterprise

SRA	Social Research Association
SUV	Sports Utility Vehicle
SWOT	Strength, Weaknesses, Opportunities, Threats
t_1	Current business (product hierarchy) of the company
t_2	Status after mode switching towards the next product hierarchy
t_3 & t_4	Status after mode switching towards a even more advanced level
TV	Television Set
Tx	Thematic Category No. x
UK	United Kingdom
UMIST	University of Manchester Institute of Science and Technology
USP	Unique Selling Proposition
VDMA	German Engineering Federation
VRIN	Valuable, Rare, Imperfect Imitable, (Non) Substitutability
VRIO	Valuable, Rare, Imitate, Organisation
WZL RWTH	Machine Tool Lab of Aachen University

1. Introduction

This chapter introduces the reader to the background within which the research is situated. The research focus and research aim are presented, methodological considerations and the research structure outlined.

1.1. About the author and his organisational context

Matthias K. W. Bandorf holds degrees in mechanical engineering, business and engineering, as well as economics. He started his professional life working with a global insurance company as a business consultant, later changing into loss adjustment for industrial risks. Followed by engagements in the materials handling business heading corporate planning & controlling and as project manager within an international medical and hygiene products enterprise. Within Schaeffler, firstly he was in charge of strategy development; presently he is holding the position of director ´New Business Development´ within the industrial division. The responsibility of ´New Business Development´ is ranging from the identification through to the implementation of new businesses. Today the company predominantly is engaged in the component business, but recognising strong demand for developing/supplying more complex solutions. Since representing new business development, however not having existent a suitable procedure/framework guiding the company to evolve into a higher product hierarchy, research improving the understanding and awareness of mode switching into a higher product hierarchy taken from real life scenarios was required.

"Schaeffler is a leading manufacturer of bearings worldwide and a renowned supplier to the automotive industry. The globally active group of companies, which is based in Herzogenaurach, Germany, generated sales of approximately 11.2 billion Euros in 2013. With around 79,000 employees worldwide, Schaeffler is one of the largest German and European industrial companies in family ownership. Schaeffler AG develops and manufactures precision products for everything that moves – in machines, equipment, and vehicles as well as in aviation and aerospace applications. With approximately 170 locations in 49 countries, Schaeffler has a worldwide network of manufacturing locations, research and development facilities, sales companies, engineering offices, and training centers. Customer proximity is important for the development of market-specific products, and for short delivery times and rapid service. The Industrial Division supplies

rolling bearing and plain bearing solutions and linear and direct drive technology for around 60 different industrial sectors via its worldwide organisation with market proximity and application support service" (Schaeffler 2013).

1.2. Establishing the research territory

The manufacturing industry stands in the middle of a dramatic transition. Many enterprises find themselves caught in rapidly changing and intensified competition structures. There is increasing pressure to develop innovative solutions in ever shorter cycles (Herstatt and Lettel 2000; Vanhaverbeke and Peeters 2005). The forces behind this acceleration are for the most part well known; new technologies, shortened product life cycles, and new competitors shaking up whole industries (Capon and Glazer 1987; Cooper, Edgett and Kleinschmidt 2001; Valentin 2001). A survey of the McKinsey Global Institute (2012) impressively illustrates this change and how countries competing globally are making headway (Figure 1.1).

Rank	1980	1990	2000	2010
1	United States	United States	United States	United States
2	Germany	Japan	Japan	**China**
3	Japan	Germany	Germany	Japan
4	United Kingdom	Italy	**China**	Germany
5	France	United Kingdom	United Kingdom	Italy
6	Italy	France	Italy	Brazil
7	**China**	**China**	France	South Korea
8	Brazil	Brazil	South Korea	France
9	Spain	Spain	Canada	United Kingdom
10	Canada	Canada	Mexico	**India**
11	Mexico	South Korea[1]	Spain	**Russia**[2]
12	Australia	Mexico	Brazil	Mexico
13	Netherlands	Turkey	Taiwan	**Indonesia**[2]
14	Argentina	**India**	**India**	Spain
15	**India**	Taiwan	Turkey	Canada

1 South Korea ranked 25 in 1980.
2 In 2000, Indonesia ranked 20 and Russia ranked 21.
NOTE: Based on IHS Global Insight database sample of 75 economies, of which 28 are developed and 47 are developing. Manufacturing here is calculated top down from the IHS Global Insight aggregate; there might be discrepancy with bottom-up calculations elsewhere.
SOURCE: IHS Global Insight; McKinsey Global Institute analysis

Figure 1.1 Top 15 manufacturers by share of global nominal manufacturing gross value added (McKinsey Global Institute 2012:2)

Other reasons driving this process are predominantly seen in the continuous increase in product complexity with simultaneous demands for cost reduction (Soppe 2007; Thomas, Francis, John and Davies 2012). This situation is also evidenced by a Bain survey (Zook 2007a), analysing the fate of Fortune 500 companies during a ten year period. Nearly 60% of those companies faced serious threats, and about 50% of them fundamentally altered their business model to survive. In this context Zook (2007b) claimed that companies which in the past prospered by simply reproducing their business model may soon run out of new territory to conquer. This position is supported by Gassmann, Frankenberg and Csik (2013:1) who stated:

"There are many companies with excellent technological products. […] Yet, many companies will not survive in the long term despite their product innovation capabilities. Why do prominent firms, […] which have been known for their innovative products for years, suddenly lose their competitive advantage? […] The answer is simple and painful: these companies have failed to adapt their business models to the changing environment. In future, competition will take place between business models and not just between products and technologies".

Due to such circumstances and to reduce complexity and cost of product developments, OEMs[1] intensify their co-operation rate with system suppliers to the disadvantage of sole component manufacturers. As a result, excellence in the development and manufacturing of technical components is no guarantee of maintaining the current business position into the future. Adjustments in component prices and functions narrow down the possibilities available to push the boundaries of differentiation between competitors on a component level.

"Companies that stick to business-as-usual approaches will be increasingly at risk. Manufacturers will no longer succeed by 'copying and pasting' old strategies into new situations. They must develop a granular understanding of the world around them – and plan the operations strategy to compete in it" (McKinsey Global Institute 2012:12).

This circumstance presents massive threats for component manufacturers, since excellence of technical components possibly no longer guarantees maintaining today's business position. However this serious

[1] OEM: Original Equipment Manufacturer

challenge may provide huge opportunities to firms who try to maintain their market position. This thesis investigates mode switching as a way of addressing this challenge. Mode switching refers to the transformation from one stage of a business model into a different one, usually at an advanced product hierarchy. Mode refers to the current business design of a company and to the aspirational design in the future. For component manufacturers mode switching implies the evolution into the next product hierarchy. This evolution is the development and manufacturing from sole components towards the supply of more complex systems.

The challenges and requirements facing a component manufacturer today are typically different compared to those facing a system supplier. Consequently, this research is aimed at offering guidance for companies who are currently on a component manufacturer level but who intend to evolve into a system business. Key aspects to be considered when performing a mode switch to an advanced product hierarchy include the intended innovation mode, organisational structure, and associated resources and competencies. A significant number of models and concepts concerning innovation mode and organisational structure are available (Schumpeter 1950; Ford and Ryan 1981; von Hippel 1988; Henderson and Clark 1990; Höft 1992; Deng 1995; Merkamm and Weber 1996; Greiner 1998; Bleicher 1999; Gomez and Zimmermann 1999; Fink 2000; Danneels 2002; Chesbrough 2003; Christensen and Raynor 2003; Kim and Mauborgne 2005; Tidd, Bessant and Pavitt 2005; Christensen 2006; Simon 2008; Herrmann 2010; Gassmann, Enkel and Chesbrough 2010; Lichtenthaler 2011; Williams 2011). However, being successful as a company is a complex combination of different resources, capabilities, knowledge sources and a flexible organisational framework that has the ability to respond to market and technology changes either within the existing organisation or, if necessary, with new and different arrangements. The significance of resources and competencies for company success and the ability to obtain competitive advantage are discussed comprehensively in the literature (Penrose 1959; Wernerfelt 1984; Barney 1986; Dierickx and Cool 1989; Henderson and Clark 1990; Prahalad and Hamel 1990; Barney 1991; Grant 1991; Mahoney and Pandian 1992; Hamel and Prahalad 1993; Kay 1993; Hunt and Morgan 1996; Teece, Pisano and Shuen 1997; Priem and Butler 2001; Sun and Tse 2009). A number of models and frameworks have been introduced that recognize the resources/competencies necessary to achieve a competitive advantage namely the resource-product matrix by Wernerfelt (1984), the VRIN/VRIO framework by Barney (1991, 2009), the roots of competitiveness by Prahalad and Hamel (1990), the five stage framework for strategy formulation by Grant

(1991), and the competitive position matrix by Hunt and Morgan (1996). However, their application to mode switching is not appropriate, as these models can be quite abstract and/or lack in operational validity (Priem and Butler 2001). Moreover, these models are mostly theoretical with limited application to practice and thus not suitable for use in a business scenario. Furthermore, core competencies are generally not the result of a single activity (Crainer 1998) and thus are not easy to duplicate, especially since their measurability and verifiability mostly proceeds ex post (Tidd, Bessant and Pavitt 2005). Thus, regardless of how sophisticated the models/concepts for the identification and the development of enhanced products and solutions are, they are unlikely to be successful unless the required organisational framework fits. Moreover, new business designs that increase product hierarchy develop into a company-wide task that creates strong pressure for organisational change towards more flexible models. Differing types of product hierarchy require different organisational modes or frameworks. Nevertheless changing existing and established structures is difficult because of resource allocation practices (Bower 1970; Prahalad and Hamel 1990; Kim and Mauborgne 2005; Christensen 2006) and path dependent reasons (Mintzberg 1987; Dierickx and Cool 1989; Barney 1991; Hunt and Morgan 1996; Teece, Pisano and Shuen 1997; Greiner 1998; Valentin 2001; Tidd, Bessant and Pavitt 2005; Barney and Clark 2009). Changes in the organisational framework must face and overcome significant barriers to be successful. A new product/solution must find legitimacy against established products, departments and mindsets by convincing stakeholders of its importance for the company and its future.

However, product enhancement often arise in the eye of the beholder, what someone calls new or even radical, may be well known by another. Furthermore the meaning of component, module and system has not been defined consistently in literature resulting in the current definition of product hierarchy depending on the viewer’s standpoint. There is no research that has examined real life businesses who have engaged in mode switching into an advanced product hierarchy. Research in this area will highlight best practice and underline the aspects that need to be considered. This emphasises the need to enhance the discussion to improve the understanding and awareness of mode switching into a higher product hierarchy. Due to the gap in the literature, this research focuses on providing a professional view taken from real life, representing a comprehensive perspective on ´mode switching from component manufacturer to system supplier´.

1.3. Research focus and research aims

This dissertation seeks to improve understanding and awareness of mode switching into a higher product hierarchy from the point of view of product development within the field of manufacturing industries. The research aim provides a professional view taken from real life, representing a comprehensive perspective on enabling *´mode switching from component manufacturer to system supplier´*. This research study involves the field of research and development (R&D). Other functions and areas of the company are considered only in the form of how they interfere with this field. This doctoral dissertation has not been constructed to cover every point in detail. Rather, it is concerned with recognising requirements in principle and providing general findings and then combining them into a practicable approach. The focus of this research study is the investigation of the various views within industry to provide an effective procedure for component manufacturers to evolve into and fulfil the requirements of a system supplier. More specifically this research is concerned with exploring the essential resources and competencies, organisational issues, and customer expectations, necessary for firms intending to mode switch into a higher product hierarchy. Further, identifying challenges and opportunities arising from evolving into a system business, as well as gaining knowledge of preferred approaches and methods is required. Finally it is the aim of this research to consider and relate these aspects within a conceptual framework, supporting companies to move more effectively into the next product hierarchy, in example, from component to system.

In a first step the research topic was compared with the existing literature examining the subsequent questions.

- Why do enterprises aspire to change their current business model?
- What are the opportunities these enterprises hope to gain?
- What are the challenges confronting these enterprises?
- What is a practical approach to achieve success at mode switching from component manufacturer to system supplier?

In a further step these initial questions have been duly appropriated into seven thematic categories (aims), namely (T1) causes and benefits, (T2) OEM expectations, (T3) challenges, (T4) definitions, (T5) organisational requirements, (T6) resources and competencies, and (T7) approaches and methods. In order to support the research questions posed by the research topic and, to bridge the identified gap in the literature, the following aims required completion:

(T1) Classifying the incentives for enterprises performing mode switching and their associated advantages.

(T2) Identifying customer expectations in order to satisfy market demand with mode switching.

(T3) Identifying challenges enterprises encounter when performing mode switching.

(T4) Developing a common definition of product hierarchy[2] and its subdivision into component, module and system.

(T5) Classifying organisational requirements for mode switching and providing ways to link with a companies' history and path dependent organisation.

(T6) Identifying necessary resources and competencies required for an enterprise to evolve into a higher value-added stage.

(T7) Providing a framework that enables and guides enterprises that are mode switching to a higher value-added stage.

Therefore a qualitative multiple case study approach comprising senior management views from OEMs, component manufacturers, system suppliers, academia, and business consultancy was adopted with 24 face-to face semi-structured interviews. With respect to the research design, firstly the cases were utilized illustrating best practice scenarios viewing the topic *´mode switching´* from the perspectives of different

[2] Product hierarchy sometimes also is called product complexity; however the meaning at this research is not related to complexity theory.

industrial tiers. Secondly these five best practice cases were compared to check for cross case synthesis. The subdivision within the cases and the cross case synthesis was in line with the seven thematic categories, highlighting the important findings necessary to analyse so as to contribute to knowledge. Thirdly the seven thematic categories of the five cases and the cross case synthesis were contrasted with the known literature in order to support the thesis research questions. Finally, a conceptual framework was developed to provide practical support to companies that are evolving into the next product hierarchy; and a new definition of component and system in an applied/practical context has been developed and introduced.

1.4. Synopsis of the thesis structure

This doctoral thesis is concerned with identifying requirements, assessing opportunities and best practices in relation to mode switching into a higher product hierarchy. This thesis will contribute to knowledge and practice by providing a conceptual framework for firms wishing to switch from component manufacturers to system suppliers. The content of this thesis is segmented into six chapters, chapter one introduces the research topic, chapter two investigates the existing literature, chapter three illustrates the underlying methodology, chapter four and five provide the primary research and in chapter six conclusions are drawn. The content of each chapter is outlined in more detail below.

Chapter 1 introduces the reader to the research area. The research focus and the research aims are illustrated, plus methodological considerations and the research structure are outlined.

Chapter 2 reviews the literature on strategy formulation with focus on the resource-based theory and innovation with its effects on organisational change. It is organised into three sections. The first section summarises the main strategy options then examines the literature of the resource-based view (RBV), and its main proponents. The second section reviews the literature on types of innovation, technological changes, and their influence on organisations. In both sections theories and proposed models are examined. The third section suggests areas for further research.

Chapter 3 presents the underlying methodology of this research. The chapter outlines the selection of suitable research methods that are required to complete the thesis aim. It is organised into six sections. The first section provides an overview of the existing literature on the research topic. The second section establishes the research focus and the aim of the study. Within the third section, the potential appropriate research designs, quantitative survey and case study research are evaluated. The fourth section describes the research process considering the issues of research preparation, data collection and data analysis. Within the fifth section ethical considerations are covered. Lastly the preceding sections are summarised and conclusions drawn.

Chapter 4 illustrates the analysed data based on the findings gained from expert interviews conducted. The received interview statements are grouped - depending on the origin of the interviewee - into one of the five cases namely OEM, component manufacturer, system supplier, academia, and business consultancy. Each of the five cases is analysed to examine the experts' standpoint regarding the thematic categories (T1) causes and benefits, (T2) OEM expectations, (T3) challenges, (T4) definitions, (T5) organisational requirements, (T6) resources and competencies, and (T7) approaches and methods. Thereafter, a cross case synthesis is undertaken, in order to link findings across the cases and to draw conclusions.

Chapter 5 discusses the findings of the single cases and the cross case synthesis in contrast with the known literature. Firstly, the findings relating to the causes and benefits from thematic category (T1) are reflected. Secondly, OEM expectations (T2), and challenges (T3) are both contrasted and discussed. Thirdly, the thematic category (T4) is discussed and a new definition with respect to product hierarchy is framed. Fourthly, a critical reflection and discussion of both organisational requirements (T5) and resources and competencies (T6) is prepared. Thereafter, approaches and methods corresponded (T7) are reflected upon: and a conceptual framework from evidence identified and discussed within the categories T1-T7 is presented. Finally, general implications with respect to the research questions RQ1 and RQ2 representing the rationale for the conceptual framework are presented.

Chapter 6 presents concluding thoughts. Within this chapter, the findings of this research study provide a professional perspective taken from current business practice. This represents a comprehensive analysis enabling mode switching from a component manufacturer to a system supplier. Firstly, the research aim and the need for this study are considered. Also, the research questions of this thesis and an introduction to the research methodology applied are presented. Secondly, the implications of this thesis for practice and their relevance for enterprises considering mode switching into a higher product hierarchy are illustrated. Thirdly, the contribution to knowledge within the investigated field of this research is appraised. Fourthly, the limitations of the research study are recognised. Fifthly, areas for future beneficial research are identified. Lastly, the key issues of this research study are summarised.

2. Literature Review

This chapter reviews the literature on strategy formulation with focus on the resource-based theory and innovation with its effects on organisational changes. It is organised as follows: The first section summarises the main strategy options then examines the literature of the resource-based view (RBV), and its main proponents. The second section reviews the literature on types of innovation, technological changes, and their influence on organisations. In both sections theories and proposed models are examined. The third section gives a conclusion indicating areas for further research.

The research framework combines strategy due to the resource-based theory, technological changes and different innovation styles, with the focus on product development from the specific perspective of a component manufacturer in the industrial industry.

2.1. Introduction / Field of Research

"The strategic landscape changes continually in ways that favour some contestants at the expense of others. In particular, societal values change, laws change, firms and customers learn, markets grow, and technological advantages create new possibilities and cost structures" (Valentin 2001: 61). Consequently, to secure stable entrepreneurial success, the reliable and in particular successful creation of product and service innovations more than ever evolves into a central challenge of each business enterprise (Schuh, Lenders and Schöning 2007). According to a study by Roland Berger Strategy Consultants, the challenges to increase future possibilities are not only limited to meeting the demands of the customers for customised solutions but also to meet that demand in a timely fashion. Rather it is essential, to open up dynamic markets with newly developed and innovative products and to adapt the firm's structures to market requirements (VDMA, WZL RWTH Aachen and Roland Berger Strategy Consultants 2007). Danneels (2002:1095) in this regard notes *"organisations need to continuously renew themselves if they are to survive and prosper in dynamic environments. This renewal challenge is even more pronounced in the current business environment characterized by fast changes in customers, technologies, and competition. […] Underlying this strong interest is the notion that ′really new′ products are crucial to firm survival in the current fast-changing business environment"*. In this context, the umbrella organisation of the German

manufacturing and plant engineering business VDMA, estimates that in the middle term, a change in integration and the allocation of role of the suppliers within the value added process will take place (VDMA, WZL RWTH Aachen and Roland Berger Strategy Consultants 2007). The differentiation and positioning of the participants within the value chain in the use of this study is as follows: end producer (OEM), system supplier (1st tier), module supplier (2nd tier) and component supplier/ manufacturer (x tier) (Meyer, Rauen, Tilebein and Gleich 2010). Stefan (2005) observed that a majority of the multinational, large-scaled enterprises intensified their co-operation rate with system suppliers. The reasons that drive this process are predominantly to be seen in the continuous increase in complexity of the final products with simultaneous demands for cost reductions. Beyond that, such strategy enables the OEM to reduce risks concerning quantity, stock, and development, as well as transferring the costs of research and development to external suppliers (Soppe 2007). In her analysis of the increasing specialisation of end producers, Soppe (2007) comes to the conclusion that not only OEMs, but also the majority of the first tier suppliers, increasingly reduced their value chain during the investigation period of 20 years (1983-2002). This offers a significant opportunity for component manufacturers, if accepted as a challenge seriously.

2.2. Strategy

"What is strategy? For a great many managers in large Western companies, the answer centers on three elements: the concept of fit, or the relationship between the company and its competitive environment; the allocation of resources among competing investment opportunities; and a long-term perspective in which ′patient money′ figures prominently. From this perspective, ′being strategic′ implies a willingness to take the long view, and ′strategic′ investments are those that require a large and pre-emptive commitment of resources - betting bigger and betting earlier - as well as a distant return and substantial risk. This dominant strategy frame is not wrong, only unbalanced. That every company must ultimately effect a fit between its resources and the opportunities it pursues, that resource allocation is a strategic task, and that managers must often countenance risk and uncertainty in the pursuit of strategic objectives all go without saying" (Hamel and Prahalad 1993:77).

Hofer and Schendel (1978:12) simply define strategy as *"the match an organisation makes between its internal resources and skills ... and the opportunities and risks created by its external environment"*. Grant (1991:116) however gives a more extensive explanation of strategy formulation and hence resulting actions by stating: *"The starting point for the formulation of strategy must be some statement of the firm's identity and purpose - conventionally this takes the form of a mission statement which answers the question: What is our business? Typically the definition of the business is in terms of the served market of the firm: e.g., Who are our customers? and Which of their needs are we seeking to serve? But in a world where customer preferences are volatile, the identity of customer is changing, and the technologies for serving customer requirements are continually evolving, an external focused orientation does not provide a secure foundation for formulating long-term strategy. When the external environment is in a state of flux, the firm's own resources and capabilities may be a much more stable basis on which to define its identity"*. A comparable position is taken by Prahalad and Hamel (1990:83), when they comment, *"since companies are in a race to build the competencies that determine global leadership, successful companies have stopped imagining themselves as bundle of business making products [...] in the core competencies underlying them, disparate business become coherent"*. Moreover, they claim *"the essence of strategy lies in creating tomorrow's competitive advantages faster than competitors mimic the ones you possess today"* (Hamel and Prahalad 1989:69).

The above mentioned approaches emphasise the organisations own set of resources as a decisive factor of competitive advantage. Beyond that Porter's (1980) industry analysis with the market-based approach still remains important and both approaches can be used in a complementary way. For each company it is not reasonable to neglect the sector of industries within which they operate, but on the other hand they should not do this at the expense of missing new business opportunities. Moreover, Peng, Wang and Jiang (2008) argue, that for answering the question of *´what drives firm strategy´* the market-based view (Porter 1980) with its external perspective and the resource-based view (Prahalad and Hamel 1990, Barney 1991, Grant 1991) with its internal perspective needs to be extended by a third leg, namely the institution-based view which focuses on political, legal, and social aspects. Peng, Wang and Jiang (2008) call the connection between industry-based competition, firm-specific resources and capabilities, and institutional conditions and transactions the *´strategy tripod´* (Figure 2.1).

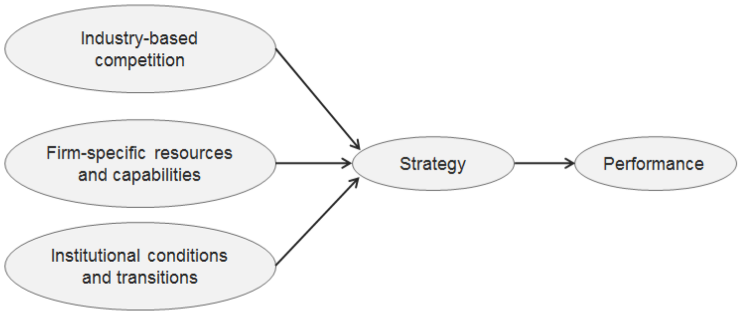


Figure 2.1 The institution-based view: a third leg of the strategy tripod (Peng, Wang and Jiang 2008:923)

2.2.1. Overview Strategy Options

Thinking of strategies and organisational changes in business there are three ways to analyse an organisation; the *institution-based view*, the *market-based view,* and the *resource-based view*. This section describes the main content of the three different approaches in order to focus on the resource-based view in detail subsequently.

2.2.1.1. Institution-based View (IBV)

The *institution-based view* focuses on the political, legal, and social aspects (Peng, Wang and Jiang 2008). Core statements backing up the institution-based view are: individuals and companies act rationally according to formal and informal institutional structures. When formal institutions fail, informal institutions regulate exchange relationships (Peng and Khoury 2009). According to North (1990:3), institutions are *"the rules of the game in a society or, more formally, are the humanly devised constraints that shape human interaction"*. Similarly, Scott (1995:33) defines institutions as *"cognitive, normative, and regulative structures and activities that provide stability and meaning to social behaviour"*. Consequently, an *"institutional framework"* is defined by Davis and North (1970:6) as *"the set of fundamental political, social, and legal ground rules that establishes the basis for production, exchange, and distribution"*. Given the influence of institutional frameworks on firms' behaviour, any strategic choice that enterprises make is inherently affected by the formal and informal constraints of a given institutional framework (North 1990; Oliver 1997). Treating institutions as independent variables, an institution-based view on business strategy therefore focuses on the dynamic interaction between institutions and organisations, and considers strategic choices as the outcome of such an interaction (Peng 2002). In terms of practical benefits, an institution-based view can help enterprises in emerging economies to enhance their competitiveness, especially when venturing abroad. Further examples for institutional interactions are the area of antidumping, China's five-year plans, Europe's CO_2 or REACH[3] (Registration, Evaluation, Authorisation and Restriction of Chemicals) regulations.

2.2.1.2. Market-based View (MBV)

The *market-based view*, first discussed by Porter (1980), argues that conditions within an industry, to a large extent, determine the firm's strategy and performance. In the market-based view, enterprises are largely seen as being homogeneous, and competition is seen as occurring via positioning in markets. Characteristic of the market-based view is its outside-in perspective, the management's main task therefore is to evaluate and analyse the business environment in order to place the own company in the most attractive branch afterwards. *"While resources represent what can be done, the competitive environment represents what must be done to compete effectively in satisfying customer needs"* explain Priem and Butler (2001:23) and they describe the principal assumption of the market-based view. They consider the company itself as a black box and concentrate primarily on external impacts. With the market-based view, the strategic challenge is seen as identifying attractive markets to compete in - attractive markets being ones with characteristics identified by the analysis of Porter's five forces: bargaining power of suppliers, bargaining power of customers, threat of new entrants, threat of substitutes, and competitive rivalry between existing players (Porter 1980). In the market-based view the company itself is of low interest, the right evaluation of the market potential being the important factor. From this it is derived that the company's success is solely defined by its competitive market environment. What is not asked in the market-based view is whether the market opportunity is one that can be exploited by the enterprise in question – that is, does the company have the resources and competencies to compete in this market? Interesting in this context is the attitude of the market-based view concerning resources: *"Resources are not valuable in and of themselves, but because they allow firms to perform activities that create advantages in particular markets"* (Porter 1991:108). Intrinsic company characteristics or specific skills are disregarded. A company is considered as a combination of product – market positions. The difference in perspective is highlighted by Levitt (1975). In his article, Levitt argues that the problem of many firms is that they define their market too narrowly. He

[3] REACH is the European Community Regulation on chemicals and their safe use (EC 1907/2006). REACH addresses the production and use of chemical substances, and their potential impacts on both human health and the environment.

gives the example of the railway industry, arguing that railway firms should see themselves as being in the transportation business, not the railway business. He argues that this change in perspective would open up new opportunities for growth; *"once it genuinely thinks of its business as taking care of people's transportation needs, nothing can stop it from creating its own extravagantly profitable growth"* (Levitt 1975:6). What this advice does not take into account is, whether the railway firms have the resources to compete in other transportation industries. Could these firms realistically manage a fleet of trucks, an airline or even a shipping fleet? Adopting the resource-based view would approach the railway question from the inside out when developing the strategy. The focus would be on what resources the railway firm has and how these resources can be leveraged in different ways. Maybe the resources of the railway firm would be better suited to expand into civil engineering or information technologies? *"The outside - in approach reflects conventional marketing wisdom embodied in the maxim 'find needs, then fill them'. It begins with a search for market voids - i.e., customers or needs not satisfied by extant offerings. Subsequently, attention turns toward identifying and, if necessary, obtaining R&Cs [resources & capabilities] required to fill seemingly attractive voids"* (Valentin 2001:62).

2.2.1.3. Resource-based View (RBV)

The cornerstone of the *resource-based view* was set by Penrose (1959). She argues that the basis for the uniqueness of a company is grounded in the quality of its resources: *"A firm is more than an administrative unit; it is also a collection of productive resources the disposal of which between different users and over time is determined by administrative decision"* (Penrose 2009:21). However, for a long time no attention was paid to her findings about the importance of resources for a company's success. The resource-based view started to be widely discussed during the late 1980s and the beginning of the 1990s (Barney 1986; Prahalad and Hamel 1990; Barney 1991; Grant 1991; Mahoney and Pandian 1992; Hamel and Prahalad 1994). This view recognises the firm as a bundle of resources. It is these resources, and the way they are combined that make firms different from one another and in turn allow a firm to deliver products and services in the market. While it might seem obvious that firms are different because they are comprised of different resources, this perspective is a significant distinction from the market-based view. While it is important to recognise that firms are different, with different resources, this does not imply that the market is unimportant. The challenge is to identify opportunities in the market that are relevant to the resource base of the firm. Conversely, resources need to fit with their environment to deliver competitive advantage. This could be viewed in a Darwinian sense, in which the firms that have the resources best suited to the market are likely to perform the best. However, markets change so this means that a firm's resources also need to change over time to continue to be relevant to the marketplace (Teece, Pisano and Shuen 1997). In the literature company resources are generally quite loosely defined, tending to include everything internal to the firm. Barney (1991:101) lists *"all assets, capabilities, organisational processes, firm attributes, information, knowledge, etc."* as resources. If resources can be anything, internal to the firm, which are the most strategically important ones? One particular resource that is being increasingly viewed as important is knowledge. Barney (1991) in his model about sustainable competitive advantage, which coined the resource-based view, assumed four major requirements which define important resources: the resource must be valuable, rare, difficult to imitate and unable to be substituted. A common example of an enterprise following a resource-based strategy is Honda. Honda built its strategy around its strength in building petrol based engines. Honda started with small clip-on engines for bicycles, moved to motorbikes, marine engines, generators, and cars. Each of these products competes in quite different product markets, but leverages a common resource in the ability to build quality petrol based engines. RBV stresses the intrinsic capabilities of the company to achieve a sustainable competitive advantage in its industries. Hamel and Prahalad (1993) believe Porter's (1980) approach not wrong but, in their opinion, unbalanced. Conner (1991) in this context claims that the RBV both reflects a strong market-based approach and is at the same time unique. Mahoney and Pandian (1992) remark that the resource-based view contribute to strategy formulation by three main characteristics; 1. The RBV combines concepts from established strategy research with unique competencies of heterogeneous enterprises. Further, the RBV deals with implications regarding diversification strategy. 2. The RBV fits perfectly into the discussion of organisational economics. 3. The RBV can be used as a supplementary approach to industrial organisation analysis. The resource-based view observes companies and questions how those companies achieve and sustain competitive advantage when deploying resources. The RBV aim is to illuminate the *black box* enterprise.

2.2.2. Key voices of the resource-based view

This section reviews the key voices of the resource-based approach from its first mentioning to today's literature. The section is subdivided into three chapters, beginning with the historical roots and its main representatives Edith Penrose and Birger Wernerfelt, followed by the RBV pioneers Jay B. Barney, C.K. Prahalad, Gary Hamel and Robert M. Grant. This structure is selected, because most thoughts and approaches build on each other and correlate or complement further views.

2.2.2.1. Historical roots

Edith Penrose

The resource-based view has a long history, which stretches back to the year 1959 and Edith Penrose's book titled *´The Theory of the Growth of the Firm´*. Her research aim was to understand how companies grow and what the limits of growth are. She claims that research must focus on the internal factors to find why some enterprises are more successful than others.

The limits of market size, Penrose (2009:11) argues, are man-made and can be overcome by a shift in mindset *"the notion that markets limits the size of firms follows the assumption that a firm is tied to given products [...] if this assumption is dropped, [...] a different concept of the ′firm′ and a different type of analysis becomes more appropriate. With a different concept of a firm one can recognize that a ′firm′, when appropriate recourses are available, can produce anything for which a demand can be found or created, and it becomes a matter of taste or convenience whether one speaks of the ′market′ or the resources of the firm itself as the consideration limiting its expansion"*. With this finding, Penrose lays the foundation for the *inside-out* approach. It is not external factors like markets or industries decide the growth potential but rather the intrinsic capabilities of the firm. In her opinion the ideal growth of the company represents the balance between the exploitation of existing resources and the development of new resources. A company may generate profit not because of better resources, but rather by making better use of them because of the firm's unique competence (Penrose 1959). One way of making a more effective use of the companies resources and spreading the market is diversification and this can take place in three ways: *"(1) the entry into new markets with new products using the same production base; (2) expansion in* *the same market with new products based in a different area of technology; and (3) entry into new markets with new products based in a different area of technology"* (Penrose 2009:98). Beyond that Penrose pointed out, that *looking outside the box* and innovating, is another source for competitive advantage, which can be fed by latent capabilities (services) available in the company but not yet used, or not used in the right way. *"Unused productive services are, for the enterprising firm, at the same time a challenge to innovate, an incentive to extend, and a source of competitive advantage"* (Penrose 2009:76).

Penrose (2009) notes that the distinction between resources and capabilities (*services*) is important: *"it is never resources themselves that are the ´inputs´ in the production process, but only the services that the resources can render. The services yielded by resources are a function of the way in which they are used – exactly the same resource when used for different purpose or in different ways [...] provides a different service or set of services. The important distinction between resources and services [...] lies in the fact that resources consist of a bundle of potential services and can, for the most part, be defined independently of their use, while services cannot be so defined, the very word 'service' implying a function, an activity"* (Penrose 2009:22). Mahoney and Pandian (1992:366) put this in more modern terms, when they interpret that *"Penrose (1959) is suggesting that resources are stocks and capabilities (services) are flows. Dynamic capabilities are created over time and may depend on the history of the use of resources in an extremely complex (path dependent[4]) process. Path dependent capabilities provide the building blocks for the firm's strategic architecture of strategic complexity"*. How valuable or profitable a resource for a company is, depends on factors like time (when it is used), the way it is used, and the knowledge of the user of the resource. With increasing knowhow of using the specific resource, the value and the chance using them profitably rises. *"Of the services available, only a few can be profitably used by a given firm at a given time. Some of the services may be alternative use of the resource – if used for one purpose the resource cannot be used for another ... the possibilities of using services change with changes in knowledge"* (Penrose 2009:67-68). She noted that a resource must be ´valuable´, one of the four attributes Barney (1991) lists years later for sustainable competitive advantage; *"resources or services without a value are ´free´ goods and are universally"* (Penrose 2009:69).

[4] Path dependency is the effect that a firm's past has on its future, what makes catching up quickly impossible or very costly. (Dierickx and Cool1989; Valentin 2001; Barney and Clark 2009)

During her investigation, she observed that not only tangible resources (plant or equipment) like those considered by traditional economists have implications for the growth of the firm, but rather productive resources (intangible) as management teams or entrepreneurial skills represent competitive implications to a large extent. Penrose (1959) noticed that the resources controlled by companies could vary considerably by company and that companies are heterogeneous even within the same industry. Since the suggestion that the companies' intrinsic capabilities are the real source of competitive advantage, Penrose indicated two important requirements for what later became the foundation for the RBV. The firm must be seen as a bundle of resources, and *"it is the heterogeneity, not the homogeneity, of the productive services available from its resources that give each company its unique character"* (Penrose 2009:67).

Birger Wernerfelt

Possibly the first article which used the term *resource-based view* was published in 1984 by Birger Wernerfelt: *´A Resource - based View of the Firm´*. Wernerfelt intended to frame a theory based on resources of a firm, as an equivalent to Porter´s (1980) theory based on the company's position in the market. The reason Wernerfelt (1984) called his theory ´resource-based´ view was because he investigated the same competitive problem described by Porter (1980) from the perspective of resources. *"For the firm, resources and products are two sides of the same coin. Most products require the service of several resources and most resources can be used in several products. By specifying the size of the firm's activity in different product markets, it is possible to infer the maximum necessary resource commitments. Conversely, by specifying a resource profile for a firm, it is possible to find the optimal product-market activities"* (Wernerfelt 1984:171). He aimed to develop a tool to shift from focusing on products towards analysing a firm's resource position to establish resource position barriers - a direct analogy to Porters (1980) entry barriers - which provide competitive advantage. *"From the resource perspective, the product entry barriers translate into a resource position barrier, since it will be irrational for entrants to buy the resource necessary to compete in a market where excess capacity would lead to cut-throat competition and low returns"* (Wernerfelt 1984:174). With this translation of the product entry barrier into the resource position barrier, he unknowingly refers to some important parameters, which are later collected in Barneys (1991) VRIO (value, rarity, imitability and organisation) framework. In his view resources can possibly act as entry barriers. Therefore a resource should at least turn into an entry barrier in one market. Wernerfelt (1984) suggested establishing and expanding resources in one sector/industry, instead of entering several markets at once.

As resources Wernerfelt (1984:172) identified *"anything which could be thought of as a strength or weakness of a given firm. More formally, a firm's resources at a given time could be defined as those (tangible and intangible) assets which are tied semi-permanently to the firm. Examples of resources are: brand names, in-house knowledge of technology, employment of skilled personnel, trade contracts, machinery, efficient procedures, capital, etc"*.

In his opinion it is the resources of a company, which limit or narrow the market, and determine the profit a company expects. *"Looking at diversified firms as portfolios of resources rather than portfolios of products gives a different and perhaps richer perspective on their growth prospects"* (Wernerfelt 1984:178). Managing a resource portfolio is philosophically spoken of similar terms as managing a product portfolio, except that the growth potential with managing the resources is bigger. As an equivalent to Porter´s (1980) theory, Wernerfelt suggests, a company will achieve a competitive advantage if it can *"create a situation where its own resource position directly or indirectly makes it more difficult for others to catch up"* (Wernerfelt 1984:173).

Resource / Market	I	II	III	IV	V
A	x				x
B	x	x			
C		x		x	
D			x		x

Resource / Market	Production Skills	International Contacts	III	IV	Domestic Contacts
Domestic	x				x
International	x	x			
C		x		x	
D			x		x

Figure 2.2 Resource-product matrix (Wernerfelt 1984: 176,177)

As illustrated in Figure 2.2, Wernerfelt linked the dimensions market (MBV) and resources (RBV) together in one framework, in order to identify sources of competitive advantage for the company. To use the resource-product matrix, resources and products (markets) are filled in lines and columns, the importance of a resource in a product (market) and vice versa are shown as intersections. With this framework and the proposition, that *"resources and products (markets) are two sides of the same coin"*, Wernerfelt (1984:171) is one of the first to express the connection, coexistence and/or dependency between markets and resources to achieve a competitive advantage.

2.2.2.2. Pioneers

The resource-based theory got its breakthrough around the 1990s with the publications of Barney (1986, 1991), Prahalad and Hamel (1990) and Grant (1991), who later became the RBV key representatives in literature.

Jay B. Barney

The intention of Barneys (1986, 1991, and 2009) resource-based examinations is, to link firm resources and its influence on competitive advantage. In his opinion for a resource to be a source of sustained competitive advantage it must fulfil distinctive attributes.

Like other RBV advocates, Barney (1986) represents the view, that a firm will gain enhanced profit by analysing its internal resources, rather than the external environment (Porter 1980) *"from the point of view of firms seeking greater than normal economic performance, our analysis suggests that strategic choices should flow mainly from the analysis of its unique skills and capabilities, rather than from the analysis of its competitive environment [...] firms can attempt to develop better expectations about the future value of strategic resources by analysing their competitive environments or by analysing skills and capabilities they already control"* (Barney 1986:1231).

Barney (1991) illustrates his approach by using the SWOT[5] – analysis model, he argues, that firms obtain sustained competitive advantage by exploiting their internal strengths in order to respond on external opportunities, as they avoiding internal weaknesses, and ward off external threats. He notes that past research has focused largely on the external analysis by trying to isolate a company's opportunities and

[5] The SWOT analysis is an instrumental framework to identify the **S**trengths, **W**eaknesses, **O**pportunities and **T**hreats for a definite company.

threats (Porter 1980) to describe the environmental conditions of a company for identifying attractive industries to place own business into.

Sustained competitive advantages arise when a firm implements a strategy which is not executed by incumbents or potential competitors and cannot be imitated by them. In Barney's opinion, the origin of companies' competitive advantage is manifested in its resources. As Barney (1991:105) makes clear, *"of course not all firm resources hold the potential of sustained competitive advantage"*. In his view, an organisation's resource must have four attributes to provide the potential for a sustainable competitive advantage: (1) it must be valuable, (2) it must be rare, (3) it must be difficult to imitate; and (4) there should be no strategic substitute for this resource.

Barney (1991:101) lists *"all assets, capabilities, organisational processes, firm attributes, information, knowledge, etc."* as resources. If resources can be anything internal to the firm, which are the most strategically important ones? As posed above, a resource must fulfil four criteria to be a source of competitive advantage; it must be valuable, rare, inimitable and non substitutable.

Valuable - correlates to the firm's capability to create activities that lead to economic value. The resource attribute of creating value is fundamental, and must be fulfilled to be considered as a feasible source of competitive advantage. If the attribute valuable (in the SWOT model sense, that value can only be created, when taken advantage of opportunities or threats are avoided) is non-existent, all others attributes (rareness, inimitability, non-substitutability), become worthless as source of competitive advantage (Barney 1991; Barney and Clark 2009).

Rareness - refers to the amount of resources with specific properties a firm possesses and which are not ordinary to other companies. (Value) resources which are broadly available cannot be a source of competitive advantage, because every competitor would be able to use or exploit that resource in a similar way. *"In general, as long as the number of firms that possess a particular valuable resource (or a bundle of valuable resources) is less than the number of firms needed to generate perfect competition dynamics in an industry, that resource has the potential of generating a competitive advantage"* (Barney 1991:107; Barney and Clark 2009:59).

While the evaluation of the two attributes *value* and *rareness* are comparatively modest, a dynamic element must be considered for the assessment of the next two attributes, because only after a lapse of time the fulfilment of the resource requirements *imitability* and *substitutability* can be estimated.

Inimitable – imperfectly imitable implies that firms without these resources face a cost disadvantage or a total inability to adopt similar proceedings in comparison to the firm that already possess the resources. *"Regardless of whether strategies, systems, or products are scrutinized, imitability affects profit potential and sustainability of competitive advantages"* (Valentin 2001:57). Valuable and rare resources provide a potential of competitive advantage. However, to achieve sustainable competitive advantage it is necessary that incumbents cannot imitate these resources. An organisation's resources will be difficult to reproduce if it embodies a unique history, path dependency, causal ambiguity, and social complexity. Barney (1991:107; Barney and Clark 2009:60) claims, *"firm resources can be imperfectly imitable (or costly to imitate) for one or a combination of three reasons: (a) the ability of a firm to obtain a resource is dependent upon unique historical conditions, (b) the link between the resources possessed by a firm and a firm's sustained competitive advantage is causally ambiguous, or (c) the resource generating a firm's advantage is socially complex (Dierickx & Cool 1989)"*.

Unique historical conditions – may be the location chosen at the company's founding, the historical route up to present with the experiences made, or the company's unique culture established during its history. "The performance of a firm does not depend simply on the industry structure within which a firm finds itself at a particular point in time, but also on the path a firm followed through history to arrive where it is. If a firm obtains valuable and rare resources because of its unique path through history, it will be able to exploit those resources in implementing value-creating strategies that cannot be duplicated by other firms, for firms without that particular path through history cannot obtain the resources necessary to implement the strategy" (Barney 1991:108).

Causal ambiguity – is present when the connection of controlled resources and its leverage on the company's competitive advantage is not obvious or only partially understood. *"Imitating firms may be able to describe some of the resources controlled by a successful firm. However, under conditions of causal ambiguity, it is not clear that the resources that can be described are the same resources that* *generates a sustained competitive advantage, or whether that advantage reflects some other non-described firm resource"* (Barney 1991:109). Hence, competitors are uncertain which resources are really important and need to be established or acquired.

Social complex – or complex social interactions can include a wide variety of firm resources, it can be the interpersonal relations between employees in a company, the culture of the company, the reputation a company has among its customers and suppliers. Physical technology is not part of this kind of resources, but the ability to exploit these technologies *"often involves the use of social complex firm resources. Several firms may all possess the same physical technology, but only one of these firms may possess the social relations, culture, traditions, etc. to fully exploit this technology"* (Barney 1991:110).

Substitutability - implies that there are no similar or comparable resources, important in this context is that those comparable resources themselves must be rare and imperfect imitable. *"Two valuable firm resources (or two bundles of firm resources) are strategically equivalent when they each can be exploited separately to implement the same strategies"* (Barney 1991:111). Substitutability occurs in two ways. (A) It is impossible to imitate another's resources exactly, but it could be possible to replace them by comparable ones which allow formulating and implementing similar strategies. (B) Entirely differing resources may be strategic substitutes.

Barney (1991) combined the attributes posed above in the VRIN - framework - value, rareness, imitability and (non) substitutability. During the years, Barney and Clark (2009) edited the framework with some additions and changed from the acronym VRIN to the VRIO – framework (Figure 2.3). The first two attributes *value* and *rareness* remained unchanged; the VRIO version pools *imitability* and *(non) substitutability* into one attribute and complements the framework with the organisational premises. *"Valuable, rare, and imitable resources can only be a source of sustained competitive advantage if the firm is organised to exploit the potential offered by these resources"* (Barney and Clark 2009:67).

From VRIN – framework to VRIO – framework

Four empirical indicators of the potential of firm resources to generate sustained competitive advantage (Barney)

V = Valuable
R = Rare
I = Imperfectly Imitable
N = (Non) Substitutability

Valuable?	Rare?	Difficult to Imitate?	Supported by Organization?	Competitive Implications	Performance
No	----	----		Competitive Disadvantage	Below Normal
Yes	No	----		Competitive Parity	Normal
Yes	Yes	No		Temporary Competitive Advantage	Above Normal
Yes	Yes	Yes	Yes	Sustained Competitive Advantage	Above Normal

Figure 2.3 VRIN to VRIO framework (based on Barney 1991 and Barney and Clark 2009)

According to Barney (1991:115) *"this framework suggests the kind of empirical questions that need to be addressed in order to understand whether or not a particular firm's resource is a source of sustained competitive advantage: is that resource valuable, is it rare, is it imperfectly imitable, and are there substitutes for that resource?" "However, that a firm has a sustained competitive advantage does not mean that its competitive advantage will last forever"* (Barney and Clark 2009:53). *"Unanticipated changes in the economic structure of an industry may make what was, at one time, a source of sustained competitive advantage, no longer valuable for a firm, and thus not a source of any competitive advantage. These structural revolutions in an industry […] redefine which of a firm's attributes are resources and which are not"* (Barney 1991:103). But the framework is not free of criticism, Priem and Butler (2001) state that it is too abstract and lacks on operational validity. A further argument is that the theory does not explain how to identify these resources and how resources can develop and change over time.

Coimbatore K. Prahalad and Gary Hamel

In contrast to Barney (1986, 1991), Prahalad and Hamel (1990) are not explicitly talking about resources but instead focus on competencies (which can be resources), and for that reason, the model from Prahalad and Hamel is, besides the term RBV, also widely known as *competence-based approach*.

The core competence approach is an inside-out model, which takes the strength equals to core competencies of an organisation as origin for a strategy. Prahalad and Hamel (1990:82) define core competencies as the *"collective learning in the organisation, especially how to coordinate diverse production skills and integrate multiple streams of technologies"*.

According Prahalad and Hamel (1990), whether a company´s growth is robust or average depends on whether the company is conceived as a portfolio of competencies or a portfolio of businesses (products). They (ibid. 1990:86) *"believe in a view of company as a portfolio of competencies"* and argue that *"the critical task for management is to create an organisation capable of creating products which customers need but have not yet even imagined"* (ibid. 1990:80).

The main idea of Prahalad and Hamel (1990), in contrast to the outside-in approach (Porter 1980) is that real competitiveness does not derive from market knowledge but rather from the ability to build core competencies, at a lower cost in an even quicker cycle than competitors. *"Global competition is not just product versus product, company versus company, or trading bloc versus trading bloc. It is mind-set versus mind-set, managerial frame versus managerial frame"* (Hamel and Prahalad 1993:77). *"In the long run, competitiveness derives from an ability to build, at lower cost and more speedily than competitors, the core competencies that spawn unanticipated products. The real source of advantage are to be found in management´s ability to consolidate corporate wide technologies and production skills into competencies that empower individual business to adapt quickly to changing opportunities"* (Prahalad and Hamel 1990:81). In this case it is important, that the company is balanced with its competencies / resources, Hamel and Prahalad (1993:81) take a stool as an example, that must have at least three legs to be balanced, in the same way, to be balanced and competitive a company needs: *"strong product-development capabilities; the capacity to produce its products or deliver its services at world-class levels of cost and quality; and a sufficiently widespread distribution, marketing, and service infrastructure. If any leg is much shorter than the others, the company will be unable to exploit the investments it has made in its areas of strength"*.

The common knowledge of all parties inside a company and the capability of working beyond organisational boundaries build the base of core competencies. Prahalad and Hamel (1990:82) argue: *"The skills that together constitute core competence must coalesce around individuals whose efforts are not so* *narrowly focused that they cannot recognize the opportunities for blending their functional expertise with those of others in new and interesting ways". "An organisation's capacity to improve existing skills and learn new ones is the most defensible competitive advantage of all"* (Hamel and Prahalad 1989:69). For Prahalad and Hamel (1990), competencies are the glue that binds businesses together and stimulate new business development, *"core competencies are the wellspring of new business development. [...] Only if the company is conceived of as a hierarchy of core competencies, core products, and market-focused business units will it be fit to fight"* (ibid. 1990:91). In contrast to physical assets, competencies do not decline, when used, applied or shared, instead they grow. The price of losing a core competence or even establishing new ones is very difficult to quantify, because it needs a long time to build them up. If a firm does not establish the right core competencies, then entering into new emerging markets will be very difficult. *"When it comes to core competencies, it is difficult to get off the train, walk to the next station, and then re board"* (ibid. 1990:85).

Prahalad and Hamel (1990:83) claim as a prerequisite for core competencies, they must: "provide potential access to a wide variety of markets, […] make a significant contribution to the perceived customer benefits of the end product, [and, are] difficult for competitors to imitate". The building and enhancement of core competencies is time consuming, firms that do not invest in them will face trouble to break into new markets. Fights for global leadership are held in the areas of core competencies, core products, and end products. "When competencies become imprisoned, the people who carry the competencies do not get assigned to the most exciting opportunities, and their skills begin to atrophy. […] people - the company's most precious asset" (ibid. 1990:87). They suggest building a strategic architecture that is "a road map of the future that identifies which core competencies to build and their constituent technologies" (ibid. 1990:89). Prahalad and Hamel argue that an enterprise should be built around core competences, and demonstrate their approach in comparison to the strategic business units (SBU) concept (Table 2.1).

	SBU	Core Competence
Basis for competition	Competitiveness of today´s products	Interfirm competition to build competencies
Corporate structure	Portfolio of business related in product-market terms	Portfolio of competencies, core products, and businesses
Status of the business unit	Autonomy is sacrosanct; the SBU "owns" all resources other than cash	SBU is a potential reservoir of core competencies
Resource allocation	Discrete businesses are the unit of analysis; capital is allocated business by business	Businesses and competencies are the unit of analysis: top management allocates capital and talent
Value added of top management	Optimizing corporate returns through capital allocation trade-offs among businesses	Enunciating strategic architecture and building competencies to secure the future

Table 2.1 Two Concepts of the Corporation: SBU or Core Competence (Prahalad and Hamel 1990:86)

Prahalad and Hamel (1990:82) use the metaphor of a tree to illustrate the distinction and ranking order between products and core competences and the impact on the company's success: *"The diversified corporation is a large tree. The trunk and major limbs are core products, the smaller branches are business units; the leaves, flowers, and fruit are end products. The root system that provides nourishment, sustenance, and stability is the core competence. You can miss the strength of competitors by looking only at their end products, in the same way you miss the strength of a tree if you look only at its leaves"*. Prahalad and Hamel hold the opinion, that a company with well positioned core competencies can affect or even specify the OEMs products. *"Maintain world manufacturing dominance in core products, and you reserve the power to shape the evolution of end products"* (ibid. 1990:85). *"The tangible link between identified core competencies and end products"* Prahalad and Hamel *"call the core products - the physical embodiments of one or more core competencies. [...] Core products are the components or sub-assemblies that actually contribute to the value of the end products"* (1990:85). *"Control over core products is critical for other reasons. A dominant position in core products allows a company to shape the evolution of applications and end markets. [...] As a company multiplies the number of application areas for its core products, it can consistently reduce the cost, time, and risk in new product development. In short, well-targeted core products can lead to economies of scale and scope"* (ibid. 1990:86).

"Understanding the what of competitiveness is a prerequisite for catching up. Understanding the why is a prerequisite for getting out in front. Why do some companies continually create new forms of competitive advantage, while others watch and follow? Why do some companies redefine the industries in which they compete, while others take the existing industry structure as a given?" (Hamel and Prahalad 1993:76). *"Competitive innovation is like judo: the goal is to use a larger competitor's weight against it. And that*

happens not by matching the leader's capabilities but by developing contrasting capabilities of one's own. Competitive innovation works on the premise that a successful competitor is likely to be wedded to a ´recipe´ for success. That's why the most effective weapon new competitors possess is probably a clean sheet of paper. And why an incumbent's greatest vulnerability is its belief in accepted practice" (Hamel and Prahalad 1989:71). *"Critical success factors become orthodoxies when a competitor successfully changes the rules of engagement. Such competitive innovation is an important way of shielding resources. […] Understanding a competitor's definition of its ´served market´ is the first step in the search for under defended competitive space. The goal is to build up forces just out of sight of stronger competitors"* (Hamel and Prahalad 1993:83).

As well as Barney's (1991) RBV approach, Prahalad and Hamel's (1990) *´Core competence of the Corporation*`, has its critics. Crainer (1998) argues that the development of core competencies resulting in the firm developing a unique ability is the result of many different activities and not just a single management decision. Further, the measurability and verifiability of core competencies, seems difficult. A core competence can only be verified in retrospect. Hence, factors for success of superior companies become core competencies ex post. Similarly Christensen and Raynor (2003:125) add for consideration, *"the problem with the core competence/not your core competence categorization is that what might seem to be a non core activity today might become an absolutely critical competence to have mastered in a proprietary way in the future and vice versa"*.

Robert M. Grant

By looking at the developments in strategy analysis during the 1980s, Grant (1991:114) claimed, that *"the link between strategy and the firm's resources and skills has suffered comparative neglect"*. Considering the contributions to the resource-based theory, he argued, that the implications of the RBV to strategic management was unclear. He gave two reasons, (A) diverse contributions are made, but they lack an integrated framework, (B) little effort has been made for the contribution to practice. His aim was, to establish a framework, where he intends to integrate the main approaches and opinions of the RBV literature.

Grant (1991) differentiates resources and capabilities. He sees resources as an input into the creation process, which includes employee skills, finance, capital equipment, brands, patents, and more. Furthermore he claims knowledge as a significant resource of the company. As a starting point, Grant (1991:119) sorts resources into six categories: *"financial resources, physical resources, human resources, technological resources, reputation, and organisational resources"*. But by themselves they are usually unproductive; productivity needs the cooperation and balancing of resource bundles. *"While resources are the source of firm's capabilities, capabilities are the main source of its competitive advantage"* (ibid. 1991:119). But providing capabilities are not simply a question of matching a bundle of resources, it is a complex interaction between humans and between humans and other resources.

There are two basic reasons why resources and capabilities are the foundation of a firm's strategy, (A) they provide the main direction for a firm's strategy and, (B) they are the essential source of revenue for the firm. *"The key to a resource-based approach to strategy formulation is understanding the relationships between resources, capabilities, competitive advantage, and profitability - in particular, an understanding of the mechanisms through which competitive advantage can be sustained over time"* (ibid. 1991:133).

According to Grant (1991:124) *"resource-based approaches to the theory of competitive advantage point towards four characteristics of resources and capabilities which are likely to be particularly important determinants of the sustainability of competitive advantage: durability, transparency, transferability, and replicability"*. The selection of Grants factors show some conformity to the empirical indicators (valuable, rare, imperfect imitable and substitutability) that Barney (1991) cited as necessary to generate sustained competitive advantage in his article *´Firm Resources and Sustained Competitive Advantage´* published in the same year.

Durability – refers to the persistence of a competitive advantage, the degree to which the affected resource and / or capability remains valid. *"The durability of resources varies considerably: the increasing pace of technological change is shortening the useful life-spans of most capital equipment and technological resources. On the other hand, reputation (both brand and corporate) appears to depreciate relatively slowly, and these assets can normally be maintained by modest rates of replacement investment. [...] Firm capabilities have the potential to be more durable than the resources upon which they are based because of* *the firm's ability to maintain capabilities through replacing individual resources (including people) as they wear out or move on"* (Grant 1991:124).

Transparency – stands for the capability of a company to keep the source of competitive advantage secret for as long as possible so that other companies are not able to imitate. A competitor trying to imitate a company's competitive advantage must have the ability to answer the questions: what is the source of competitive advantage and how is it obtained? *"If a firm wishes to imitate the strategy of a rival, it must first establish the capabilities which underlie the rival's competitive advantage, and then it must determine what resources are required to replicate these capabilities"* (ibid. 1991:125). Depending on the number of performance variables underlying the competitive advantage, it is challenging for a competitor to determine what resources and / or capabilities required.

Transferability – is a reference to the ease at which a competitive advantage can be ′bought′. If resources needed to imitate a competitive advantage can be acquired on the market, then the durability of this advantage is only temporary. However, often resources and capabilities are not easy to transfer; hence *"competitors are unable to acquire (on equal terms) the resources needed to replicate the competitive advantage of an incumbent firm"* (ibid. 1991:126). The insufficiency in transferring competitive advantage is based on several causes:

Geographical immobility – is the high amount of expenditure needed when acquiring and relocating physical equipment and/or highly specialised employees, in contrast to companies possessing these resources.

Imperfect information – is the lack of information about the value of a resource, caused by the heterogeneity and the insufficient knowledge of the potential of the individual resource by a competitor. As result, the price of such a resource can be under or overvalued.

Firm-specific resources – are advantages directly linked with the company possessing them. If they are acquired by a different company they might lose efficiency or decline. Examples are, the productivity of hired away employees, the reputation of a brand, or change in ownership.

The immobility of capabilities – implies that capabilities (since they need a bundle of resources) are much more static as distinct resources. To transfer capabilities, the acquisition of the whole resources bundle supporting them is necessary. *"However, even if the resources that constitute the team are transferred, the nature of organisational routines - in particular, the role of tacit knowledge and unconscious coordination - makes the recreation of capabilities within a new corporate environment uncertain"* (ibid. 1991:127).

Replicability – stands for the ability to imitate or replicate a company's resources and/or capabilities. Complex organisational routines or highly developed complex capabilities can prevent a company from replication, and maintain its competitive advantage.

He underlines the most important capabilities and resources *"are those which are durable, difficult to identify and understand, imperfectly transferable, not easily replicated, and in which the corporation possesses clear ownership and control"* (ibid. 1991:129). He calls them *crown jewels* or sources of competitive advantage, and advises that they are protected, because they play a key role in strategy. *"The returns to a firm's resources and capabilities depend upon two key factors: first, the sustainability of the competitive advantage which resources and capabilities confer upon the firm; and, second, the ability of the firm to appropriate the rents earned from its resources and capabilities"* (ibid. 1991:123).

Grant´s (1991) contribution to practice was the development of a resource based framework for strategy formulation (Figure 2.4). In this framework (1) the company's resources are identified and classified, (2) capabilities and dependent resource inputs are identified, (3) the potential capabilities and the necessary resources are appraised; (4) the best fitting strategy to exploit these resources and capabilities is selected. As a fifth step, a feedback loop is conducted, to identify resource gaps and invest in developing or extending the pool of resources and capabilities.

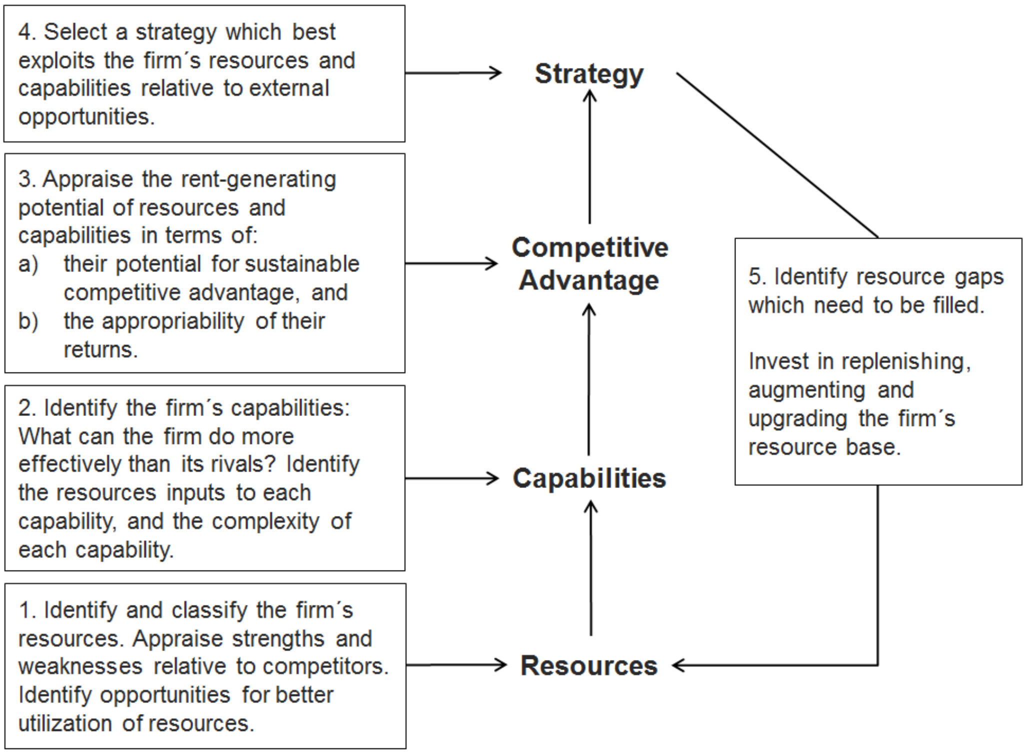


Figure 2.4 RBV based five stage framework for strategy formulation (Grant 1991:115)

Grant´s (1991:131) *"resource-based approach to strategy is concerned not only with the deployment of existing resources, but also with the development of the firm's resource base"* by *"harmonizing the exploitation of existing resources with the development of the resources and capabilities for competitive advantage in the future"* (ibid. 1991:132). *"The returns to a firm from its resources and capabilities depend not only on sustaining its competitive position over time, but also on the firm's ability to appropriate these returns"* (ibid. 1991:128).

2.2.2.3. Further RBV representatives and thoughts

Since the initial studies of Barney (1986, 1991) Prahalad and Hamel (1990), and Grant (1991), further research on the resource-based approach was conducted: Dierickx and Cool (1989), Mahoney and Pandian (1992), Kay (1993), Hunt and Morgan (1996), Teece, Pisano and Shuen (1997); Priem and Butler (2001), Sun and Tse (2009), are some of the authors in this area.

Teece, Pisano and Shuen (1997) illustrate the distinction between the market-based and the resource-based approach by looking at the market entry process and the associated assumptions and simplifications. *"The* *link between market share and innovation has long been broken, if it ever existed. All of this is to suggest that product market position, while important, is too often overplayed. Strategy should be formulated with regard to the more fundamental aspects of firm performance, which we believe are rooted in competences and capabilities and shaped by positions and paths"* (Teece, Pisano and Shuen 1997:522). This is in accordance with Grant (1991) and his framework for strategy formulation (Figure 2.4), developing strategy starting from the company's resources and capabilities. Such an approach is especially significant, since companies are heterogeneous regarding resources and capabilities and hence they are connected *"with what they have and may have to live with what they lack"* (ibid. 1997:414). This strong correlation occurs for three reasons: (A) business development is a complex process, and requires organisational capacity to develop new competences; (B) some resources are simply not tradable; (C) even purchasing a required resource may provide minimal advantage (Teece, Pisano and Shuen 1997). This is in accordance with Barney (1986:1231) claiming, that unless a firm hold exclusive information, *"the cost of acquiring strategic resources will approximately equal the economic value"*. Further, Teece, Pisano and Shuen (1997:515) argue, that accumulating unique resources and valuable technology assets is not sufficient to obtaining lasting competitive advantage, since *"winners in the global marketplace have been firms that can demonstrate timely responsiveness and rapid and flexible product innovation, coupled with the management capability to effectively coordinate and redeploy internal and external competences"*. They characterise this as *'dynamic capabilities'*, a new aspect and form of competitive advantage in the RBV. *Dynamic* in this context implies the ability to regenerate the firm's competences in accordance to requirements, innovations, market, and technological changes. *Capabilities* describe the management task to adapt, integrate, and reconfigure the company's resources, competences and skills to adjust them to the demands of a changing environment. Teece, Pisano and Shuen (1997:516) define *"dynamic capabilities as the firm's ability to integrate build and reconfigure internal and external competences to address rapidly changing environments. Dynamic capabilities thus reflect an organisation's ability to achieve new and innovative forms of competitive advantage given path dependencies and market positions"*. Dynamic capabilities, or paraphraseing, understanding of the connection between processes and organisational capabilities is important, especially for the development of architectural and radical innovations. The cause that architectural and radical innovations are often conducted by new entrants is the mismatch between incumbents existing processes and those required for new innovations (Teece, Pisano and Shuen 1997). Usually incumbents possess and develop organisational processes needed to support their ancestral product portfolio, but those, in most cases, are unable to support new technologies. In this context Teece, Pisano and Shuen (1997) argue, innovations beyond incremental innovations require new and specific processes and, in some cases, even organisational autonomy. *"Radical organisational reengineering will usually be required to support the new product, which may well do better embedded in a separate subsidiary where a new set of coherent organisational processes can be fashioned"* (ibid 1997:520). Focussing on adjusting and improving competencies to respond on changes in company´s environment, they connect internal resources and competencies (RBV) with external events (MBV). However, as with the RBV models of Barney (1991) and Prahalad and Hamel (1990), the dynamic capabilities are criticised as unclear and inoperable (Priem and Butler 200), plus their effect on firms performance is unanswered (Helfat and Peteraf 2009).

Kay (1993:69) states, *"architecture does not create extraordinary organisations by collecting extraordinary people. It does so by enabling very ordinary people to perform in extraordinary ways"*. He argues that for providing an organisation to have a competitive advantage, then there must be substantial distinctive capabilities of the organisation's resources. Capabilities in his understanding are only distinctive when they come from an attribute other companies do not possess. Dierickx and Cool (1989) point out, that resource bundles are the source of a companies' success, but to deploy these capabilities, they need to be protected in order to achieve advantageous market positions for the company. *"Managers often fail to recognize that a bundle of assets, rather than the particular product market combination chosen for its deployment, lies at the heart of their firm's competitive position. [...] The managerial implication drawn is that firms should focus their analysis mainly on their ´unique´ skills and resources rather than on the competitive environment"* (Dierickx and Cool 1989:1504).

Hunt and Morgan (1996) claim in their ´Resource-Advantage (R-A) theory of competition´, that the competitiveness of company processes is affected by five environmental factors: societal resources; societal institutions; competitor actions; consumer behaviour; and public policy decisions. Couple with these external factors, innovation plays a key role in their theory. They *"distinguish between proactive innovation (i.e., innovation by firms in the absence of specific competitive pressures) and reactive innovation (i.e., innovation directly prompted by competition)"* (Hunt and Morgan 1996:109). The R-A theory *"views competition as an evolutionary process in real-time (rather than as a static process), [...]*

technology as a nonrival, partially excludable resource in the production process (rather than as a production function freely available to all firms), […] innovation as an outcome of the process of competition (rather than as exogenous to competition), […] firms as having the rational expectation that superior financial performance results from innovations that contribute to efficiency and/or effectiveness (rather than viewing superior performance as constituting rents resulting from market imperfections), and […] societal institutions (e.g., the patent system) as potentially facilitating or inhibiting competition-induced growth (rather than as being superfluous to competition)" (ibid. 1996:112). Hunt and Morgan developed a nine cell model, the *´competitive position matrix´* (Figure 2.5), to identify the position of the company in comparison to its competitors. The individual position results from the company's resource assortment relative to its competitors. The perceived value of the offerings for some market segments and the costs to produce the goods are examined. Being in the position of competitive disadvantage (cells 4, 7, and 8), but seeking for competitive advantage (cells 2, 3, and 6) the company *"must attempt to neutralize and/or leapfrog the advantaged competitor through reactive innovation: by better managing existing resources, obtaining the same or equivalent value-producing resource, and/or seeking a new resource that is less costly or produces superior value. The time required for reactive innovation to succeed depends on, among other things, the extent to which an advantaged firm's resources are protected by such societal institutions as patents and/or they are causally ambiguous, socially complex, tacit, or have time compression diseconomies"* (ibid. 1996:109). The main challenge by using the ´competitive position matrix´ in order to deduct a strategy to achieve competitive advantage is getting access to reliable data concerning the value and cost of competitors' resources. As discussed within Barney´s (1991, 2009) VRIN/VRIO framework, resources that are a source of sustained competitive advantage, are difficult to acquire and not offhand describable. For that reason, working with the ´competitive position matrix´ will be more guess work than an ideal accessory for strategy formulation.

		Relative Resource-Produced Value: Lower	Relative Resource-Produced Value: Parity	Relative Resource-Produced Value: Superior
Relative Resource Costs	**Lower**	1 Indeterminate Position	2 Competitive Advantage	3 Competitive Advantage
	Parity	4 Competitive Disadvantage	5 Parity Position	6 Competitive Advantage
	Higher	7 Competitive Disadvantage	8 Competitive Disadvantage	9 Indeterminate Position

Figure 2.5 Competitive Position Matrix (Hunt and Morgan 1996:109)

Mahoney and Pandian (1992) argue, that the resource-based view and its approach make a contribution to diversification, by reflecting growth limitations, considering motivations for diversification, supplying a theoretical perspective for the direction of diversification, and providing the rationale for diversification. In their opinion *"the direction of a firm's diversification is due to the nature of its available resources and the market opportunities in the environment"* (Mahoney and Pandian 1992:367). It is crucial for this diversification that companies capabilities are *"upstream from the end product"* (Mahoney and Pandian 1992:366) and therefore can be used for different products and industries, *"firms did not diversify at random, but rather were more likely to diversify into industries with characteristics similar to their primary industries"* (MacDonald 1985:590). When resources are used effectively and linked with others, innovation can take place. Mahoney and Pandian (1992) suggest combining the approaches of the resource-based view and dynamic capabilities (Teece, Pisano and Shuen 1997) with organisational economics. They see the RBV *"as a framework within which an integrated analytical model may be constructed"* (Mahoney and Pandian 1992:374), and add time and attention as a fourth dimension of resources to the model. As time and attention are rare resources, according to Barney (1991), they can embody a source of competitive advantage.

Sun and Tse (2009) extend the resource-based approach by external resources like network effects or customer relationships. In their opinion, these connections can become critical resources within certain market contexts. Referring to Wernerfelt (1984:171), that *"for the firm, resources and products are two sides of the same coin"*, they indicate that the market context can play an important role for a company and be a critical resources in certain circumstances. The key point is that it is only when someone joins such a network – becomes a member – that they can become a critical resource for the company. *"This suggests that it is the 'membership' that distinguishes network participants from potential participants, which converts external factors into internal resources"* (Sun and Tse 2009:52). Beyond that, combining market context with the RBV may help to define the value of a resource, because the value of a resource is related to a certain industry or market; and in one market it might be valuable, in a different market it might not be. *"Therefore, putting RBV in specific market contexts will reveal the true relationships among resources, products and competitive advantages"* (ibid. 2009:46). Further Sun and Tse submit that, the RBV literature *"only refers to one-way dependences (i.e. one asset depends on the other, but not the other way around)"*, but *"cross-group network effects create a two-way feedback cycle and thus lead to two-way interconnectedness"* (ibid. 2009:53). The findings of Sun and Tse (2009) concern the so called two-sided markets[6], where customers can be viewed as resources, because they are connected with the product and have a direct effect on expenses or believed advantages associated with the offer. Examples for two-sided markets are: payment cards, video games, high definition DVD standard, newspaper, TV channel, and PC operating systems. *"Therefore, it is an important first step to identify market context before RBV analysis is conducted. Otherwise, it may lead to incorrect identification of critical resources"* (ibid. 2009:56).

2.2.3. Systemizing resources

The objective of the RBV is to locate and deploy companies' unique resources in order to achieve and sustain competitive advantage. Core competencies, skills, capabilities, or simply internal resources are among the items suggested by various authors that are capable of giving a firm its competitive advantage. The meaning of these various resources that create competitive advantage varies and finding a consistent terminology is difficult.

[6] The value and the amount of members / users in a two-sided market depends on the attractiveness for other people to join / choose. It is likely that people would prefer join a network with 1 million members than one with 100 or buy a software system that is widely used.

In general, resources can be seen as inputs that allow an organisation to fulfil its tasks, but resources are only valuable to the company when they are used productively. Resources are commonly classified as tangible and intangible. Tangible resources are physical assets a company holds; they can be subdivided into physical resources, financial resources, and human resources. Intangible resources imply intellectual resources (patents/copyrights), technological resources (ability to innovate) and reputation or ‘goodwill’. Teece, Pisano and Shuen (1997:516) prefer the term firm-specific assets, instead of resources, because they think it is misleading: *“resources are firm-specific assets that are difficult if not impossible to imitate”*. Wernerfelt (1984:172) *“by a resource is meant anything which could be thought of as strength or weakness of a given firm”* and Barney (1991:101) *“firm resources include all assets, capabilities, organisational processes, firm attributes, information, knowledge, etc. controlled by a firm that enable the firm to conceive of and implement strategies that improve its efficiency and effectiveness”* give resources a very wide and general scope. Nevertheless, to be a source of competitive advantage, Barney (1991) defines resources as having the following attributes (1) valuable, (2) rare, (3) difficult to imitate, and (4) no substitute for this resource. Hofer and Schendel (1978) subdivide the company’s resource profile into: physical resources, organisational resources, human resources, financial resources, and technological capabilities. Grant (1991) sees the classification of resources into: physical resources, organisational resources, human resources, financial resources, technological resources, and reputation as a useful starting point. But his main complaint is the inadequacy of financial balance sheets, since they ignore intangible resources and *“people-based skills - probably the most strategically important resources of the firm”* (Grant 1991:119). In his opinion, resources and capabilities must embody durability, transparency, transferability, and replicability, to be a source of competitive advantage for the company. He differentiates resources and capabilities thus resources are the inputs and capabilities are the capacity to perform some activity. For Grant, the key to shape a resource-based strategy is to understand *“the relationships between resources, capabilities, competitive advantage, and profitability”* (ibid. 1991:133).

As demonstrated, in various definitions and explanations above, resources are important for a company, but resources per se do not provide much benefit for a company. Only if these resources are configured in an efficient way can they provide an organisation with competencies. Competence is the quality a company needs to be able to compete in the market. Teece, Pisano and Shuen (1997:516) *“define those competences that define a firm’s fundamental business as core. […] The degree to which a core competence is* *distinctive depends on how well endowed the firm is relative to its competitors, and on how difficult it is for competitors to replicate its competences"*. Prahalad and Hamel (1990:82) claim that *"core competencies are the collective learning in the organisation, especially how to coordinate diverse production skills and integrate multiple streams of technologies"*. In general, core competence indicates the capability of an organisation to gain competitive advantage by performing its activities in a better way than its competitors. Core competencies may not be available on the marketplace, but the firm who knows their core competencies, has the ability to systematically use and expand them. Possible ways to identify their core competences are questions concerning, (A) customer value: has the company used its core competencies to effect a sustainable added value for the customer; (B) protection against imitation: does the company control the core competencies exclusively, or is it easy for a competitor to imitate them; (C) differentiation: does differentiation lead this core competence to a sustained competitive advantage against competition; and (D) diversification: provides this core competence potential access to new market places and businesses. Hofer and Schendel (1978:25) first linked competitive advantage and core competencies. *"Competitive advantage, [...] is the unique position an organisation develops vis-à-vis its competitors through its pattern of resource deployments"*. Prahalad and Hamel (1990) claim core competencies must enable the firm to expand into different/new markets, contribute significantly to the benefits of the customers' product, and be difficult to replicate. The building and enhancement of core competencies is time consuming, but firms that do not invest in them will find it hard to emerge into new markets. Fights for global leadership are held in the areas of core competencies, core products, and end products. It is important, to differentiate between these three areas *"because global competition is played out by different rules and for different stakes at each level. To build or defend leadership over the long term, a corporation will probably be a winner at each level"* (Prahalad and Hamel 1990:85). Concerning core competence and competitive advantage, Hamel and Prahalad (1989:69) find *"an organisation's capacity to improve existing skills and learn new ones is the most defensible competitive advantage of all"*.

2.2.4. Summary

The resource-based approach demonstrates the importance of resources for the company's success and the development of sustained competitive advantage. Various definitions, beliefs, views, and likely ways to perform resource-based approaches are feasible. Literature (Wernerfelt 1984, Prahalad and Hamel 1990, Barney 1991, Grand 1991) proposes different models that try to identify resources, core competencies or give guidance for strategy formulation. But all RBV literature does not explain in detail how resources, and as a result, - core competences - are identified and developed to be a source of competitive advantage for the company. Further the literature does not state the resources a company requires to develop in order to be (more) successful. *"There is no widely accepted definition or method of measurement of competencies, whether technological or otherwise"* (Tidd, Bessant and Pavitt 2005:187).

This ´inaccuracy´ in the resource-based approaches and models have always been a source of criticism. The resource-based literature is closely linked with strategic topics like segmentation, corporate diversification, vertical integration and mergers and acquisitions. However distinct processes and practical details are missing in the literature. At present, the existing RBV models and approaches are not sufficient to develop a strategy that meets the complexity and detail requirements of a company's vertical forward integration (component to system).

In this context the open research question concerning resource-based strategy, resources, and core competencies is to develop a framework that identifies requirements for a company that wants to move to a higher value-added stage. To bridge the gap in literature and make a contribution to knowledge and practice, the tasks that need to be completed are:

- Classifying the incentives for enterprises performing mode switching and their associated advantages.

- Identifying customer expectations in order to satisfy market demand with mode switching.

- Identifying necessary resources and competencies required for an enterprise to evolve into a higher value-added stage.

- Providing a framework that enables and guides enterprises that are mode switching to a higher value-added stage.

2.3. Innovation

Research and Development (R&D) or even the desired outcome, namely innovation in its various characteristics builds the fuel for companies' future. However, R&D or innovation is not an asset that can be stocked: it is like a muscle that needs practice to keep in shape. Dierickx and Cool (1989:1508) illustrates this, when they argue *"as is the case with physical plant and equipment, all asset stocks decay in the absence of adequate maintenance expenditures, R&D know-how depreciates over time because of technological obsolescence; brand awareness erodes because the consumer population is not stationary (existing consumers leave the market, while new consumers enter), consumers forget, et cetera"*. Deutsche Bank Research (2011a) estimates that the worldwide spending on research and development to be 1,000 Billion Euros per year. They surveyed 1,000 R&D intensive companies during 2002-2009, and found that companies with an R&D spend 50% higher than the industry average generated a 14-21% higher market capitalisation. However a high R&D intensity does not obviously ensure a better market position: an important fact is continuity. *"Crash R&D programs, for example, are typically less effective than programs where annual R&D outlays are lower but spread out over a proportionally longer period of time. [...] For example, firms who already have an important stock of R&D know-how are often in a better position to make further breakthroughs and add to their existing stock of knowledge than firms who have low initial levels of know-how"* (Dierickx and Cool 1989:1507-1508). These figures illustrate the importance of innovation for corporate success, and demonstrate that huge expenses and efforts are undertaken to stay ahead of competitors. *"Any company that is a bystander on the road to the future will watch its structure, values, and skills become progressively less attuned to industry realities"* (Hamel and Prahalad 1994:124).

Innovation has various definitions, according to Teece (1986:288) *"an innovation consists of certain technical knowledge about how to do things better than the existing state of the art"*. Other definitions include, innovation is the identification, development, of new products, procedures, processes, and organisational structures (Dosi 1988), but also the start of new opportunities by joining different knowledge sets (Tidd, Bessant and Pavitt 2005) as well as the interaction of market, organisation and technology (Kim and Mauborgne 2005; Tidd, Bessant and Pavitt 2005). Von Hippel (1988) even counts strategies, which try to predict and generate innovation as a form of innovation themselves. *"Schumpeter argued that those who succeed at innovating are rewarded by having temporary monopoly control over what they have created.*

This control, in turn, is the lever that allows innovators to gain an enhanced position in the market and related temporary profits or economic rents from their innovations" (von Hippel 1988:43). Innovation is no simple colour by numbers approach; innovation originates by applying specific behaviours and requires a particular mindset. Tidd, Bessant and Pavitt (2005:559) *"have identified four clusters of behaviour which [...] represent particularly important routines.*

- *Successful innovation is strategy-based.*
- *Successful innovation depends on effective internal and external linkages.*
- *Successful innovation requires enabling mechanisms for making change happen.*
- *Successful innovation only happens within a supporting organisational context".*

Dr Neil MacGilp (Director, Corporate R&D, Procter & Gamble) described innovation in his preface to Tidd, Bessant and Pavitt (2005) as follows. *"Innovation is the cornerstone of what makes businesses successful: offering something uniquely better to the consumer. Innovation, while key, is probably the most difficult (maybe even impossible) element of corporate activity to manage or plan".*

2.3.1. Types of innovation

Innovation is often in the eye of the beholder, what someone might call new or even radical, may be well known by another. Despite this subjectivity various models exist which try to explain, identify, and classify innovation in its different dimensions and interactions. Henderson and Clark (1990) focus on the reconfiguration of existing product technologies, and call it architectural innovation. Their focus is on innovations that change the product's architecture while leaving the components and the core design concept unchanged. Danneels (2002:1102) by contrast observes the relationship between technology and the customer. In his opinion product innovation is found as follows, *"innovation requires the firm to have competences relating to technology and relating to customers, and each of these competences is constituted by a set of resources".* A similar picture is drawn by Dougherty (1992:78), *"a product constitutes the integration of markets and technologies, and cannot be understood as one or the other separately".* While Kim and Mauborgne (2005) aim to create blue oceans (innovations) by leveraging the correlation of benefit and cost in new markets and thus be in the position to create new demand by avoiding competition. All of these different models focus on a specific area of innovation: to review a wide variety of innovation a different approach is necessary. *"Innovation is driven by the ability to see connections, to spot opportunities and to take advantage of them. […] But innovation is not just about opening up new markets – it can also offer new ways of serving established and mature ones"* (Tidd, Bessant and Pavitt 2005:3).

With the '*4Ps of innovation*' a model is available, that builds on the presumption that innovation is about change, and this can take place in different forms, the main categories for such change are (Tidd, Bessant and Pavitt 2005:10):

- *"'Product innovation' – changes in the things (products/services) which an organisation offers;*
- *'Process innovation' – changes in the ways in which products and services are created or delivered;*
- *'Position innovation' – changes in the context in which the products/services are framed and communicated;*
- *'Paradigm innovation' – changes in the underlying mental models which shape what the organisation does"*.

The categories of innovation are one dimension of the model, additional dimensions, are the degree of novelty and the level of complexity. Any of the 4P innovation categories can range from incremental through to radical. The whole area of innovation, within which an organisation can operate, is shown in Figure 2.6.

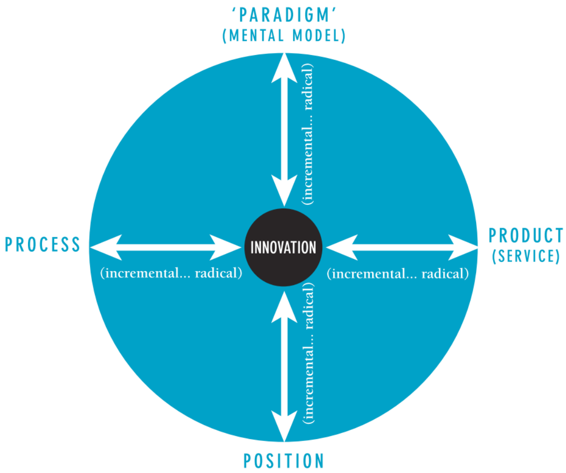


Figure 2.6 Innovation space (Tidd, Bessant and Pavitt 2005:13)

In the next sections the 4Ps model, with its categories and dimensions is used, to explore the different types of innovation. Whereas today's business environment is characterised by rapid changes (Capon and Glazer 1987, Cooper, Edgett and Kleinschmidt 2001, Vanhaverbeke and Peeters 2005), collaboration in different configurations is more than ever a reasonable option for companies to succeed. Thus the 4Ps model is enlarged by a fifth category to become a 5Ps model. The new category in the 5Ps model is called '*Partner innovation*' - changes in the mode in which innovation is created. Partner innovation is the way innovation is created and implemented in collaboration with different organisations and/or an anonymous community.

Hence, the advanced model with its 5Ps of innovation consists of the categories:

- *"'Product innovation' – changes in the things (products/services) which an organisation offers;*
- *'Process innovation' – changes in the ways in which products and services are created or delivered;*
- *'Position innovation' – changes in the context in which the products/services are framed and communicated;*
- *'Paradigm innovation' – changes in the underlying mental models which shape what the organisation does"* (Tidd, Bessant and Pavitt 2005:10).
- '*Partner innovation*' - changes in the mode in which innovation is created.

2.3.1.1. Product innovation

The most noted innovation category is probably product innovation. *"A product innovation is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics"* (OECD 2007:620).

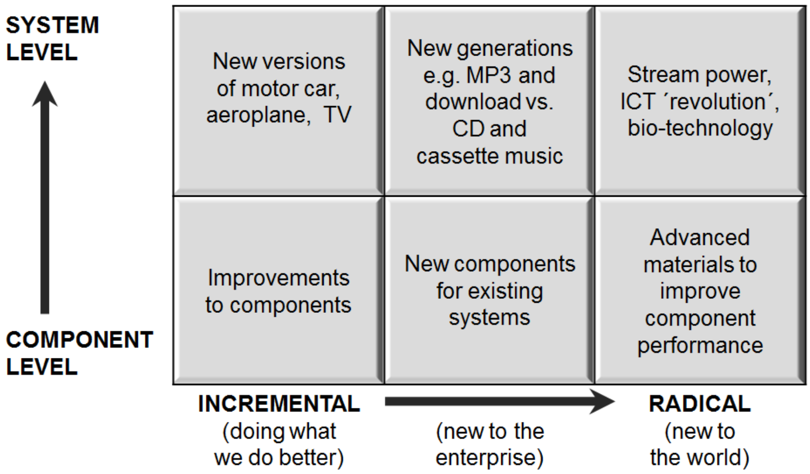


Figure 2.7 Dimensions of innovation (Tidd, Bessant and Pavitt 2005:12)

The two dominant dimensions in product innovation are the degree of novelty and the level of complexity. The level of complexity depends on the number of parts and interfaces between these parts (Figure 2.7). Henderson and Clark (1990:11) define component as *"physically distinct portion of the product that embodies a core design concept and performs a well-defined function"*. This difference between the component as a distinct portion of the product and the product as a system itself needs different types of knowledge for building product innovations. On the one hand, knowledge about the component and its parameters is required; also required is the knowledge of integration and interactions, in which the particular components are interconnected into a consistent unit or system (Henderson and Clark 1990). In industrial practice the complexity is commonly subdivided into three main levels: components, modules and systems. The Schaeffler Group (2009), as one example, terms these three levels as follows. *Components* are technical products consisting of few individual parts that make a contribution to the function of a superior unit. Often components only perform one or two functions. A *module* is a technical product, assembled from different components that feature a predefined interface to be connected with and integrated into a superior unit. Modules result primarily from the integration of functions and benefit the customer with lower mounting and/or handling effort. A *system* is a technical product, composed of several modules and/or components which are integrated into the superior unit by interfaces developed together with the customer. The interface configuration happens in tight collaboration with the customer. Nevertheless, the definition of components, modules, and systems in general depends on the viewer's standpoint. The same product can be seen from the supplier's point of view as a system, whereas a customer might see it as a subordinate component of their system. For example, a combustion engine will be seen by its manufacturer as a system, but by the car - producer as a module or even as a component.

The prime target of product innovation and development is to form technical solutions, which fulfil their required functions over the whole lifetime (Koller 1998). Henderson and Clark (1990) classify the degree of novelty with their model (Figure 2.8) two dimensionally; the horizontal dimension records the effect on the component itself, whereas the vertical dimension records the linkage among them. Outlined in this way, modular and architectural innovation represents diagonally opposed points. Two further extremes are radical and incremental innovation. *"The distinctions between radical, incremental, and architectural innovations are matters of degree"* (Henderson and Clark 1990:13).

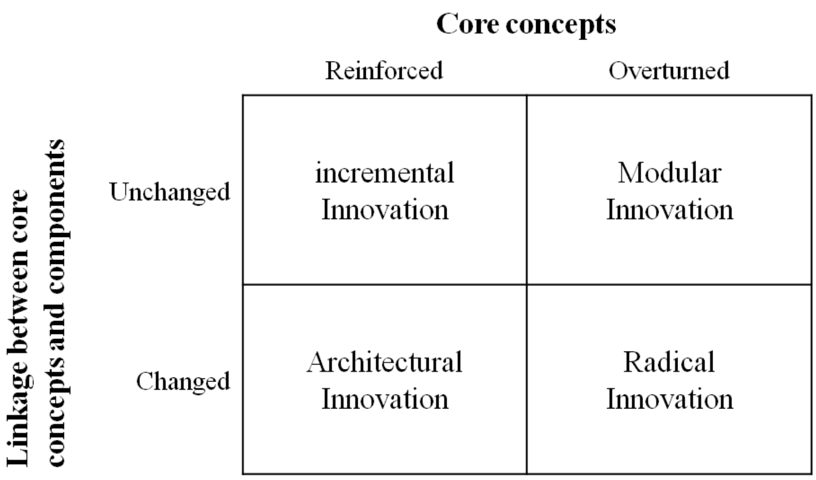


Figure 2.8 A framework for defining innovation (Henderson and Clark 1990:12)

Incremental Innovation

Incremental or sustaining innovation is the continuous improvement to products by using the company's knowledge of its core components to make minor changes to the existing product based on the established design (Ettlie, Bridges and O'Keefe 1984; Tushman and Anderson 1986; Tidd, Bessant and Pavitt 2005). *"Incremental innovation refines and extends an established design. Improvement occurs in individual components, but the underlying core design concept, and the linkage between them, remains the same"* (Henderson and Clark 1990:11). Almost all sustaining innovations aim to increase the performance of existing and established products with solutions that the majority of customers have historically valued (Christensen 2006). This and the paradigm *´keeping close to the customer´* in mind, implies, that most product development or product innovation is accomplished with historical data. In conclusion, a company that only conducts incremental innovation is like driving while permanently looking in the rear-view mirror, it cannot see what is ahead. *"The popular slogan ´stay close to your customers´ appears not always to be robust advice. One instead might expect customers to lead their suppliers toward sustaining innovation and to provide no leadership - or even to explicitly mislead - in instances of disruptive technology change"* (Christensen 2006:54). Beyond that, with focus on a rapidly changing environment and increasing competition, incremental innovation might not be fruitful for a forward-looking company. Incremental innovation can embody a pillar on the way to the future, the one, providing the company with returns needed to identify and develop new ways, territory and solutions. *"Companies that try to differentiate themselves by focusing on incremental innovation instead of game-changing, disruptive innovation will differentiate themselves right out of business. Companies simply cannot afford to wait until they get backed into a corner. They need to be consistently making bold moves, even at the very peak of their success. So, instead of ´differentiate or die´, the real mantra should be ´differentiate all you want, but figure out a way to be the only one who does what you do, or die´"* (Williams 2011:2). Continuous innovation, even if it is incremental is an effective basis for the development of new and more complex products *"an organisation that is used to continuous small changes and that has balanced strategic expertise at the top with operating expertise and entrepreneurship at the bottom is probably better prepared for a big leap than an organisation that has gone for several years without any change at all"* (Hayes 1985:117).

Modular Innovations

Modular innovation changes one element of the product in a significant way, while the main architecture remains unchanged. This implies that major shifts are not necessary for the company; rather knowledge just needs to be expanded within its established framework of resources and customers (Tidd, Bessant and Pavitt 2005). *"Innovation that changes only the core design concepts of a technology is a modular innovation, such as the replacement of analog with digital telephones"* (Henderson and Clark 1990:12). The opposite of modular innovation is architectural innovation**.**

Architectural Innovations

The term architectural innovation was established by Henderson and Clark (1990). They noticed that the traditional view of innovation (with the two dimensions incremental and radical) did not explain why established firms fail in catching obvious developments, especially in fields where they are amongst the leaders in technology. One example Henderson and Clark (1990) highlight Xerox as a technology leader in the mid-1970s. When confronted with new competition offering smaller copiers, it took Xerox more than eight years and the loss of half of its market share before they responded. The examination of comparable innovations led Henderson and Clark (1990) to enlarge the traditional categorisation of innovation and additionally to distinguish between the knowledge of components and the knowledge about how they are integrated into a system or linked together. *"We define innovations that change the way in which the components of a product are linked together, while leaving the core design concepts (and thus the basic knowledge underlying the components) untouched, as architectural innovation"* (Henderson and Clark 1990:10). *"The essence of an architectural innovation is the reconfiguration of an established system to link together existing components in a new way. This does not mean that the components themselves are untouched by architectural innovation. Architectural innovation is often triggered by a change in a component - perhaps size or some other subsidiary parameter of its design - that creates new interactions and new linkages with other components in the established product. The important point is that the core design concept behind each component - and the associated scientific and engineering knowledge - remain the same"* (Henderson and Clark 1990:12). Tidd, Bessant and Pavitt (2005) distinguish between a change in the overall architecture and a change in one component when examining architectural innovation. A survey investigating product developments in 56 companies over 22 years found that the balance between radical change of the architecture and sustaining innovations within this architecture was a critical issue (Jones 2003). From this perspective a future orientated company should not always be radical or even faster in product innovation; rather a balance between radical platform changes and product developments based on existing architecture is the most sustainable strategy.

System knowledge is significantly relevant to successfully handle architectural innovation. *"Once an organisation has recognized the nature of an architectural innovation, it faces a […] major source of problems: the need to build and to apply new architectural knowledge effectively. Simply recognizing that a new technology is architectural in character does not give an established organisation the architectural knowledge that it needs. It must first switch to a new mode of learning and then invest time and resources in learning about the new architecture"* (Henderson and Clark 1990:17). A subtle challenge in this context is that, on the one hand lots of existing knowledge in the company is valuable and can be adapted to new products. On the other hand some knowledge that is currently not in use might, if it was used, harm the company. *"An established organisation setting out to build new architectural knowledge must change its orientation from one of refinement within a stable architecture to one of active search for new solutions within a constantly changing context"* (Henderson and Clark 1990:17). Beside the required architectural knowledge a different kind of organisational thinking, able to develop and commercialise such innovations is necessary, what faces most established companies with problems, *"because their architectural knowledge is embedded in channels, filters, and strategies, the discovery process and the process of creating new information (and rooting out the old) usually takes time"* (Henderson and Clark 1990:18).

Radical Innovations

The path to the development of radical innovations or disruptive technologies and the final outcome from developing them is unknown. Therefore companies have to work to different rules to achieve these outcomes and this presents opportunities for new entrants (Tidd, Bessant and Pavitt 2005). *"Radical innovation establishes a new dominant design and, hence, a new set of core design concepts embodied in* *components that are linked together in a new architecture"* (Henderson and Clark 1990:11). Hence, disruptive innovation frequently generates huge obstacles for well-established companies, because existing capabilities become useless, and new competition is able to conquer the market or even redefine the whole industry (Cooper and Schendel 1976; Daft 1982; Rothwell 1986; Tushman and Anderson 1986). Another factor is that well known methods for developing existing products are not suitable for ascertaining the potential of disruptive technologies. Best-in-class companies primarily pay attention to their key accounts; therefore they are often blind to new opportunities in the market and leave the field open to newcomers (Christensen and Bower 2008). To overcome this challenge, some firms develop parallel organisational structures to identify and trace ideas outside the company's mainstream thinking. *"Engineers need new ideas that snap into the skills they already have. They want to use the tools they've mastered"* (Gomory 1989:102). With this in mind, and thinking of (A) identifying and (B) integrating radical technologies by the same staff involved in everyday development business, may lead to *´not invented here´* phenomena or even to non recognition of these technologies and the associated potential for the company. The protection of new and different ideas or products from the mainstream organisation until they have gained a valuable commercial status is another very important purpose underlying such a dual structure (Buckland, Hatcher and Birkinshaw 2003; Tidd, Bessant and Pavitt 2005; Gomez, Raisch and Rigall 2007). *"Myopic incumbents frequently overlook that embryonic technologies often have much more potential for improvement than their mature counterparts and, therefore, will eventually engender superior performance/cost ratios"* (Valentin 2001:62). The observations on disruptive technologies by Christensen (2006) indicated that new firms enter the market in most cases from the bottom. Customer satisfaction with these new firms grows until they overtake the established product, system or solution. *"Disruptive technologies, however, are distinctly different from sustaining technologies. Disruptive technologies change the value proposition in a market. When they first appear, they almost always offer lower performance in terms of the attributes that mainstream customers care about. […] disruptive technologies […] are typically cheaper, smaller, simpler, and frequently more convenient to use. Therefore, they open new markets. […] the developers of disruptive technologies will always improve their products´ performance; they eventually are able to take over the older markets"* (Christensen 2006:264).

Radical innovation is about leaving the comfort zone of common expectations, by not looking at the obvious, and trying to accept insights from surprising results and sources and learning from this. *"Back in*

1992, some residents of a small Welsh town called Merthyr Tydfil were participating in a clinical trial of a new angina drug. Unfortunately for the pharmaceutical company, the drug didn't do much for angina. But, the drug did have a lot of side effects in men, including back pain, stomach trouble, and erections. If everyone at Pfizer had stayed focused on finding an angina drug, it would have stopped the trials and dropped the drug. But, by shifting the focus from the obvious to the unexpected - from primary effects to side effects - it generated the insights that became one of the most successful drugs ever: Viagra" (Williams 2011:61). The Viagra case is a good example of an unexpected disruptive product development. However while identifying the effects of the new drug was possible, it was not possible to predict the success of the drug. *"Markets that do not exist cannot be analysed [...]. Not only are the market applications for disruptive technologies unknown at the time of their development, they are unknowable. The strategies and plans that managers formulate for confronting disruptive technological change, therefore, should be plans for learning and discovery rather than for execution"* (Christensen 2006:165). Analysing the Viagra example, a further conclusion can be drawn: the frequency of identifying a disruptive innovation for a company within a defined process cannot be very high. Ettlie (1999) claims that only 6 - 10% of all successful projects called innovation are really new to the world or indeed disruptive innovations. Christensen (2006) discovered that established companies are familiar with developing disruptive innovations and building prototypes from them. However most of these disruptive innovations failed as established companies tended to favour allocating resources to existing products. In his research leading to *´The Innovators Dilemma´* (2006), he found, that historically, no new technologies were involved in disruptive innovations. It was always a combination of existing components built around proven technologies in a new way, which offered customers a combination of features previously unknown and unavailable. Consequently, Christensen (2006) rejects technology competence as the reason for companies' failure at disruptive innovation; rather he identifies senior management´s decision making as the problem, *"what the best executives in successful companies have learned about managing innovation is not relevant to disruptive technologies"* (Christensen 2006:156). Nevertheless, a new and different set of approaches in conducting disruptive innovation is required; likewise an organisational structure which is able to identify weak signals about discontinuities and the potential to allocate resources in projects lying far outside the company's usual innovation path (Henderson and Clark 1990; Buckland, Hatcher and Birkinshaw 2003; Tidd, Bessant and Pavitt 2005; Vanhaverbeke and Peeters 2005; Christensen 2006).

2.3.1.2. Process innovation

Innovations also concern processes through which goods are developed, produced, and delivered. Garvin (1998) defines process, as something that provides a likely solution, or in a broader sense, a collection of activities and tasks, which together transform inputs into outputs. He differentiates the organisational framework (Table 2.2) into work, behavioural and change processes. According to the OECD (2007:618) definition *"a process innovation is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software. Context: Process innovations can be intended to decrease unit costs of production or delivery, to increase quality, or to produce or deliver new or significantly improved products"*.

	Work Processes	**Behavioral Processes**	**Change Processes**
Definition	Sequences of activities that transform inputs into outputs	Widely shared patterns of behavior and ways of acting/interacting	Sequences of events over time
Role	Accomplish the work of the organization	Infuse and shape the way work is conducted by influencing how individuals and groups behave	Alter the scale, character, and identity of the organization
Major categories	Operational and administrative	Individual and interper-sonal	Autonomous and induced, incremental and revolutionary
Examples	New-product develop-ment, order fulfillment, strategic planning	Decision making, com-munication, organizational learning	Creation, growth, trans-formation, decline

Table 2.2 Organisational processes framework (Garvin 1998:17)

Process innovation such as the capability of doing something in a way nobody else is able to, or in a manner that no one can do it better/cheaper results in a source of competitive advantage to a company. *"Whilst new products are often seen as the cutting edge of innovation in the marketplace, process innovation plays just as important a strategic role. Being able to make something no one else can, or to do so in ways which are better than anyone else is a powerful source of advantage. [...] Unless an organisation is able to move into further innovation, it risks being left behind as others take the lead in changing their offerings, their operational processes or the underlying models which drive their business"* (Tidd, Bessant and Pavitt 2005:6). Zook and Allen (2003:5) within their investigations found, *"even when competitors work in the same geographic markets, seek the same customers, and are affiliated with the same channels, the company with a repeatable formula will typically grow faster and more profitably than its rivals"*.

Process innovation is also the process to innovation, and can be seen in different modes. One mode is ´doing what the firm already does, but better´; another mode, in contrast, is ´going where the rules just have shifted and doing most things different´. Referring to Christensen and Raynor (2003), companies confronted with fast changing environments need to establish competencies and processes to incorporate both modes of innovation. For these modes a distinct set of capabilities must be managed (Tidd, Bessant and Pavitt 2005:84).

- *Recognizing*: scanning the environment of triggers for change. Drucker (1985) suggests that the search process be systematic rather than accidental. He recommended the following as source of change: changes in industry or market structure, process needs, demographic changes, unexpected successes or failures, incongruities (gaps between expectations and reality), new knowledge, and changes in perception to be monitored on a regular basis. In cases of new business development Tidd, Bessant and Pavitt (2005) additionally identified customer requests for new solutions, investigation of the firm´s internal resources, processes, and competencies, plus the examination of related markets, services and technologies as sources for ideas.

- *Aligning*: assuring the fit between the planned change and the company's strategy – not because innovating is fashionable. *"Innovating firms without the requisite manufacturing and related capacities may die, even though they are the best at innovation"* (Teece 1986:285).

- *Acquiring*: alignment of the firm's own limitations with the ability to connect to external resources, and to transfer these outside resources into the company´s relevant organisational points. Capon and Glazer (1987:2) distinguish three sources of resources or know-how *"product technology (the set of ideas embodied in the product), process technology (the set of ideas involved in the manufacture of the product or the steps necessary to combine new materials to produce a finished product), and management technology (the set of management procedures associated with selling the product and administration of the business unit)"*.

- *Generating*: cultivate the in-house ability to develop some items of new technology through internal R&D. *"Engineers need to go out and find what they can use and ´pull´ it into the* *company. This works far better than anyone trying to ′push′ ideas from the outside that really may not fit"* (Gomory 1989:103). A different perspective is captured by von Hippel (1988), from his research over a period of twelve years interviewing hundreds of people from different industries. He identified by distinguishing the functional sources[7] of innovation that successful innovation is an interaction between ′push′ and ′pull′. Especially at process innovation (in contrast to the mainstream assumption) is ′pushed′ by users and then applied by producers.

- *Choosing*: pick out the most suitable reaction to the recognised triggers of change, which fits best to the company's strategy, resources, and technology network. Zook and Allen (2003:2) found that *"most sustained profitable growth comes when a company pushes out the boundaries of its core business into an adjacent space. […] because growing business is normally a complex, experimental, and somewhat chaotic process"*.

- *Executing*: starting new product, system, or process development from scratch up to the final launch, with continuous controlling and monitoring measures. *"As Edison realized, innovation is more than simply coming up with good ideas; it is the process of growing them into practical use. Definitions of innovation may vary in their wording, but they all stress the need to complete the development and exploitation aspects of new knowledge, not just its invention"* (Tidd, Bessant and Pavitt 2005:65).

- *Implementing*: ensuring that management accept change so as the new innovation can be used effectively. *"Little is learned in the laboratory or in product-development committee meetings. True learning begins only when a product – imperfect as it may be – is launched"* (Hamel and Prahalad 1991:87).

[7] Functional source of innovation: von Hippel (1988) distinguishes innovations by the source wherefrom the innovation first was developed. In his observation he identified that innovation not always comes from the final producer, innovation can be developed by product users, suppliers, and others. *"Major product innovations in some fields, such as scientific instruments, are almost always developed by product users. In sharp contrast, product manufacturers are the developers of most of the important innovations in some other fields, and suppliers in still others"* (von Hippel 1988:5).

- *Learning*: use lessons learned to reflect and improve the process. *"A repeatable model allows managers to refine skills and systematize processes that are developed mostly through guesswork the first time"* (Zook and Allen 2003:4).

- *Developing the organisation*: establishing effective and efficient routines in structure, process, behaviour, and mode switching to support and expand innovation. *"No matter how well developed the systems are for defining and developing innovative products and processes they are unlikely to succeed unless the surrounding organisational context is favourable. […] Increasingly, innovation is becoming a corporate-wide task, involving production, marketing, administration, purchasing and many other functions; this provides strong pressure for widespread organisational change towards more organic models"* (Tidd, Bessant and Pavitt 2005:473&474).

2.3.1.3. Position innovation

Position innovation focuses on changes in the way established products, solutions, services or processes are shaped and/or transferred. Position innovation can be seen in a comparable way to architectural innovation (Henderson and Clark 1990:10) *"change in the way in which the components of a product are linked together"*, though not in the sense of changes in the components linking, but rather in the change a different usage than was originally intended.

Henry Ford changed transportation, not by inventing the automobile; his position innovation was the change from handcrafted manufacturing, to a linked automated manufacturing process, by transferring the stockyard processes. This change of perspective finally ensured mass production and hence the ability to deliver transportation to everyone at an affordable price. Further examples of position innovations are the Levi Strauss jeans, developed as workers´ clothing and then reframed as a fashion article. Off-road-vehicles originally were developed to cross rough terrain, but are now used as a lifestyle family car called SUV (sports utility vehicle). *"Innovation is driven by the ability to see connections, to spot opportunities and to take advantage of them. […] But innovation is not just about opening up new markets – it can also offer new ways of serving established and mature ones"* (Tidd, Bessant and Pavitt 2005:3).

Position innovation often emerges from looking at something from a different perspective and imagining a different usage for it. *"People actually do not buy gasoline. They cannot see it, taste it, feel it, appreciate it, or really test it. What they buy is the right to continue driving their cars"* (Levitt 1975:9). The *´desire of travelling from A to B´* provides similar possibilities such as using an electric car, travelling by motor cycle, by plane, or by ´beaming´ if such technology existed. *"The reason disruptive technologies and new distribution channels frequently go hand-in-hand is, in fact, an economic one. [...] Just as disruptive technologies don't fit the model of established firms for improving profits, they often don't fit the models of their distributors, either"* (Christensen 2006:248).

2.3.1.4. Paradigm innovation

Paradigm innovation relates to changes in the intellectual pattern which frames what the company, or even an entire sector or industry does. Paradigm innovation is about inventing things that people are not aware they currently need. *"Go back a decade or two. How many of us were asking for microwave ovens, cellular telephones, compact disc players, home fax machines, or electric whiteboards? Of course it is important to listen to customers, but it is hard to be a market leader if you do no more than that"* (Hamel and Prahalad 1991:85). Hamel and Prahalad (1991) distinguish three types of firms, (A) the everlasting followers, who ask their customers what they want; (B) those that push customers in directions they do not want; and (C) companies which provide customers with products/solutions they want, before they know it by themselves. The latter are companies that understand the power of paradigm innovation and rethink the business, examples include low cost airlines, online banking, Cirque du Soleil[8], or iTunes. Williams (2011:3) calls paradigm innovation as disruptive thinking *"disruptive thinking is not so much about how to spot and react to disruptive changes in technology and the marketplace; it's about how to be the disruptive change. Being the disruptive change in an industry is exactly the sort of thing that new start-ups and small-scale enterprises are best at"*. Essential for paradigm innovation or disruptive thinking is not *"seeing things as they are and asking, Why? [it is] the ability to imagine things as they never were and ask, What if?"* (Williams 2011:18).

[8] *"From a group of 20 street performers at its beginnings in 1984, Cirque du Soleil is a major Québec-based organisation providing high-quality artistic entertainment. The company has 5,000 employees, including more than 1,300 artists from more than 50 different countries. Cirque du Soleil has brought wonder and delight to more than 100 million spectators in more than 300 cities on six continents. The mission of Cirque du Soleil is to invoke the imagination, provoke the senses and evoke the emotions of people around the world"*. www.cirquedusoleil.com (Accessed December 2011).

Blue ocean strategy (Kim and Mauborgne 2005)

Paradigm innovation according to Kim and Mauborgne´s (2005) blue ocean strategy is not to compete in crowded markets rather real opportunity occurs by creating new unchallenged market space. Kim and Mauborgne define a market as two different kinds of oceans: a blue and a red one. Red oceans represent all industries known today whereas blue oceans embody all sectors and industries that at present are non-existent and unknown (Table 2.3). The idea of *"creating the future [...] that the industry evolves in a way that is maximally advantageous [...] may not fit neatly within the boundaries of current business units and divisions"* (Hamel and Prahalad 1994:127) is not new, but so far, a models to conquer them, were missing.

Red Ocean Strategy	Blue Ocean Strategy
Compete in existing market space	Create uncontested market space
Beat the competition	Make the competition irrelevent
Exploit existing demand	Create and capture new demand
Make the value-cost trade-off	Break the value-cost trade-off
Align the whole system of a firm´s activities with its strategic choice of differentiation ***or*** low cost	Align the whole system of a firm´s activities in pursuit of differentiation ***and*** low cost

Table 2.3 Strategies for red and blue oceans (based on Kim and Mauborgne 2005:17)

The keystone at blue ocean strategy is value innovation. Kim and Mauborgne (2005) call it value innovation because it focuses on beating the competition by establishing new unchallenged market space as a way to create value for customers and companies. Value innovation and common value added differ in the following way. Value innovation develops new things or creates well known things in a fundamentally different way whereas value added is generated by simply doing the same things in a better way. The studies of Kim and Mouborgne (2005) show, that value innovation does not identify solutions for existing issues, it's rather a question of re-defining it. To re-define market space, Kim and Mouborgne (2005) developed the four actions framework (Figure 2.9) and the complementary Eliminate-Reduce-Raise-Create Grid (ERRC).

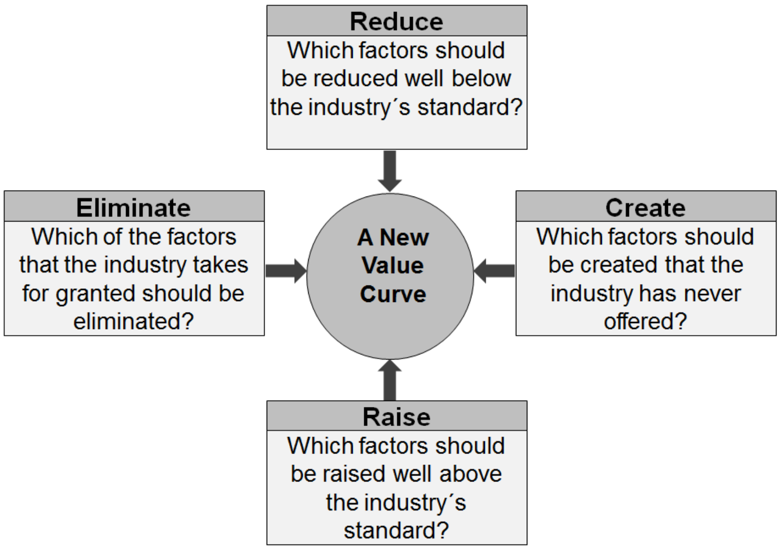


Figure 2.9 The four actions framework (based on Kim and Mauborgne 2005:26)

Kim and Mauborgne (2011) identified six paths to examine in a methodical way when redefining market boundaries and creating new unchallenged market space. *"These are:*

1. *looking across alternative industries - instead of focusing on competing within an industry,*
2. *looking across strategic groups within industries - instead of a company confining itself to established strategic groups,*
3. *looking across the chain of buyers - instead of focusing on the same buyer group as the rest of the industry,*
4. *looking across complementary products and services - instead of a company limiting itself to the scope of an industry's products and services,*
5. *looking across functional or emotional appeal to buyers - instead of accepting an industry's functional or emotional orientation,*
6. *looking across time - instead of focusing on the same point in time as the rest of the industry".*

Another tool to identify and evaluate the potential benefit for customers is provided by the *buyer utility map* (Figure 2.10). It illustrates the firm's utility levers in combination with the stages of buyers' experiences, during the product life cycle. The buyer utility map enables firms to compare current industry focus with new paradigm innovations (blue ocean offerings) and beyond that, offers the opportunity to identify new product/solution characteristics.

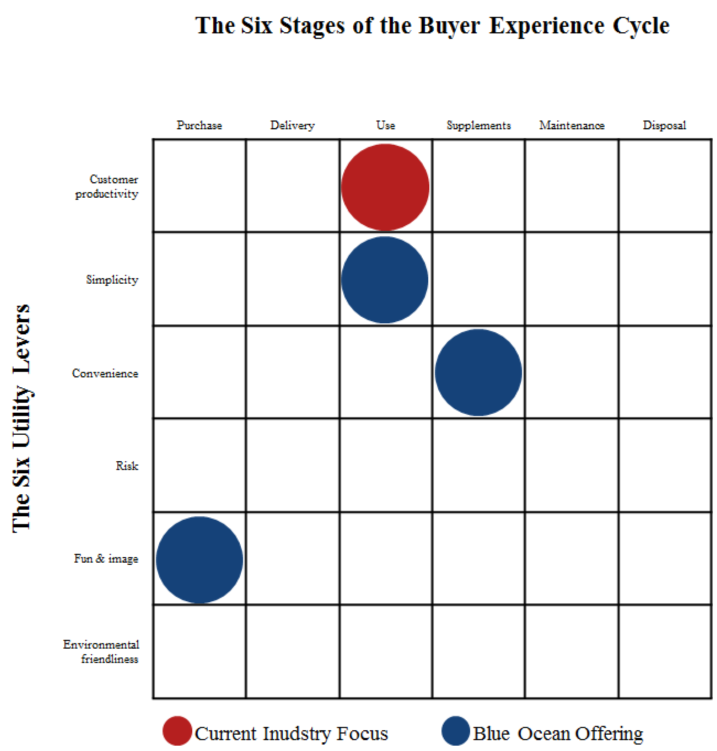


Figure 2.10 The buyer utility map (based on Kim and Mauborgne 2005:111)

2.3.1.5. Partner innovation

Partner innovation is how innovation is created and implemented by collaborating with different kinds of organisations, partners, and networks. Almost all companies have a network that they conduct business with; customers, suppliers, distributors, universities, R&D consortia and others. Most of these networks have grown from long-term relationships, developed through recurring commercial activities that increased mutual confidence (Bidault and Fischer 1994). But *"faced with rapid changing technologies, shorter product life cycles, and heightened global competition"* (Cooper, Edgett and Kleinschmidt 2001:361), firms might find it hard to stay in business or, alternatively to grow, as the firm would need to possess all the relevant resources in-house. The challenge will be developing the right products/solutions for the market - *"market leader know what customers want before customers know it themselves"* (Hamel and Prahalad 1991:85) - in an even shorter time, without having all the resources and capabilities within the company. In today's competitive environment R&D is a critical aspect of a firms' success and consequently the efficient use of existing R&D resources is important. Faced with fast changing markets, companies recognise that *"one company's peripheral technologies are usually another's core activities, and that it often makes sense to source such technologies externally, rather than to incur the risks, costs and most* *importantly of all, timescale associated with-in-house development"* (Tidd, Bessant and Pavitt 2005:286). Zook and Rigby (2002:82) found in their studies, *"that some of the fastest growing and most profitable industries are finding open-market innovation to be a critical new source of competitive advantage"*. The reasons why companies collaborate are manifold, they collaborate to…

- reduce expenses for the development of new competencies and skills,
- reduce development expenses for new technologies,
- reduce expenses for market development and market entry,
- reduce risk concerning new developments and market entry,
- achieve economies of scale,
- shorten the development and commercialisation period for new products/solutions,
- accelerate the companies learning,
- broaden the product range,
- respond to technology changes,
- respond to changing customer needs.

Tidd, Bessant and Pavitt (2005:317), subsume the causes for collaborations in two fields, access to markets and technology takeover. *"The most common reason for international alliances is market access, whereas the most common reason for intraregional alliances is technology acquisition"*. To benefit from collaboration several principles should be considered because collaboration is a different form of competition and learning from partners has priority (Hamel, Doz and Prahalad 1989). *"A strategic alliance can strengthen both companies against outsiders even as it weakens one partner vis-à-vis the other. […] Cooperation becomes a low-cost route for new competitors to gain technology and market access. […] It takes so much money to develop new products and penetrate new markets that few companies can go it alone in every situation. […] Time is another critical factor"* (Hamel, Doz and Prahalad 1989:190). However collaboration or alliances are no panacea, a UMIST (University of Manchester Institute of Science and Technology) study of 100 UK-based alliances, realised some risks related with cooperation:

- *"leakage of information,*
- *loss of control or ownership, and*
- *divergent aims and objectives, resulting in conflict"* (Tidd, Bessant and Pavitt 2005:290).

A further outcome from this study was that nearly 50% of the involved firms believed that cooperation makes development more complex and expensive. Nevertheless, Zook and Rigby (2002:82) found, that *"Companies that collaborate with outsiders on their R&D reap a higher percentage of their total sales from new products than companies that don't collaborate"*.

Partner innovation is not confined to collaboration among companies; firms can innovate with people or groups outside the traditional company's network. Sources for partner innovation could be universities, research consortia, lead user[9], or even anonymous innovation networks. In this context Chesbrough (2003) uses the term *´open innovation´*. This term illustrates the distinction between common ´closed´ innovation strategies (with limited interactions between the company and their external environment) and the wide field of external knowledge exploration and exploitation (Lichtenthaler 2011). *"All of the traditional views are based upon ownership and control as the key levers in achieving strategic success. All focus largely within the firm, or within the value chain in which the firm is embedded. None take much notice of the potential value of external resources that are not owned by the firm in question, but may nonetheless create value for the firm"* (Chesbrough and Appleyard 2007:60). Open innovation is defined as *"the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively"* (Chesbrough, Vanhaverbeke and West 2006:1). Open innovation can be divided in *inbound* open innovation and *outbound* open innovation (Chesbrough and Garman 2009; Gassmann, Enkel and Chesbrough 2010; Lichtenthaler 2011). Inbound open innovation is an outside-in process, where the company acquires knowledge, in terms of the development of substantial parts/components from external sources. Outbound open innovation is an inside-out process, where the company commercialises internal technological knowledge to others outside its own walls. Open innovation seems to be a helpful option (in response to disaggregated value chains) for companies that wish to expand their innovation capabilities (Gassmann, Enkel and Chesbrough 2010), since not everything can be done in-house (Lichtenthaler 2011). The challenges with open innovation includes the management and control of something the firm doesn´t own and the gaining of trust between network participants without excessive red tape. The area of open innovation is just at its beginning, and opens a wide field for research.

[9] *"Lead users face needs that will be general in a marketplace, but they face them months or years before the bulk of that marketplace encounters them, and lead users are positioned to benefit significantly by obtaining a solution to those needs"*. (von Hippel 1988:107).

2.3.2. Organisational change

As illustrated in the previous chapters, innovation - no matter which type or category - does not occur in a vacuum. One very important factor in innovations prospering is the organisational context in which these innovations are embedded (Tidd, Bessant and Pavitt 2005). *"Organisations need to continuously renew themselves if they are to survive and prosper in dynamic environments. This renewal challenge is even more pronounced in the current business environment characterized by fast changes in customers, technologies, and competition. [...] Underlying this strong interest is the notion that ′really new′ products are crucial to firm survival in the current fast-changing business environment"* (Danneels 2002:1095). Companies able to react to changing environments by organising themselves to meet future requirements and who can capably manage new technologies as a business function (Burgelman and Rosenbloom 1989), own a value source of competitive advantage, allowing them to be one step ahead of competition. *"The essence of strategy lies in creating tomorrow's competitive advantages faster than competitors mimic the ones you posses today"* (Hamel and Prahalad 1989:69). In the next section factors that influence organisations evolution will be discussed, and this will lead to a subsequent discussion of opportunities in organisational development.

2.3.2.1. Factors of influence

Organisational change does not occur in the green countryside; rather it is influenced by different factors internal and external to the organisation. This paragraph describes some important dependencies and gives an overview of associated models and concepts.

Path dependency

Organisational structures, products, and innovations are built through a continuous process of improvements and developments over periods that span decades or even longer. This unique history sets the cornerstone of each firm's current position and abilities to conduct business (Barney 1991; Hunt and Morgan 1996; Greiner 1998; Valentin 2001; Tidd, Bessant and Pavitt 2005). *"Where a firm can go is a function of its current position and the paths ahead. Its current position is often shaped by the path it has* *travelled. […] Thus a firm's previous investments and its repertoire of routines (its history) constrain its future behaviour. […] This is because learning is often a process of trial, feedback, and evaluation"* (Teece, Pisano and Shuen 1997:522). Depending on a firm´s past it may be costly or even impossible for competing firms to catch up (Dierickx and Cool 1989; Valentin 2001; Barney and Clark 2009). As a consequence, most companies are caught by their past activities, responding to current and/or future challenges is to some extent limited by what has been done or established by the firm before. This may be a reason, for the findings of MacDonald (1985:590) that *"firms did not diversify at random, but rather were more likely to diversify into industries with characteristics similar to their primary industries"*. Nonetheless path dependency should not be seen as trap for companies; instead it should be understood as a competitive advantage that enables the company to break away from its competitors. Competition will find it very challenging if not impossible to replicate core competencies that have resulted from the path a firm has followed (Tidd, Bessant and Pavitt 2005). *"Actions in the past determine much of what will happen to a company in the future. […] The intriguing paradox is that by learning more about history, we may do a better job in the future"* (Greiner 1998:67). With this in mind, the task should be to identify processes that link the company's history and path dependent organisation with flexible structures that can respond to today's fast changing challenges – one option could be the establishment of an independent organisation. Mintzberg (1987:75) mentioned in his article Crafting Strategy: *"While strategy is a word that is usually associated with the future, its link to the past is no less central. As Kierkegaard once observed, life is lived forward but understood backwards. Managers may have to live strategy in the future, but they must understand it through the past"*.

Resource allocation

The success strategies of companies regarding existing customer needs are exactly those that inhibit activities in non customer related or disruptive innovations (Christensen 2006). One reason for such behaviour is, the resource-allocation process, because *"successful companies want their resources to be focused on activities that address customers´ needs, that promise higher profits, that are technologically feasible, and that help them accomplish these things also to do something like nurturing disruptive technologies - to focus resources on proposals that customers reject, that offer lower profit, that underperform existing technologies and can only be sold in insignificant markets - is akin to flapping ones* *arms with wings strapped to them in an attempt to fly. Such expectations involve fighting some fundamental tendencies about the way successful organisations work and about how their performance is evaluated"* (Christensen 2006:112). In short, resource allocation is the mechanism that decides which initiatives get resources and money. The resource allocation process and its major components; definition, impetus, and determination of context are described in more detail by Bower (1970). Confronted with new technologies, and radical innovations, Christensen (2006) suggests two options for escaping the resource allocation processes, (A) convincing the decision maker, to do it anyhow, because of its long-term strategic significance, or (B) build an independent organisation that develops such innovations. Prahalad and Hamel (1990:89) recommend creating *"a road map of the future that identifies which core competencies to build and their constituent technologies [and] make resource allocation priorities transparent to the whole organisation"*. Whereas Kim and Mauborgne (2005) propose asking which activities devour lots of resources but have marginal effects on performance and vice versa. They assert that by asking this, the organisation will quickly gain an overview and the knowledge needed to decide how to allocate resources to the really important projects. Because *"like all organisational processes, strategic planning is subject to the first law of bureaucracy: if you give a smart, ambitious person a job to do, no matter how meaningless, he or she will try to make it bigger and more important"* (Hayes 1985:114).

Life cycle models and concepts

The original life cycle models explained life phases and cycles in technical and technological systems in an analogous way to biological systems with limited lifespan (Herrmann 2010), with phases of rise and decay.

In literature mainly three kinds of concepts are distinguished:

- *Life phase models* (flow-orientated) show the correlation between material/product flows and energetic flows of a system in a sequential way. Each single phase is oriented in a time logical sequence through the whole product process from well to drain, production of raw materials, product development, production, usage, disposal or recycling (Deng 1995; Merkamm and Weber 1996).

- *Life cycle models* (condition-orientated), show the dynamics of systems by illustrating the movement of important variables over time. To simplify, each system can be illustrated/described as black box with inputs and outputs that affect some systems behaviour, differing over time. By examining a systems life cycle, repetitive characteristics and cyclic patterns can be observed, with the result that a classification in different life stages is possible. The most popular concept (Fink 2000, Simon 2008, Hermann 2010) is the product life cycle model with four or five stages, (1) the market introduction stage, (2) the growth stage, (3) the maturity stage, (4) the saturation and (5) decline stage. The classic life cycle model (Figure 2.11) shows the revenue/profit progress of an object (product or product category) over its time span, starting with its market introduction.

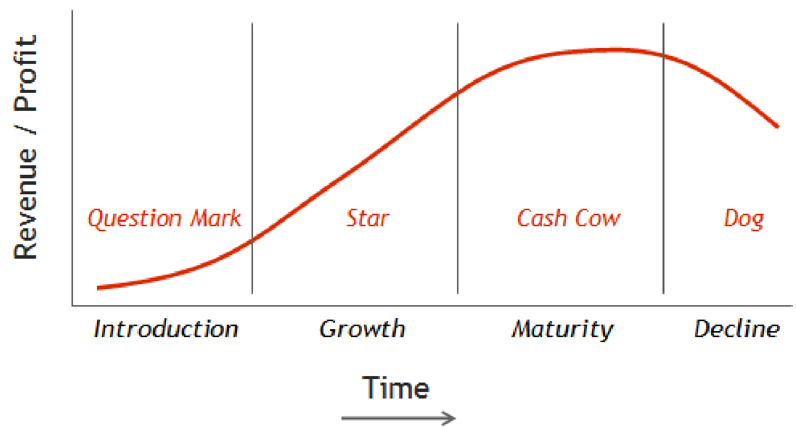


Figure 2.11 Life cycle model, referring to the BCG - Matrix

- *Integrated life cycle models* (phase-orientated) enlarges the original life cycle model with its stages of introduction, growth, maturity, saturation by including further stages at the beginning and/or at the end of the life cycle. The additional stages at the beginning include product creation with the elements innovation and development, and stages at the end include after market activities like service, and maintenance.

Beside products or product categories, life cycle models are used for technologies (Ford and Ryan 1981; Höft 1992; Christensen 2006). Ford and Ryan (1981) distinguish six stages in their technology life cycle model; (1) technology development, (2) technology application, (3) application launch, (4) application growth, (5) technology maturity, and (6) degraded technology. The main parameter for each stage is the spread (or usage) of the viewed technology.

As well as the product life cycle model, the Arthur D. Little (Höft 1992) technology life cycle concept classifies the four stages; introduction, growth, maturity, and decline. The typical shape of this life cycle concept is an S, and is therefore often called the S-curve concept. The S-curve concept is usually used to identify/illustrate limits of performance or saturation of a technology. *"The technology S-curve forms the centrepiece of thinking about technology strategy. It suggests that the magnitude of a product's performance improvement in a given time period or due to a given amount of engineering effort is likely to differ as technologies mature. The theory posits that in the early stages of a technology, the rate of progress in performance will be relatively slow. As the technology becomes better understood, controlled, and diffused, the rate of technological improvement will accelerate. But in its mature stages, the technology will asymptotically approach a natural or physical limit such that ever greater periods of time or inputs of engineering effort will be required to achieve improvements"* (Christensen 2006:44). Figure 2.12 shows the S-curves of a technology 1 and a technology 2, the difference between both curves shows the limits of technology 1 or the potential of technology 2 that might remove/substitute the current technology in the future. *"Movement along a given S-curve is generally the result of incremental improvements within an existing technological approach, whereas jumping onto the next technology curve implies adopting a radically new technology"* (Christensen 2006:11).

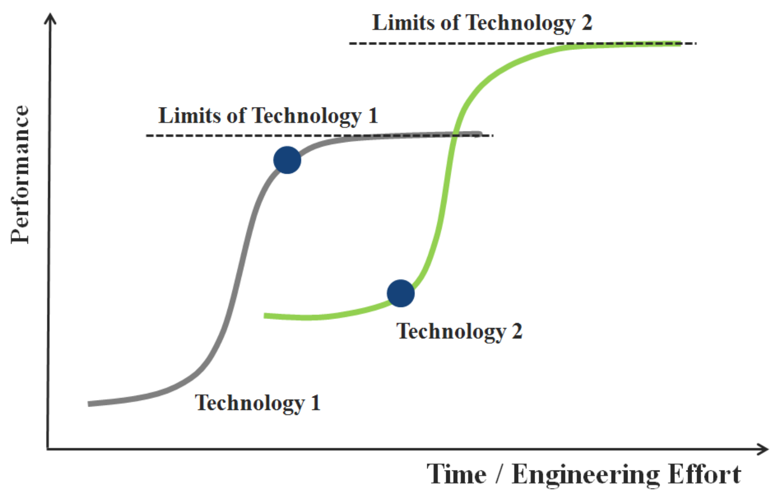


Figure 2.12 S-curve concept (Höft 1992; Christensen 2006)

Life cycle concepts also built the base for organisational models; two representative models are from Gomez and Zimmermann (1999) and Greiner (1998). The Greiner (1998) growth model (Figure 2.13) is subdivided into five phases which characterise different periods of the organisation: *"each evolutionary period is characterized by the dominant management style used to achieve growth; each revolutionary period is characterized by the dominant management problem that must be solved before growth can continue. […] It is important to note that each phase is at once a result of the previous phase and a cause for the next phase"* (Greiner 1998:58). Analysing research Greiner (1998) found five key dimensions describing an organisation: the growth rate of its industry, its stages of evolution and revolution, its age, and its size. The model has its critics. Christine Volkmann (Professor for company start-ups at the University of Wuppertal) claims that numerous models are available, but in real life, they are precious little help. She does not declare the assumptions of Greiner (1998) are wrong, but is sceptical of its value as assistance to a company (Höhmann 2010).

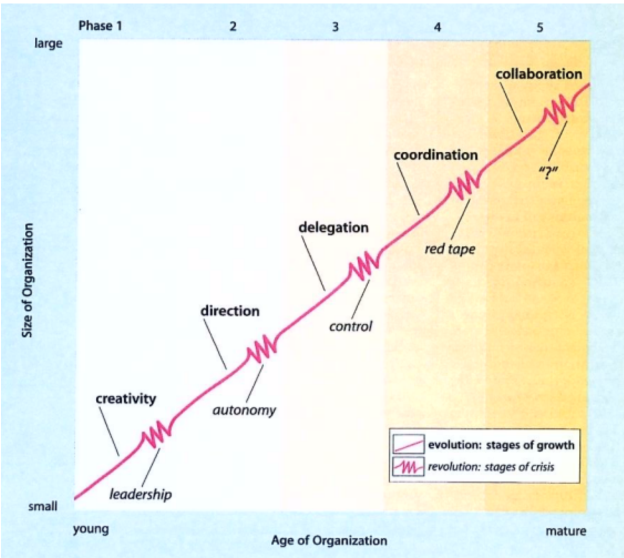


Figure 2.13 The five phases of growth (Greiner 1998:58)

All life cycle models have one thing in common in that they try to detect the position of their viewed object (product, technology, and organisation) in order to develop further actions to establish or defend competitive value added. But Hamel and Prahalad (1989:73) argue that following the life cycle model without critical scrutiny the definition and interpretation of the different stages may lead to serious misinterpretations: *"concepts like ´mature´ and ´declining´ are largely definitional. What most executives mean when they label a business mature is that sales growth has stagnated in their current geographic* *markets for existing products sold through existing channels. In such cases it's not the industry that is mature, but the executives´ conception of the industry"*. Comparable argument is presented by Dhalla and Yuspeh (1976:105), when they claim, *"at certain points, a product may appear to have attained maturity when actually it has only reached a temporary plateau in the growth stage prior its next big upsurge"*. The most uncertain variable in almost all life cycle models is the time axis, because it is very difficult to determine exactly the life stage of an object (Prahalad and Hamel 1989). *"Hundreds of marketing studies have attempted to fit the adoption of specific products to the S-curve, ranging from television sets to new drugs. In most cases mathematical techniques can provide a relatively good fit with historical data, but research has so far failed to identify robust generic models of adoption"* (Tidd, Bessant and Pavitt 2005:272).

2.3.2.2. Organisational development

Today's challenge is to develop an organisational structure that can respond to fast changing requirements and develop innovative behaviour for new and different applications, markets, customers, and business models. *"Organisational transformation must be driven by a point of view about the future of the industry"* (Hamel and Prahalad 1994:127). The creative combination of the system in place and the development of new and/or different disciplines within the company may be a factor for success. Teece (1986: 285&288) in this context states *"innovating firms without the requisite manufacturing and related capacities may die, even though they are the best at innovation. [...] In almost all cases, the successful commercialization of an innovation requires that the know-how in question be utilized in conjunction with other capabilities or assets. Services such as marketing, competitive manufacturing, and after-sales support are almost always needed"*.

Zook and Allen (2003:2) draw two major conclusions from their research: (1) *"most sustained, profitable growth comes when a company pushes out the boundaries of its core business into an adjacent space"* and (2) companies develop and follow *"a formula for expanding those boundaries in predictable, repeatable ways"*. They found that companies that follow both of these rules were twice as likely to be successful as the average company. The success rate was found to be 25% when companies used this repeatable model. This model enabled them to improve their skills and systemise processes thereby benefitting from a learning curve effect. Mode switching from component to system requires a strong base to build on, for instance a gear wheel manufacturer might evolve into a drive train specialist. In contrast Christensen (2006) claims, using examples of Micropolis Corporation and Digital Equipment Corporation (DEC), that a single organisation is incapable of tracing radical/disruptive innovations while remaining competitive in its ancestral markets. His advice for such a dilemma is to separate the organisation, because different organisations and types of thinking are needed. Other authors support this position as well (Campbell, Birkinshaw, Morrison and van Basten Batenburg 2003; Henderson 2006).

Hamel and Prahalad (1989:67) suggest five important topics for an organisation to be effective at building corporate competitive advantage; *"(1) creating a sense of urgency or quasi crisis (by amplifying weak signals, instead of allowing inaction to precipitate a real crisis), (2) developing a focus for competitors at all company levels (everyone should benchmark his/her efforts to personalise the challenge), (3) providing the employees with all the necessary skills to work efficiently, (4) permit the organisation time to resolve one challenge before launching another, and (5) track and monitor the progress by clear milestones". "The goal is to make the challenge inescapable for everyone in the company"* (ibid. 1989:68).

The elements that most affect what an organisation can and cannot do are its values, its processes, and its resources. In the start-up stages the resources are most important, over time the spotlight shifts towards processes and values of the organisation (Christensen 2006). *"Hence, the location of the most powerful factors that define the capabilities and disabilities of organisations migrates over time – from resources toward visible, conscious processes and values, and then toward culture"* (Christensen 2006:195). One reason companies fail, is that they fail to create processes that enable them to develop successful products in sequence. Christensen and Raynor (2003) hold the opinion that almost all forms of change require a new set of core elements; resources, processes, and values. However, very rarely all three dimensions need to be replaced. To illustrate this they developed a framework (Figure 2.14) to illustrate an appropriate organisational structure that indicates which resources/elements to sustain and which to acquire/develop.

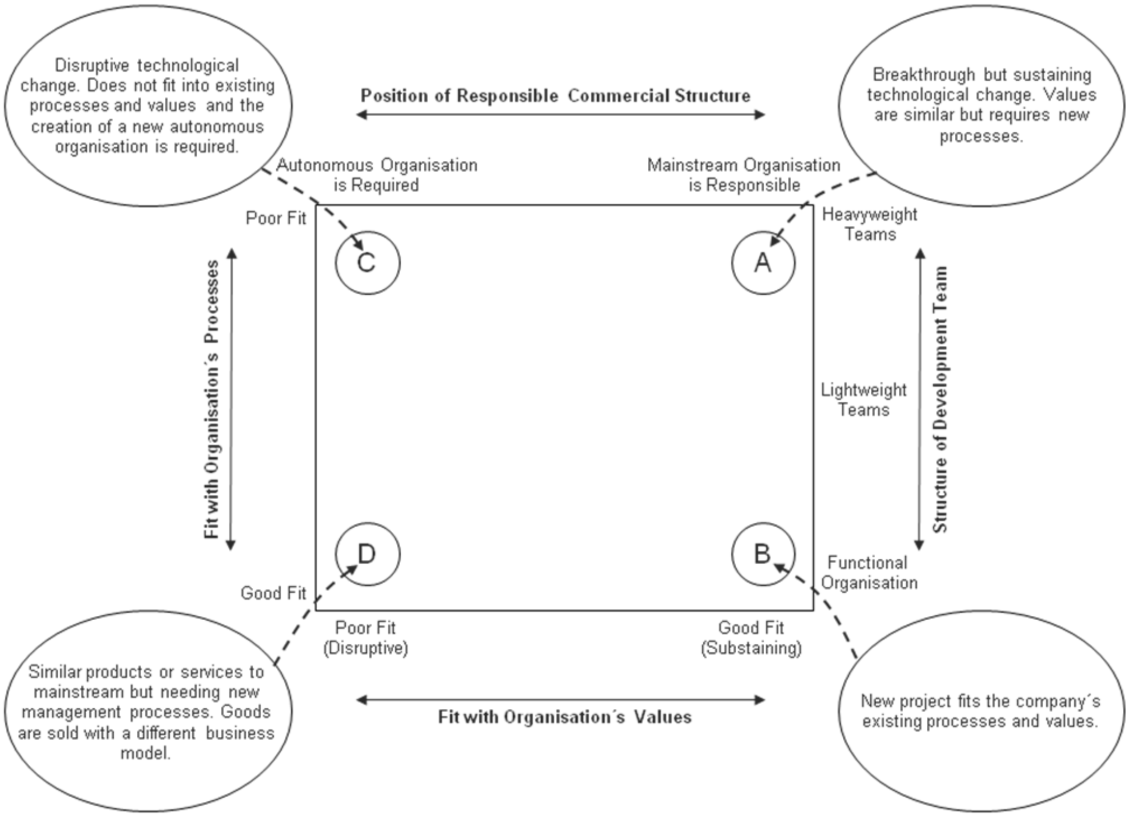


Figure 2.14 Framework for Finding the Right Organisational Structure and Home (following Christensen and Raynor 2003:191)

Organisations seeking new businesses, have three options: (1) changing all aspects of the organisation (structure, processes, and culture), which is time consuming with an uncertain outcome, (2) acquisition of an organisation with the required competencies, which is expensive, needs an appropriate option to exist and the outcome is likewise uncertain, and (3) establishing a separate organisation, with different structures, processes and culture (Christensen 2006). This option in literature is called (internal) corporate venturing (von Hippel 1988; Block and McMillan 1993; Tidd and Taurins 1999; Tidd, Bessant and Pavitt 2005; Henderson 2006) or new business development (Vanhaverbeke and Peeters 2005); it enables the venture to be equipped with assets of a big company with the benefits of a start-up company. Corporate ventures or new business development require the necessary knowledge to develop the required processes and products and the ability to advertise and distribute its solutions to the market and the parent company. *"A corporate venture differs from conventional R&D and product development activities in its objectives and organisation. The former seeks to exploit existing technological and market competencies, whereas the primary function of a new venture is to learn new competencies"* (Tidd, Bessant and Pavitt 2005:427). Success rates of corporate ventures vary, but on average about 50% of all started ventures become operating units. Of these some are profitable after three years and nearly half of the remaining after six (Block and McMillan 1993; Tidd and Taurins 1999).

"New business development in particular – offers a suitable organisational framework in which the multiple and often contradictory demands of mainstream businesses and the new business development activities of the company cannot only coexist but do actually nurture the innovative capability of the firm" (Vanhaverbeke and Peeters 2005:255).

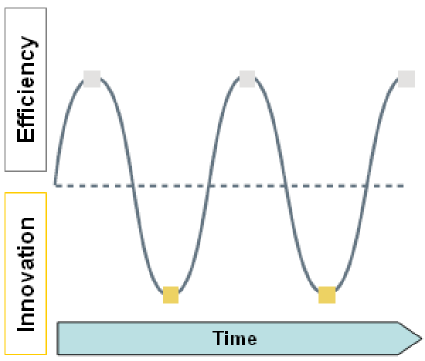
Gomez, Raisch and Rigall (2007) distinguish between disruptive and evolutionary market changes; to face these challenges they suggest four organisational strategies: (1) circular changes, (2) geographic separation, (3) parallel organisation, and (4) integrated network.

(1) Circular change organisations (Figure 2.15), alternate between centralised and decentralised structures. The switch to decentralised structures is made in times of weak innovation (decentralised structures create entrepreneurial spaces and reinforce innovative strength), then moving back to centralised structures when efficiency is declining (centralised structures strengthen control and coordination and ergo increase efficiency). The ambivalent requirements for profitable growth in this organisation strategy are solved by the lasting change between centralised and decentralised structures. It is important for the success of this strategy that the next change is triggered at the right time to avoid losses. Companies using this kind of organisational strategy are: *"Ericsson, Heidelberger Druckmaschinen, Hewlett-Packard, Nokia, Sitronic Elektrotechnik, Sony, Swiss Life, and Zürich Financial Services"* (Gomez, Raisch and Rigall 2007:25).

(2) Geographic separation (Figure 2.15) divides the organisation into operational and innovative units, and disconnects them entirely as they have separate budgets, employees and technologies. XEROX and its Palo Alto Research Centers (PARC) are a good example for this organisational strategy. The operational unit covers the core businesses with main focus on continuously improving processes and products. The innovative units concentrate on detecting new business fields and product development. Companies using this kind of organisational strategy are: *"AT&T, Bayer, Bosch, Ericsson, Nestle, Procter & Gamble, Synthes, and Xerox"* (Gomez, Raisch and Rigall 2007:25).

(3) Parallel organisations (Figure 2.16) allocate their employees, into projects or within the company's primary structure depending on the task. The main idea behind this organisational strategy is, to switch employees between the primary structure and the project structure in order to execute operational tasks as well as innovative activities; contrasting demands of flexibility and efficiency might be satisfied within the same organisation. The following illustrates how parallel organisations might work: one way is to establish a centralised primary structure that cares for efficient processes and an additional project structure for open spaces and innovation, a different way might be a decentralised primary structure that cares for innovation and flexibility and an additional project structure that seeks synergies and efficiency. Companies using this kind of organisational strategy are: *"ABB, BP, BASF, BMW, Daimler, General Electric, Novartis, and Siemens"* (Gomez, Raisch and Rigall 2007:25).

(4) Integrated networks (Figure 2.16) consist of two dimensions within its primary structure; one dimension is aligned to products and is primarily concerned with long lasting product development and innovation. The second dimension focuses on regions and functions and is concerned with quick wins and efficiency increases. Integrated networks unwind the contradiction of flexibility and efficiency. The two dimensions interface in the style of a matrix, and in this way the company is able to combine short-term and long-term targets into one structure. Companies using this kind of organisational strategy are: *"Citigroup, Deutsche Bank, Hilti, Nestle, Shell, Siemens, and Unilever"* (Gomez, Raisch and Rigall 2007:25).



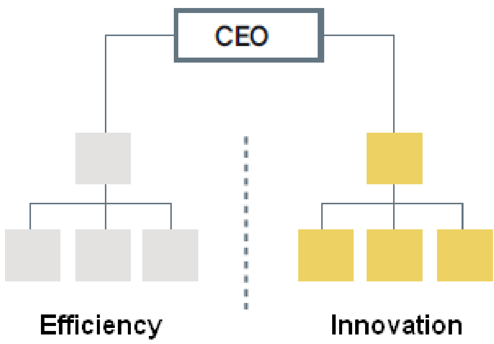


Figure 2.15 Circular change and Geographic separation
(following Gomez, Raisch and Rigall 2007:25)

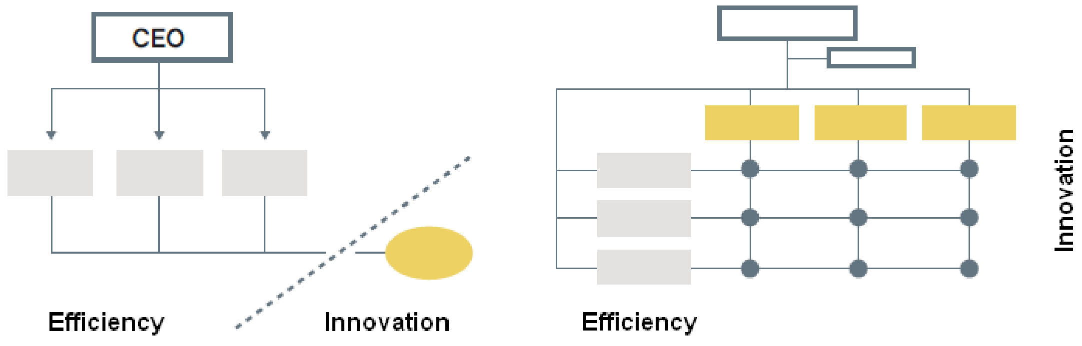


Figure 2.16 Parallel organisation and Integrated network (following Gomez, Raisch and Rigall 2007:25)

The most suitable strategy for a company depends on the dynamics of its environmental change and the chosen competitive strategy or a combination of strategies. Regardless of which corporate strategy is chosen an incentive system and the adjustment of its corporate culture and management structure are all necessary for a successful implementation.

"Unfortunately, processes are very hard to change - for two reasons. The first is that organisational boundaries are often drawn to facilitate the operation of present processes. [...] The second reason new process capabilities are hard to develop is that, in some cases, managers don't want to throw the existing processes out - the methods work perfectly well in doing what they were designed to do. [...] while resources tend to be flexible and can be used in a variety of situations, processes and values are by their nature inflexible. [...] When disruptive change appears on the horizon, managers need to assemble the capabilities to confront the change before it has affected the mainstream business. In other words, they need an organisation that is geared toward the new challenge before the old one, whose processes are tuned to the existing business model, has reached a crisis that demands fundamental change" (Christensen 2006:201).

2.3.3. Summary

A significant number of models and concepts concerning innovation are known in literature (Schumpeter 1950; von Hippel 1988; Henderson and Clark 1990; Danneels 2002; Chesbrough 2003; Christensen and Raynor 2003; Kim and Mauborgne 2005; Tidd, Bessant and Pavitt 2005; Christensen 2006; Gassmann, Enkel and Chesbrough 2010; Lichtenthaler 2011; Williams 2011), but successful innovation is not simply the result of following a common process. It is a complex combination of different resources, skills, knowledge sources, capabilities, in a flexible organisational framework, that is able to react to market and technology changes within the existing organisation or, if necessary, with different arrangements. As with innovation, numerous models concerning the life cycle are available (Ford and Ryan 1981; Höft 1992; Deng 1995; Merkamm and Weber 1996; Greiner 1998; Bleicher 1999; Gomez and Zimmermann 1999; Fink 2000; Christensen 2006; Simon 2008; Herrmann 2010), but in real life most are of little help. The uncertain variable in almost all models is the time axis, and it is very difficult if not impossible, to determine exactly the stage the company is currently at. Research has been conducted to fit specific products to the life cycle, and in most cases a relatively good fit with historical data can be provided. But research so far has no valid model to locate the current stage of a product (Tidd, Bessant and Pavitt 2005).

Regardless of how sophisticated the models/concepts for the identification and the development of innovative products and solutions are, they are unlikely to be successful unless the required organisational framework fits. Innovation develops more than ever into a company-wide task, involving departments from R&D, marketing, purchasing and production, right up to administration and others, creating strong pressure for organisational change towards more flexible models. However, innovation often arises in the eye of the beholder, what someone calls new or even radical, may be well known by another. Also the definition of complexity depends on the viewer´s standpoint regarding component, module and system. It is not defined consistently in the literature.

Innovation modes requiring different sets of organisational framework like *´doing better´* and *´doing different´* confront the organisations culture and ability to adjust its structures. At *doing better* almost all resources, skills, and processes available in the company may be valuable. At *doing different*, the firm is asking new questions concerning market and technology that demand employing new problem-solving capabilities using different processes and organisational structures. Differing types of innovation require different organisational modes or frameworks. Nevertheless changing existing and established structures is difficult because of resource allocation issues and for path dependent reasons. Changes in the organisational framework have to face and pass significant barriers to be successful. A new product/solution must find legitimacy against established products, departments and mindsets by convincing the company of its importance for future. It is necessary to be successful in future to not focus on one kind of innovation, rather use a balanced mix (Christensen and Raynor 2003; Jones 2003) of incremental and radical innovation. Likewise there needs to be a focus on the interaction between technology push and market pull (Gomory 1989). Most sustained profitable growth can be expected by pushing the boundaries of core business into an adjacent space (Zook and Allen 2003). Mode switching to a higher value-added stage (component to system) requires a strong base to build on; one possibility might be a strong core business from which adjacent growth takes place.

In this context bridging the gap in the literature and making a contribution to knowledge and practice, the tasks to be completed are:

- Identifying challenges enterprises encounter when performing mode switching.
- Developing a common definition of product hierarchy and its subdivision into component, module and system.
- Classifying organisational requirements for mode switching and providing ways to link with a companies' history and path dependent organisation.

2.4. Conclusion and research question

This section specifies the research question considering in the context of the completed literature review in this chapter. The central aim of this thesis is identifying requirements and assessing opportunities in order to provide a conceptual framework that permits sole component supplier enterprises to set up their product development in such a way that it fulfils the requirements of a system supplier. In accordance with the research aim, four initial questions were addressed.

- Why do enterprises aspire to change their current business model?
- What are the opportunities these enterprises hope to gain?
- What are the challenges confronting these enterprises?
- What is a practical approach to achieve success at mode switching from component manufacturer to system supplier?

To investigate these subjects the following research questions RQ1 and RQ2 were reviewed with the existing literature at the intersection of strategy due to the resource-based theory, technological changes and different innovation styles, with a focus on product development from the specific perspective of a component manufacturer in the industrial industry.

RQ1: ***How should the company, and in particular R&D act - or more precisely how should it organise its resources - in order to support mode switching from component to system supplier successfully?***

and

RQ2: ***What is the most effective procedure for R&D to follow in order to support the organisations' objective to successfully evolve from component manufacturer to system supplier?***

The evidence for the validity of the initial questions was presented in the previous sections of the literature review, in addition more specific issues and impacts concerning the research question were identified. The main variables affecting the thesis aim and the research question were identified and fall into the thematic categories (T1) causes and benefits, (T2) OEM expectations, (T3) challenges, (T4) definitions, (T5) organisational requirements, (T6) resources and competencies, and (T7) approaches and methods. From investigating the literature in these categories, however, some questions/topics remain uncertain, and further evidence is required to bridge the gap in the literature. To make a contribution to knowledge the following tasks are to be completed.

(T1) Classifying the incentives for enterprises performing mode switching and their associated advantages.

(T2) Identifying customer expectations in order to satisfy market demand with mode switching.

(T3) Identifying challenges enterprises encounter when performing mode switching.

(T4) Developing a common definition of product hierarchy and its subdivision into component, module and system.

(T5) Classifying organisational requirements for mode switching and providing ways to link with a companies' history and path dependent organisation.

(T6) Identifying necessary resources and competencies required for an enterprise to evolve into a higher value-added stage.

(T7) Providing a framework that enables and guides enterprises that are mode switching to a higher value-added stage.

The aim of this thesis is to provide a conceptual framework as a contribution to knowledge and practice. This framework will permit organisations on the component manufacturer level to set up their product development in such a way that it fulfils the requirements of a system supplier.

3. Methodology

This chapter outlines the selection of suitable research methods necessary to execute the thesis aims. It is organised into six sections. The first section provides an overview of the existing literature and its use in the context of the research topic. The second section establishes the research focus and the aim of the study. In the third section, the potential appropriate research designs including quantitative surveys and case study research are evaluated. The fourth section describes the research process considering the issues of research preparation, data collection and data analysis. Within the fifth section ethical considerations are covered. Lastly the preceding sections are summarised and conclusions are drawn.

3.1. Introduction

From the literature analysis, there is consensus that suppliers aiming for system delivery in the future will have new and different requirements concerning customer knowledge needs (Paliwoda and Bonaccorsi 1993, Dittler 1995). In addition, an adjustment of the organisational structure plays a significant role within this process (Paliwoda and Bonaccorsi 1993; Dittler 1995; Henke 2000). This is illustrated by the following quote:

"The fundamental organisational and managerial problem in system-oriented companies is the coordination of different functions and tasks" (Paliwoda and Bonaccorsi 1993:159).

Furthermore, success in the future necessitates focusing on a balanced mix of incremental and radical innovation (Christensen and Raynor 2003; Jones 2003). Likewise, there needs to be a focus on the interaction between technology push and market pull (Gomory 1989) whereby the most sustained profitable growth can be expected by pushing the boundaries of core business into adjacent space (Zook and Allen 2003). The literature feature a large number of models and concepts concerning innovation (Schumpeter 1950; von Hippel 1988; Henderson and Clark 1990; Danneels 2002; Chesbrough 2003; Christensen and Raynor 2003; Kim and Mauborgne 2005; Tidd, Bessant and Pavitt 2005; Christensen 2006; Gassmann, Enkel and Chesbrough 2010; Lichtenthaler 2011; Williams 2011), and shows that being successful is not simply the result of following a common process. Rather, it is a complex combination of different resources, capabilities, knowledge sources, and a flexible organisational framework that has the ability to respond to market and technology changes either within the existing organisation or, if necessary, with new arrangements. The resource-based approach demonstrates the importance of resources for the company's success and the development of sustained competitive advantage. Various definitions, beliefs, views, and likely ways to perform resource-based approaches are feasible. The literature (Wernerfelt 1984; Prahalad and Hamel 1990; Barney 1991; Grand 1991) proposes different models which try to identify resources and core competencies or give guidance for strategy formulation. However, all RBV literature does not explain in detail how resources and, as a result, core competences are identified and developed in the right way to be a source of competitive advantage for the company. Further the question of which resources a company requires to develop in order to be (more) successful is left unanswered, as illustrated by the following quote:

"There is no widely accepted definition or method of measurement of competencies, whether technological or otherwise" (Tidd, Bessant and Pavitt 2005:187).

Nevertheless, from reviewing the literature, most research concerning changes in organisational modes predominantly frame ´reality´ by assuming theoretical reflections. According to Eisenhardt (1989) theoretical developments in organisational research traditionally have been completed by linking observations of prior literature and common sense. In contrast Siggelkow (2007:23) suggests:

"A paper should allow a reader to see the world, and not just the literature, in a new way".

Thus, the existing literature does not offer much guidance on how to perform the evolution from component manufacturer to system supplier from a practical perspective. Consequently, conducting research that focuses on organisational upgrades to higher value stages, with practical relevance, is necessary. Hence, the aim of this thesis is to develop a conceptual framework which permits a component manufacturer to upgrade their product development so that they can successfully carry out the change to system supplier and thereby be able to fulfil (both internally and externally) the requirements of the market and its customers.

3.2. Research focus / aim of study

This thesis is concerned with identifying requirements and assessing opportunities in order to provide a conceptual framework that permits sole component supplier enterprises to set up their product development in such a way that it fulfils the requirements of a system supplier. To investigate the research focus and frame suitable research questions, the main aspects of the research area as well as associated initial questions were identified and verified within the literature review. The following research questions were recognised performing the process illustrated in Figure 3.1. The research question represents a ´how´ question, focussing on development of good practice, which is supported by a second question belonging to the ´what to do´ type, serving as empowerment (White 2009; Denscombe 2010; Bryman 2012) of the topic.

RQ1: ***How should the company, and in particular R&D act - or more precisely how should it organise its resources - in order to support mode switching from component to system supplier successfully?***

and

RQ2: ***What is the most effective procedure for R&D to follow in order to support the organisations' objective to successfully evolve from component manufacturer to system supplier?***

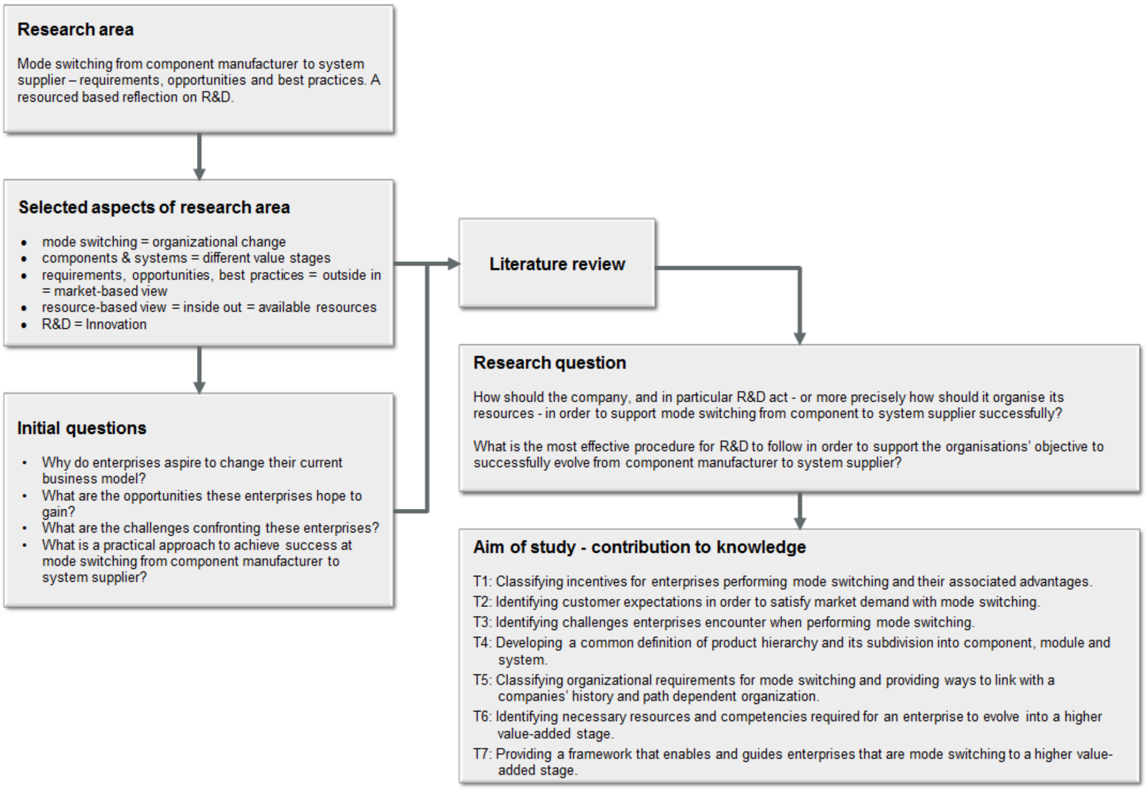


Figure 3.1 Development of research focus and aim of study

As indicated previously, the aim of this thesis is to provide a conceptual framework as part of the contribution to knowledge and practice that permits an organisation at component manufacturer level, to set up their product development so that it fulfils the requirements of a system supplier. This research study involves the field of product development. Other functions and areas of the company are considered only in the form of how they interfere with this field. This doctoral dissertation has not been constructed to cover every point in detail. Rather, it is concerned with recognising requirements in principle and providing general findings and then combining them into a practicable approach. The focus of this research study is the investigation of various views within industry to provide an effective procedure for component manufacturers to evolve into and fulfil the requirements of a system supplier.

3.3. Research Design

According to Bryman (2008), the distinction between qualitative and quantitative research is not as obvious as many writers suggest. This is because the only difference between both research strategies is that one utilises measurement whereas the other does not. But actually there is a much deeper distinction than the existence or nonexistence of quantification. Quantitative and qualitative research strategies differ mostly regarding the areas connecting theory and research, epistemology, and ontology as contrasted in Table 3.1.

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

Table 3.1 Differences in quantitative and qualitative research strategies (Bryman 2008:22)

In contrast to Yin (2009), who uses the term research methods and research design synonymously, Bryman (2008) puts emphasis on the distinction between them:

“A research design provides a framework for the collection and analysis of data. […] A research method is simply a technique for collecting data” (ibid: 31).

Consistent with Yin (2009), Bryman (2008) number experiment, survey or in his words cross-sectional design as well as case study similarly to research design, complemented by the special forms longitudinal design and comparative design.

Yin´s (2009) contrasting juxtaposition (Table 3.2) of relevant research methods was consulted in order to select the most appropriate research design in order to achieve the thesis aim.

Method	Form of Research Question	Requires Control of Behavioural Events?	Focuses on Contemporary Events?
Experiment	how, why?	yes	yes
Survey ✓	who, what, where, how many, how much	no	yes
Archival Analysis	who, what, where, how many, how much?	no	yes/no
History	how, why?	no	no
Case Study ✓	how, why?	no	yes

Table 3.2 Relevant Situations for Different Research Methods (Yin 2009:8)

Taking the above evaluation criteria (research question, control requirements, and event focus) in relation to the research's intention, and seeking conformity with Bryman´s (2008) view of research design, survey and case study research emerge as the most appropriate research strategy. Considering the research aim of the study, data generation focussing on the participants' point of view was deemed necessary and appropriate in order to gain the deep insights required to develop a conceptual framework for organisational mode switching. Additionally, contextual understanding of the complex interactions is required. In relation to the research questions and its resultant research approach (White 2009; Denscombe 2010), using an inductive research approach for finding new theory appears necessary. In context of deductive or inductive research Bryman (2012) notes, that a deductive research strategy is usually required with quantitative research and an inductive research strategy is typically linked with qualitative research.

This research takes the ontological position of constructivism, which proposes constant revision of the social world and its phenomena (Eisenhardt and Graebner 2007; Saunders, Lewis and Thornhill 2009; Bryman 2012). In this study the need for in depth data to explore the phenomenon, requires the selection of qualitative research methods. Similarly, collection of data from multiple points of view might enrich findings and allow a much wider and multi-layered understanding of the research subject (Eisenhardt and Graebner 2007; Saunders, Lewis and Thornhill 2009; Silverman 2010; Bryman 2012). By applying inductive logic, using the research to generate a non-generalisable theory or model from deep insights gleaned, the aim of this thesis may be addressed. Equally, building a close relationship between the researcher and the research topic is worth aspiring to for the purpose of gaining learning curve effects (Easterby-Smith, Thorpe and Jackson 2008; Bell 2010; Bryman 2012).

In relation to establishing a comprehensive and robust research design, the criteria reliability, replication, and validity (Bryman 2008; Yin 2009; Silverman 2010) are most important. Whereas reliability questions if the results of the research are reputable, replication is concerned about whether the results of the research may be reproduced by a third party. The third criterion, validity, queries the integrity of the research conclusions. Validity is commonly classified into three types; measurement validity or construct validity, internal validity and external validity (Bryman 2008; Yin 2009). To achieve credibility, validity, and reliability the literature suggests the use of triangulation (Bryman 1993; Hussey and Hussey 2003; Easterby-Smith, Thorpe and Jackson 2008). Patton (2002) outlines the alternatives, triangulation of aspects to similar data sets (theory triangulation), triangulation of diverse investigators (investigator triangulation), triangulation of data sources (data triangulation), and triangulation of methods (methodological triangulation). Predominantly, research uses methodological triangulation (Bryman 1993; Patton 2002; Hussey and Hussey 2003). In contrast, Yin (2009) preferring case study research, supports data triangulation, being a rationale for the collection and usage of many different sources of evidence, a strong point in case study research.

3.3.1. Survey

Bryman (2008:46) prefers the term cross-sectional design to survey, accordingly his definition *"survey research comprises a cross-sectional design in relation to which data are collected predominantly by questionnaire or by structured interview in more than one case (usually quite a lot more than one) and at a single point in time in order to collect a body of quantitative or quantifiable data in connection with two or more variables (usually many more than two), which are then examined to detect patterns of association"*.

There are four key elements within this definition; (1) more than one case, (2) single point in time, (3) quantitative or quantifiable data, as well as (4) patterns of association. This implies that survey research (1) is concerned with variation; (2) data collection takes place at one particular time; (3) application of a systematic and identical method for measuring variation is essential, and (4) making connections among the variables is possible (ibid 2008). In comparison Yates (2004) counts measurement, sampling, and questionnaire design as the three most important aspects of survey research. Measurement is the operationalisation of research concepts, while sampling recognises the selection of respondents and/or cases, and makes certain that the results obtained are representative. Sampling is the researchers' key, enabling him or her to define the kind and amount of factors that influence the research. The number of possible sampling methods is vast; however the main methods of conducting a questionnaire are, on one hand, interactively, and on the other hand, self-completion via participants (Bryman 2012). Questionnaire design can be tailored so that question phrasing and structure are based on the subject matter. If using a survey comprising of self-completion questionnaires, the issues addressed should not need explanation, so as to prevent misinterpreting and receiving imprecise or even incorrect answers, which could misrepresent results (Bryman 2012). Additionally, survey research is considered to be a quick and low-cost method, its main purpose is reaching large numbers of respondent to explore opinions through the use of representative samples (Jankowicz 2000).

In relation to the parameters reliability, replicability, and validity in survey research, reliability strongly depends on the value of the measures applied, not necessarily on the chosen research design (Yin 2009; Bryman 2012). Replicability is usually expected in most quantitative research, where the design procedures are specifically explained. In survey research external validity, when random sample selection occurs, is strong, however, internal validity is usually poor. This is because, as mentioned at (4) above, establishing causal relationship from the data is difficult (Bryman 2008). Finally, the survey in this context is understood as a research method involving any kind of procedure asking questions. Within this definition, a survey can be anything from a written questionnaire through to interviews. Quantitative research methods, like surveys, are based on numbers, reflect the researchers' perspective and are ideally suitable for theory testing approaches (Bryman 2008). Due to the critical success factors noted above, and considering the research aim, to generate new theory, the quantitative survey approach appeared not to be the most suitable research method for new theory and model development in relation to organisational mode switching (Eisenhardt 1989; Eisenhardt and Graebner 2007; Saunders, Lewis and Thornhill 2009; Yin 2009; Bryman 2012). Additionally, as the key purpose of this study is to develop theory, gaining access to a significant number of survey participants with the knowledge necessary to provide insightful responses about the research topic that may prove to be statistically relevant (Eisenhardt 1989; Eisenhardt and Graebner 2007; Easterby-Smith, Thorpe and Jackson 2008; Saunders, Lewis and Thornhill 2009; Bell 2010; Bryman 2012) appears challenging if not visionary.

3.3.2. Case study research

Case study research is concerned with the investigation of complex social phenomena in its real life context (Stake 1995; Yin 2009) and is especially suitable for new topic areas (Eisenhardt 1989: 548) *"case study research [...] is particularly well-suited to new research areas for which existing theory seems inadequate"*. Bryman (2012) states that case study research is primarily associated with qualitative research, as often qualitative methods are favoured. Despite this, case study research can, in principle, be used for qualitative and quantitative approaches as well as in a combination of both (Saunders, Lewis and Thornhill 2009; Bell 2010; Bryman 2012). Theory building from case studies can be conducted using single cases or multiple cases as a starting point from which to develop novel theory inductively (Eisenhardt 1989, Yin 1994; Eisenhardt and Graebner 2007). Case studies are descriptions of occurrences usually drawing on a range of data sources (Yin 1994; Eisenhardt and Graebner 2007). The process of theory building commonly takes place using iterative data tabulation and extant literature (Eisenhardt und Graebner 2007). Case study as a research strategy may be used for different purposes: explanatory (Anderson 1983; Pinfield 1986; Allison and Zelikow 1999), exploratory (Harris and Sutton 1986; Gersick 1988) or descriptive (Kidder 1982; Neustadt and Fineberg 1983). The case study approach allows the researcher to conduct an in-depth examination of the subject (Hakim 1997) in order to gain understanding of the real life context within selected settings (Eisenhardt 1989). Typically data collection methods within case study research involve: archival records, interviews, questionnaires, observations, documents, and physical artifacts (Eisenhardt 1989, Yin 1994). Yin (1994, 2009) as well as Eisenhardt and Graebner (2007) suggest that the research question specifically affects the choice of research design. The more the research question tries to find out about present phenomena, with ′how′ or ′why′ questions, coupled with a requirement for in-depth description, the more the case study could be the approach of choice. In case study research the question often asked is, what is the case? Bryman (2012:68) suggests reserving *"the term ′case study′ for those instances where the ′case′ is the focus of interest in its own right"*. Siggelkow (2007:22) summarised, *"regardless of how cases are eventually used, research involving case data can usually get much closer to theoretical constructs and provide a much more persuasive argument about causal forces than broad empirical research can"*. In addition, Eisenhardt (1989:532) argues that *"this research approach is especially appropriate in new topic areas. The resultant theory is often novel, testable, and empirically valid. Finally, frame breaking insights, the tests of good theory [...], and convincing grounding in the evidence are the key criteria for evaluating this type of research"*.

The research criteria of reliability, replicability, and validity must also be addressed in relation to case study research. In terms of reliability, similar to other methods, this strongly depends on the quality of documentation. A preferred tactic to address this issue is the use of case study protocols combined with the development of a case study database (Eisenhardt 1989; Eisenhardt and Graebner 2007; Yin 2009). Concerning replicability, Yin (2009) argues that when using multiple cases and two or more of them support or develop the same theory, replication can be claimed. Concerns regarding construct validity and subjective judgment in case study research are rejected by Eisenhardt and Graebner (2007:25) with the argument that: *"although sometimes seen as ′subjective′, well-done theory building from cases is surprisingly ′objective′, because its close adherence to the data keeps researchers ′honest′. The data provide the discipline that mathematics does in formal analytic modeling"*.

Further, Yin (2009) and Eisenhardt and Graebner (2007), recommend removing such concerns by using multiple sources of evidence, close reasoning, and review of the draft case study report by respondents (Smith 1991; Stake 1995; Siggelkow 2007). Internal validity in exploratory case studies is fragile especially the risk of misleading inferences or the deduction of incorrect conclusions. To overcome this issue, Yin (2009) suggests pattern matching, the use of logic models, as well as addressing rival positions (Eisenhardt and Graebner 2007). External validity or scientific generalisation is often mentioned as a drawback of the case study approach (Siggelkow 2007; Easterby-Smith, Thorpe and Jackson 2008; Saunders, Lewis and Thornhill 2009; Bell 2010; Bryman 2012). Yin (2009:15) states that: *"Case studies, like experiments, are generalizable to theoretical propositions and not to populations and universes [...] in this sense, the case study, like the experiment, does not represent a ′sample′, and in doing a case study, your goal will be to expand and generalize theories (analytic generalization) and not to enumerate frequencies (statistical generalization)"*.

To allay such concerns, replication logic in multiple case studies could be employed. According to Herriott and Firestone (1983), the use of multiple cases appears more convincing, and therefore the entire research is considered more robust. An important advantage of the case study, is its capability to describe the assumed underlying connections in real-life phenomena, which are by contrast too complex for the use of survey or experimental research (Eisenhardt and Graebner 2007; Siggelkow 2007; Yin 2009).

3.3.3. Design of the research

Having discussed the research design alternatives, survey and case study in detail, both designs are compared side by side in order to select the most robust methodology to support the thesis aim. Based on the selection criteria illustrated in Table 3.3 the case study research method appears the most suitable approach to achieve the research aims.

	thesis criteria	survey	case study
research question	how ?	✓	✓
research topic	complex real life phenomena	x	✓
research logic	theory generation (inductive)	x	✓
ontological orientation	constructivism	x	✓
epistemological orientation	interpretivism	x	✓
research strategy	qualitative*	✓	✓
data characteristic	in-depth	x	✓
access to data	few samples (interviewees)	x	✓

***Bryman (2012) consider a survey may be either qualitative or quantitative**

Table 3.3 Research design selection

The procedure of building theory from case study research is illustrated in detail notably by Eisenhardt (1989) and Yin (1994). Eisenhardt (1989:533) explains her approach in eight steps; (1) getting started: formulation of the research question in at least broad terms as well as identifying some important variables; (2) selecting cases: defining the set of research samples from which to obtain statistical evidence; (3) crafting instruments and protocols: selection and combination of different data collection methods; (4) entering the field: involving the overlapping of data collection, analysis, and taking field notes; (5) analysing data: becoming familiar with each case as a stand-alone entity and searching for cross-case pattern; (6) shaping hypotheses: iterating comparison of theory and data; (7) enfolding literature: comparison of the findings, with the extant literature (similar as well as conflicting), and (8) research closure: reaching theoretical saturation, or plan in advance the number of cases to include. Yin (2009) characterises case study research as a linear but iterative process, which should regard, if not contain the elements: plan, design, prepare, collect, analyse, and share. The plan element involves the vital consideration, whether case study is the most suitable approach for the research topic in question. For guidance in deciding which approach may be suitable, Yin (2009) developed a matrix (Table 3.2) which was consulted in the research design of this thesis. Assuming that case study research is suitable, issues relating to design such as propositions, theory development, shape of study (single or multiple), research logic and study procedures need further consideration. Preparation involves activities such as designing the questionnaire, defining and selecting respondents, addressing ethical considerations and organising the case study protocol. The subsequent data collection should be in conformity with the case study protocol and exploit as many sources of evidence as possible to create a rich case study database. Data analysis comprises investigating, classifying, organising, scrutinising, and rearranging of the data to describe empirically based conclusions. Sharing involves the assembly of the research report comprising the study's findings and conclusions. A comparison of the procedures of case study research proposed by Eisenhardt (1989) and Yin (2009) demonstrates that both approaches vary slightly in wording and number of performed steps, but not fundamentally in content. Eisenhardt (1989) uses eight steps while Yin (2009) uses six steps, more or less combining Eisenhartdt´s (1989) three steps (6) shaping hypotheses, (7) enfolding literature and (8) research closure in one element, ´share´. In this study the research design[10] was formulated by reference to the structure with six elements proposed by Yin (2009). The thesis research design is shown in Figure 3.2.

[10] "A research design is a logical plan for getting from here to there, where here may be defined as the initial set of questions to be answered, and there is some set of conclusions (answers) about these questions" (Yin 2009:26).

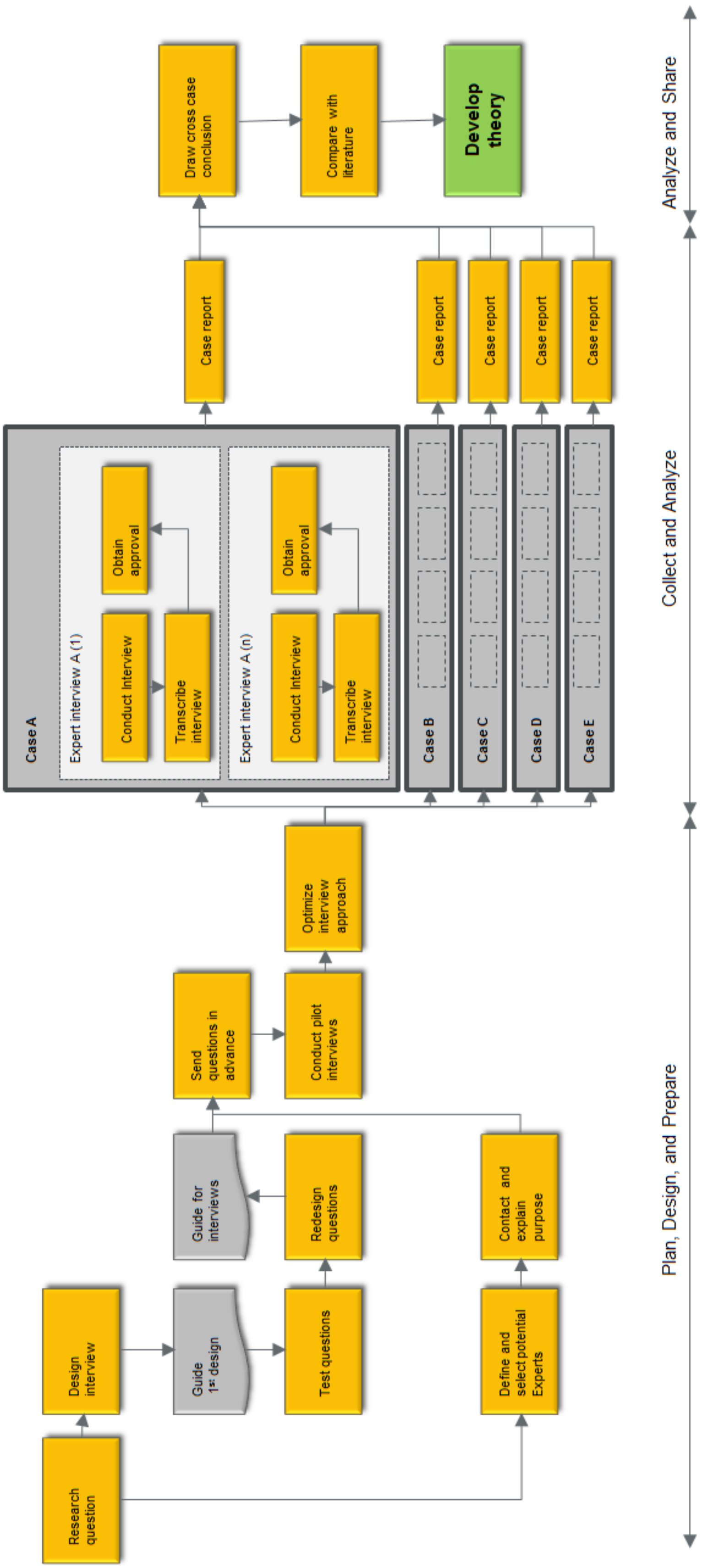


Figure 3.2 Thesis research design

This exploratory study, investigating ways to mode switch from component manufacturer to system supplier from an R&D point of view, is designed as a case study involving semi-structured interviews that will be compared with extant approaches arising from the literature review. The case study method was chosen to achieve in-depth understanding for the purpose of inductive theory development (Eisenhardt 1989; Smith 1991; Yin 1994; Stake 1995; Eisenhardt and Graebner 2007; Johanson 2007; Siggelkow 2007; Yin 2009; Bryman 2012). With the focus on theory development and not theory testing, theoretical case selection as per Eisenhardt and Graebner (2007) is appropriate. To attain broad credibility and provide a stronger base for grounding theory, a multiple case study approach (Yin 1994, Yin 2007) comprising five cases was selected. Twenty four experts from various industrial sectors (automotive, industry, consulting, and academia), different types of enterprises (trusts, SMEs[11], and universities), and different areas of employment specialism agreed to participate in the study. The research process is explained and illustrated in more detail in the next section.

3.4. Research process

The following section describes the research process illustrated in Figure 3.2 focusing on the main elements namely, research preparation, data collection, and data analysis. Methods and procedures applied, logic used and reflections as well as ethical considerations are also discussed.

3.4.1. Research preparation

This section outlines the development of the interview guide for the semi-structured interviews, the selection of the interview participants, and the preparation work done before the expert interviews.

3.4.1.1. Development of interview guide

"Case studies can accommodate a rich variety of data sources; [...] interviews often become the primary data source. Interviews are a highly efficient way to gather rich, empirical data" (Eisenhardt and Graebner 2007:28). Data gathering was regarded as expert consultation through interviews, and to guide the

[11] SMEs: small and medium-sized enterprises

conversation, a list of questions was used. According to Yates (2004), in designing a list of guiding questions there is a need to distinguish between two question types, open and closed. Usually closed questions are more common in quantitative research, while qualitative research favours open questions, which give the interviewee free range to answer (Saunders, Lewis and Thornhill 2009; Bell 2010; Silverman 2010; Bryman 2012). For the expert interviews, a semi-structured interview approach was chosen, because the interviewee is able to answer in his own words, which allows the interviewer to gain a richer understanding of individual experiences, impressions, and emotions (Eisenhardt and Graebner 2007). Moreover, organisational relations can be captured and, if required, additional requests for more detail or information are possible (Bell 2010; Silverman 2010; Bryman 2012). The development of the interview guide occurred as an iterative process, starting with the research questions, and the consequent research tasks as illustrated in Figure 3.1, and from this an initial set of questions emerged. During the drafting process additional aspects were considered and relevant literature was consulted (Mayer 2009). Each set of questions was tested during peer discussions[12], and amended if necessary. At the beginning of the interview process pilot interviews were conducted (Remenyi, Williams, Money and Swartz 1998; Robson 2002; Yin 2009; Silverman 2010; Bryman 2012) to broaden the researchers' perspective and for the purpose of testing and adjusting the questions. The pilot interviews also provided the opportunity to improve the questioning technique, as well as to ensure that all questions were easy to understand and possible to answer (Hussey and Hussey 2003; Bryman 2012). The final interview guide contained a set of 12 open ended questions (Partington 2003), with the option of sub-questions for additional in depth discussion. The study was executed in Germany with German participants, therefore the original guide was designed and written in the German language (see Appendix A: Interview guide). The twelve open ended interview questions aim to obtain as much in-depth information as possible to support the research questions and address the gap identified in the literature review. The critical debate on capturing in depth information and the nature of the open ended semi-structured interview approach is led by Eisenhardt and Graebner (2007).

To ensure a structured and replicable data analysis approach, providing significant information and capable of drawing conclusions on the stated research questions and the gaps identified in the literature review, it was necessary to categorise the gaps in the literature into themes. The thematic categories are (T1) causes and benefits, (T2) OEM expectations, (T3) challenges, (T4) definitions, (T5) organisational requirements,

[12] Peer discussion: communication within the authors research community and professional network

(T6) resources and competencies, and (T7) approaches and methods. Each of these categories correlates with at least one of the twelve open ended interview questions (Q1 – Q12) in a linear manner, where Q12 summarises and concludes the statements of the respondent; therefore Q12 may contribute to all categories. Causes and benefits (T1) are predominantly underpinned by Q1 and Q2; OEM expectations (T2) by Q11; challenges (T3) by Q4; definitions (T4) by Q10; organisational requirements (T5) by Q5, Q8, and Q9; resources and competencies (T6) by Q3 and approaches and methods (T7) by Q6 and Q7. However, it is likely that each interviewee's response may support several categories.

	Research Question		research aim (see chapter: literature review)	Question
RQ1	How should the company, and in particular R&D act - or more precisely how should it organise its resources - in order to support mode switching from component to system supplier successfully?	T1	Classifying the incentives for enterprises performing mode switching and their associated advantages.	Q 1 Q 2 Q 4 Q 10 Q 11 Q 12
		T2	Identifying customer expectations in order to satisfy market demand with mode switching.	
		T3	Identifying challenges enterprises encounter when performing mode switching.	
		T4	Developing a common definition of product hierarchy and its subdivision into component, module and system.	
RQ2	What is the most effective procedure for R&D to follow in order to support the organisations' objective to successfully evolve from component manufacturer to system supplier?	T5	Classifying organizational requirements for mode switching and providing ways to link with a companies' history and path dependent organization.	Q 3 Q 5 Q 6 Q 7 Q 8 Q 9 Q 12
		T6	Identifying necessary resources and competencies required for an enterprise to evolve into a higher value-added stage.	
		T7	Providing a framework that enables and guides enterprises that are mode switching to a higher value-added stage.	

Table 3.4 RQs, research aims (thematic categories), and corresponding interview questions

Table 3.4 illustrates the interrelationship of the research questions, RQ1 and RQ2, with the thematic categories (T1 to T7) identified from the gaps in the literature and their resultant interview questions Q1 to Q12. Questions Q1 to Q11 support the research questions RQ1 and RQ2 in a direct manner, while question Q12 additionally encourages the respondents to summarise and conclude the interview by mentioning the most important issues that require consideration.

3.4.1.2. Selection of respondents

Johanson (2007:275) defines the selection criteria regarding research respondents: *"Utilizing an exploratory grounded theory design, sample representation is not considered an important issue. What is important in developing grounded theory is access to companies experiencing the phenomenon of interest and gaining new insight from their practice"*. Nevertheless, the identification of knowledgeable experts to mitigate bias and obtain broad credibility appeared most difficult in the beginning. The selected experts should be drawn from varying industrial sectors (automotive, industry, consulting, and academia), as well as various types of enterprises (trusts, SMEs, and universities), and also differ in area of employment specialism (Eisenhardt and Graebner 2007; Easterby-Smith, Thorpe and Jackson 2008; Saunders, Lewis and Thornhill 2009). In this context Eisenhardt and Graebner (2007:28) note:

"A key approach is using numerous and highly knowledgeable informants who view the focal phenomena from diverse perspectives. These informants can include organisational actors from different hierarchical levels, functional areas, groups, and geographies, as well as actors from other relevant organisations and outside observers such as market analysts. It is unlikely that these varied informants will engage in convergent retrospective sense making and/or impression management".

To address this challenge, different means of identifying and recruiting knowledgeable experts were employed:

(1) business contacts of the author were verified concerning eligibility;
(2) own business contacts were asked for recommendation of knowledgeable experts;
(3) the employers business network was used and asked to identify experts;
(4) the German Engineering Federation (VDMA[13]) was asked for expert recommendation;
(5) own supervisors were asked to recommend experts;
(6) identified experts themselves were asked for additional recommendations.

The result, from approaching all of the above mentioned channels, was a list of 78 potential experts, all in top management positions, including some holding the position of CTO[14] or CEO[15]. It was considered essential for interview respondents to be employed in a top management position due to their impact on long term strategic decision making. For ease of access, a file on each expert was completed including the following information; type of enterprise, industrial sector, and job title/area of specialism. Initially, all experts were sent an e-mail containing the name of the person who had recommended them, a short summary of the research study, and a request for permission to contact them via telephone to provide further explanation. In almost all of the cases, the expert had already been informed about the research

[13] VDMA: German Engineering Federation (Verband Deutscher Maschinen und Anlagenbau)
[14] CTO: Chief Technology Officer
[15] CEO: Chief Executive Officer

study by the recommending person. The next step was an explanatory telephone call with all responding experts and the request for a one hour face to face interview.

"Interview literally means to develop a shared perspective and understanding (a view) between (inter) two or more people. In other words the researcher and the participant(s) develop a shared understanding of the topic under discussion" (Yates 2004:156).

Using this approach in (1) identifying a broad sample of experts from six different sources of reference, (2) initially contacting all recommended experts via e-mail to inform them about the study, and (3) only proceeding with those experts who responded, allowed random composition of a panel of experts and should mitigated the risk of bias. From this process 28 experts confirmed that they would participate in a face to face expert interview; unfortunately four interviewees withdrew their offer, so that in total 24 experts agreed to be interviewed.

3.4.1.3. Preparation for expert interviews

To avoiding obtaining limited, snapshot information during the interview, the interview guide was sent to the experts in advance. Bryman (2012) recommends such an approach to introduce the research and provide respondents with a credible rationale for the research. Before the interview, each respondent was asked for permission to digitally record the interview, as well as to use, compare, and analyse the data obtained in a doctoral dissertation. Furthermore, all interviewees were asked for permission to include the name of their company in the research. With the exception of two experts, all interviewees gave permission for their company name to be used. The interview itself was scheduled by agreement with each expert personally or with their secretary. All interviews were conducted as face to face interviews (Eisenhardt and Graebner 2007) and took place at the expert´s workplace.

3.4.2. Data collection

The data gathering took place in semi-structured interviews designed as part of a case study approach. The expert interviews were subdivided according to potential thesis impact and organised into industry voices, building the thesis focal point, and external perspectives to complement and enhance perceptions. Hence, three case studies were defined representing the core stakeholders addressing the research question, and in addition two complementary cases were designed to verify and reflect on the findings from an external perspective. Overall, five case studies[16] were conducted; three cases representing industry voices, with 21 expert interviews and two complementary cases representing external perspectives comprising three expert interviews. In terms of contribution to knowledge and practice, the thesis predominantly focuses on the three cases representing industry voices. The rationale for providing additional cases representing external perspectives is to broaden the views collected on the research topic and to enhance data verification and credibility of findings. The single foci of interest or cases (Bryman 2012) representing the industry voices from industrial sectors are (1) original equipment manufacturer (OEM), (2) component manufacturer and (3) system supplier and to complement findings, representing the external perspective (4) academia and (5) business consultancy. The entire interview process took place over a five month period and the duration of each face to face interview was between 45 and 60 minutes (Danneels 2002). In total 24 experts from 16 different companies/employers were interviewed (Table 3.5).

Case / foci of interest	Company	Sector
OEM	BMW	Automotive
	Daimler	Automotive
	Porsche	Automotive
	Heidelberger Druck	Industrial
Component manufacturer	Schaeffler (interviews in different areas of activity)	Industrial
	*)[17]	Industrial
System supplier	*)	Automotive
	Siemens	Industrial
	Plansee	Industrial
	FESTO	Industrial
	LuK	Automotive
	MAHLE	Automotive
	SEW-EURODRIVE	Industrial
Academia	Heilbronn University	Industrial Engineering
	Munich University	Logistics
Business Consultancy	**)[18]	Service & Software

Table 3.5 Interview participants

In terms of interviews conducted by case, the OEM case comprises four experts; the component manufacturer case eight experts; the system supplier case, nine experts; the academia case two experts; and the business consultancy case one expert. To ensure anonymity of the experts interviewed, all interviewees were given a unique reference code and any statements quoted were coded using this reference (Table 3.6).

[16] Case study: intensive study of a specific context; foci of interest within this research: component manufacturer, system supplier, OEM, academia, and business consultancy in relation to the RQs.
[17] Two companies preferred to remain anonymous, consequently they are indicated as *)
[18] Permission for mentioning the name of the interviewed business consultancy was granted, but due to the fact of the one on one relationship within the data analysis, the author decided to safeguard confidentiality by not naming.

Each interview was subsequently transcribed and sent to the expert for approval (Sieber 1992). The information from the most recent interview was constantly compared with that of prior interviews. By comparing the interviews, each respondent´s understanding and knowledge of the research topic (Yates 2004) might have contributed a further building brick to the holistic picture.

Case / foci of interest	Experts
OEM	E02; E09; E17; E20
Component manufacturer	E01; E04; E05; E06; E07; E12; E19; E21
System supplier	E08; E13; E14; E15; E16; E18; E22; E23; E24
Academia	E03; E10
Business Consultancy	E11

Table 3.6 Coding of interviewees

3.4.3. Data analysis

Yin (2009:126) notes that, with respect to case study data analysis: *"analysing case study evidence is especially difficult because the techniques still have not been well defined"*. His advice to overcome this situation is the use of general analytic strategy and the definition of *"priorities for what to analyse and why"* (ibid: 126). Miles and Huberman (1994) explain some analytic manipulations as approach in this content, however according to Yin (2009) such activities cannot replace an analytic strategy. The strategy chosen in this research project is ´relying on theoretical propositions´ (Yin 2009). Using this strategy, the theoretical propositions organise and guide the case and help to identify alternative explanations and feature that are observed[19]. To execute and support the chosen strategy Yin (2009) proposes a number of techniques including: pattern matching, explanation building, time-series analysis, logic models, and cross-case synthesis. According to Yin (2009), the technique of pattern matching is usually used to compare empirically grounded patterns with predicted ones. Explanation building is a particular form of pattern matching, with the aim of investigating the data by establishing explanations about the case. Time-series analysis is used to track changes over time, trends within the case are matched either with hypothetically significant trends or rival trends prior to the study. Logic models can be used in a variety of situations, and explain a complex cause and effect relationship pattern. Cross-case synthesis relates exclusively to the analysis of multiple cases and tries to combine findings across the cases. Hence, in this research cross case synthesis would appear to be most suitable and this has been applied and will be used in the following

[19] theoretical propositions used in this research study are: research area, selected aspects of research area and initial questions (see Figure 3.1)

sections for analysing the data (Miles and Huberman 1994; Mathison 2004; Weed 2005; Byrne and Ragin 2009; Yin 2009).

To ensure a replicable data analysis approach providing significant information and capable of drawing conclusions with respect to the stated research questions, the structure illustrated in Figure 3.3 for analysing the data was applied. Initially the 24 interview transcripts were sorted by their case foci (1) OEM, (2) component manufacturer, (3) system supplier, (4) academia and (5) business consultancy (see section 3.4.2), and using the interview statement allocation based on seven thematic categories (see section 3.4.1.1 and Table 3.4). Next, the data allocation was basically achieved by cutting and pasting of relevant transcript data into the thematic categories. Brewerton and Millward (2001), consider this a reasonable method to ensure any prejudice or bias is avoided. To further arrange the quantities of data from the 24 interview transcripts, a coding system was utilised to categorise the data. Miles and Huberman (1994) suggest such an approach in the analysis of qualitative data in order to reduce, present and proof data. Thus, the sorted data was content analysed to identify common elements and assigned to an emergent theme (Smith 1991), and coded using keywords. Applying this type of approach facilitated the analysis of the significant quantities of data collected.

In the next stage of analysis (see item 1 in Figure 3.3), each of the five cases was considered to obtain the experts' standpoint regarding the thematic categories (T1 – T7) representing ´best practice´ interpretations (see section 4.1, 4.2, 4.3, 4.4, and 4.5). As defined in section 3.4.2, cases C1 to C3 represent the industry voices which are the focus of the research and cases C4 and C5 have an external perspective serving to broaden the view on the research topic and to enhance the data verification and credibility of findings. Subsequently, (see item 2 in Figure 3.3), the perspectives from the five cases (best practices) were cross compared to establish the existence of any cross case synthesis (see section 4.6). To achieve this the findings from the five cases in relation to each thematic category were obtained and dominant and minor opinions were both identified from the cases (see Table 4.3, Table 4.4, Table 4.5, Table 4.6, Table 4.7, Table 4.8, Table 4.9 and Table 4.10). In order to link the findings across the cases the most suitable opinions, based on the thematic categories, were highlighted. Finally, (see item 3 in Figure 3.3), the findings were interpreted and discussed in the light of the thematic categories (see chapter 5) derived from gaps in the literature (see section 2.4 and 3.4.1.1).

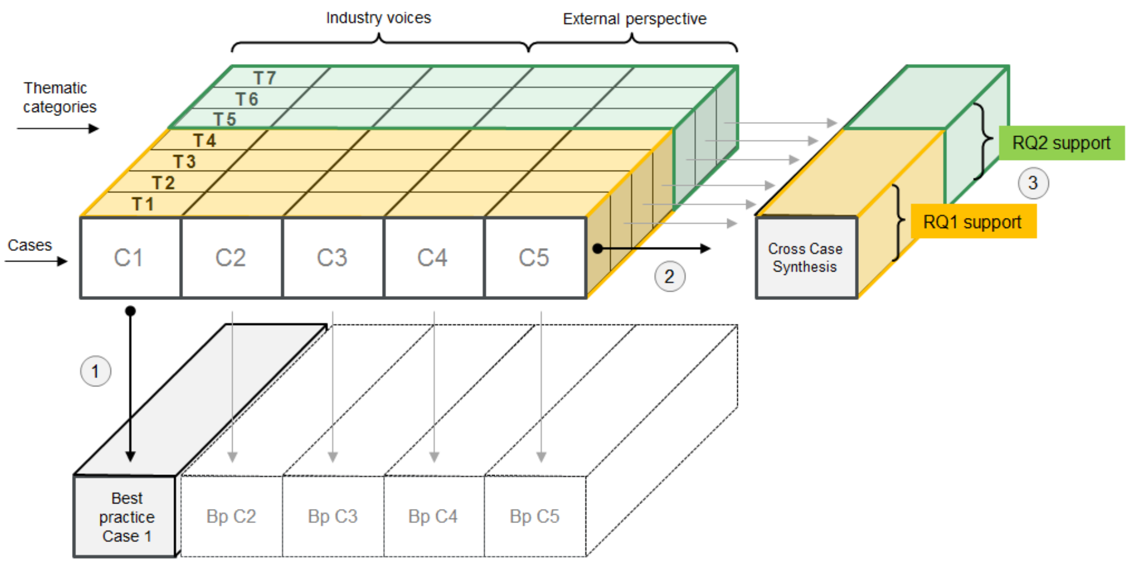


Figure 3.3 Structure of data analysis

3.5. Ethical considerations

This section comprises ethical considerations and their impact upon this thesis. General ethical issues and fundamental principles of the University of South Wales (former University of Glamorgan) are summarised in the mnemonic FAIR. "Ethics is a complex subject, but in professional contexts some of its central concerns are: to treat people **fairly**; to respect the **autonomy** of individuals; to act with **integrity**; to seek the best **results** - by minimising harm and maximising benefits" (University of Glamorgan 2008:3). Besides these concerns, codes of ethics in social research are formulated by professional associations (Bryman 2012), such as the British Psychological Society (BPS), the British Sociological Association (BSA), the Economic and Social Research Council (ESRC), the American Sociological Association (ASA), the Social Research Association (SRA), and many others.

Case study research, particularly in-depth face to face interviews, often requires participants to supply potentially sensitive and confidential information. In recognition of this, to comply with ethical considerations, every effort was made to act sincerely and preserve the confidentiality of both the respondents and the companies participating in this study (Miles and Hubermann 1994; Saunders, Lewis and Thornhill 2009; Bell 2010; Bryman 2012). During the process of identifying potential respondents, individual e-mails containing the name of the recommending person, a short summary of the intended research, and a request for approval to contact the expert via telephone for further explanations were sent out. Subsequent telephone contact was established only with those experts who gave permission and who indicated their interest in participating in the study. The telephone call provided more detail to the experts about the aim of the research and for what purpose the interview data would be used. Furthermore, the interview guide comprising 12 open ended questions was sent to the experts in advance, so as to give an overview of how the interview would be structured and what topics would be discussed in-depth. Before commencement of the interview, each respondent was asked for permission to digitally record the interview, and also that the data collected could be used, compared, and analysed within a dissertation. In addition, all interviewees were asked for authorisation to include the name of their company in the research; to protect the identity of the individual respondent, each expert was given a pseudonym ´Exx´ (Babbie 1998). In the business consultancy case study, as there was only one interview, the company name was excluded even though permission had been granted, to preserve confidentiality and avoid positive identification. After the interview had been conducted, each interview was transcribed and sent to the expert for approval (Sieber 1992). Every contradiction, ambiguity, misunderstanding, or misinterpretation identified in the transcript was corrected and resubmitted to the interviewee for approval; only transcriptions that had final approval were included in the data analysis. The importance of reporting data truthfully and objectively was emphasised by Ghauri and Groenhaug (2002). All data collected has been kept in a secure database, information and data enabling the pseudonyms or transcripts to be decoded merely will be kept until the dissemination of research is completed, and hereafter destroyed.

3.6. Conclusion

Based on the literature analysis, it appears that most research concerning changes in organisational modes predominantly frame ´reality´ by applying theoretical reflections. Thus, the existing literature does not offer much guidance on how to demonstrate the evolution from component manufacturer to system supplier with a focus ´gained in practice, for use in practice´. Hence, the most promising way to gain knowledge in a systematic manner on organisational mode switching seemed to be by asking experts about their experiences and perceptions. However, bearing this in mind, it appears crucial to question their understanding of topics and terms concerning components, modules and systems. The aim was to deduce a common understanding, to develop a procedure companies can pursue to change or mode switch from one value stage into the next higher one, described in a pragmatic way. To employ the focus ´gained in practice, for use in practice´, using a distant, generalising, and static research method such as quantitative data gathering (Bryman 2008) appeared unsuitable. Therefore, the emphasis of this research was on the case study approach with the main focus being on expert interviews which are supported by available information and documentation. To attain broad credibility the experts who participated in the study were drawn from different industrial sectors, various types of enterprises, and differing areas of employment. The data was collected using semi-structured interviews with a set of 12 open ended questions. Previous to the interview sessions, pilot interviews were conducted to broaden the researchers' perspective and for the purpose of testing as well as adjusting the interview guide. Before the commencement of the interview each respondent was asked for permission to digitally record the interview, as well as to use, to compare, and to analyse the data collected within a dissertation. Additionally, all interviewees were asked for authorisation to include the name of their company in the study and all except two experts gave permission. Subsequent to the interview, each was transcribed and sent to the expert for approval. The findings from the 24 experts interviewed will be presented in the following chapter, using the five case study classifications: OEM, component manufacturer, system supplier, academia and business consultancy.

4. Data Analysis

This chapter presents the outcome of 24 interviews with relevant experts. The interview statements are grouped, dependent on the origin of the interviewee, into one of the five cases namely OEM, component manufacturer, system supplier, academia and business consultancy (see section 3.4.2 and 3.4.3). Each of the five cases is analysed to examine the experts' standpoint regarding the thematic categories (T1) causes and benefits, (T2) OEM expectations, (T3) challenges, (T4) definitions, (T5) organisational requirements, (T6) resources and competencies, and (T7) approaches and methods (see section 3.4.1.1). The subsequently outlined cases (section 4.1 - 4.5) represent ´best practice´ interpretations from the experts' standpoint. Thereafter, a cross case synthesis (section 4.6) is undertaken, in order to link findings between the cases and to draw conclusions. To ensure anonymity of the participants, each expert interviewed was given an individual code ranging from E01 to E24. Referencing to expert statements (as an example: E11:2) are outlined by the individual experts coding (E11) and the page of the transcript where the quoted comment is written down (page 2).

Chapter 5 and 6 offer a critical reflection of the research findings in the context of the reviewed literature. These chapters also discuss the research´s contribution to knowledge and practice in actual businesses.

4.1. Industry voice - Original equipment manufacturer

As defined in the methodology chapter, the expert findings are clustered into seven thematic categories (T1) causes and benefits, (T2) OEM expectations, (T3) challenges, (T4) definitions, (T5) organisational requirements, (T6) resources and competencies, and (T7) approaches and methods (see section 3.4.1.1). A representative sample of the expert statements is used for each of the twelve main questions with additional discussion regarding the seven clusters included to provide meaning and clarity (see section 3.4.3). The described procedure and clusters are consistently employed for all the cases analysed.

4.1.1. Causes and benefits

The findings reveal that OEMs find themselves confronted with an increasing quantity of variants and rising complexity (E02; E09). These processes become more manageable by outsourcing the development and production of whole systems to a system supplier (E02; E09; E20). In addition to reducing complexity, cost advantages (E02; E09; E20) are expected to occur by contracting out entire systems. Component manufacturers faced with this strategy attempt to safeguard their position within the OEM value creation process by increasing their portfolio (E09; E17) to meet customer requirements. Companies venturing into the system business aim to improve their growth potential (E02; E09; E17) and intend to differentiate themselves from the competition (E09; E20) by increasing product value (E02; E09; E17). In contrast, companies that just increase output follow a short-term strategy, neglecting potential future aspects (E02; E09; E20). The following quote illustrates OEMs view concerning the evolution into system supply.

“Either the supplier will be forced into the role of system supplier by the OEM, or the supplier decides to take this step on his own, in order not to be eliminated by a competitor” (E02:2).

One expert stressed a very different perspective on switching from component to system supply. The respondent suggested that the 2008 financial crisis had a strong impact on enterprises´ attitude to mode switching (E17) because, according to him, crises always lead to new questions concerning a companies’ future.

“The crises 2008, forced companies to bring into question whether they are still well positioned in their current business field. One possible strategy to overcome this situation might be portfolio diversification via additional offerings, hence companies start to broaden their business portfolio, what in most cases is unsurprisingly directed into system responsibility” (E17:2).

However, the causes for the evolution into system business must be seen in the majority of cases as externally driven according to the experts interviewed (E02; E09; E20).

“OEM constantly asks, what to manufacture in-house and what to source externally? Even entire system developments increasingly tend to be sourced externally” (E20:2).

Concerning benefits of system business, suppliers hope to gain higher margins (E02; E09) through offering systems, since components are easier for customers to calculate the cost, than a complex and highly integrated product like a system (E02). Further advantages of being a system supplier are seen in less compatibility (E02; E09; E17; E20), the opportunity of achieving a unique selling proposition (E17; E20), and opening new business fields (E09; E17). As the system business necessitates an understanding of the entire product with all sub elements as well as adjacent components and systems (E09; E20), additional benefits for the supplier according to the interviewees might include: extending R&D competency concerning interface management (E09), interaction of complex systems (E20), enhancing communication on a par with the OEM (E17) plus the opportunity of obtaining OEM insights that other suppliers are unable to obtain (E02; E20). Concerning turnover predictability system suppliers are in a good position, because once a system is contracted it is unlikely to be changed during a running production series (E02; E20) as illustrated by the following statement.

"The replacement of a system supplier is always much more difficult and expensive than the replacement of a component supplier. This is the risk you take as OEM when relying on system supply" (E20:2).

OEM experts estimate that it will be increasingly challenging to stay in business without having to supply more complex products (E02; E09; E17; E20). That is why progressing from sole component manufacturing towards system development appears essential for such companies. However, while that is said, the majority of the interviewed OEM experts support the idea that there are more benefits for a company transforming into system business, than remaining at component manufacturer level.

4.1.2. OEM expectations

The OEMs´ key expectations for their system suppliers are technical understanding of the entire system as well as knowledge in relation to the prior system and its interfaces (E02; E09; E17; E20). Further, OEM expectations include, skills and knowledge to support the OEM solving their challenges (E09; E17; E20), processes in line with OEM ones (E17), reliability, and openness in case of problems (E17). The following comment is representative:

“We are aware of the complexity in system development and manufacturing, but these are challenges we will not be confronted with by the system supplier and for that reason we decided to supply the system and not perform it on our own” (E09:6). […] “Our expectation is a ′all-round carefree package′, up to now we have not got one in reality” (E20:4).

A significant issue is ′information gaps′ (E20) such as the difficulty in finding a common understanding of terms such as component, module, and system. This is discussed in detail in sections 4.1.4, 4.2.4, 4.3.4, 4.4.4, 4.5.4, and 4.6.4. Similar challenges occur with phrases within a requirement specification and these result in different interpretations, mismatches and consequently in problems (E20). Hence, firstly the system supplier must be in the position to understand the OEMs problem and strategic direction (E09; E17). Secondly, they should be able to imagine a solution (E17), which implies they have a competence and an ability to develop and manufacture a system with required functions (E02; E17; E20). Thirdly, OEMs and system suppliers should communicate and collaborate on equal terms (E17) as indicated by the following statement.

“The communication with the system supplier takes place ideally in such a manner, that I as OEM does not realise, that my counterpart belongs to a different company” (E17:5).

Furthermore, experts assume that the OEM is the only one receiving and selling the goods produced by the system supplier (E02), including the after sales business as the subsequent quote suggests.

“It is unwanted, that system supplier behaves as spare part distributors directly to the market” (E02:4).

Some additional expectations that are placed on the system supplier were identified, such as open book calculation (E02), reliable risk management (E02), adoption of system responsibility (E02; E09; E17; E20), managing complexity (E02; E09), and delivery of specified goods in accordance with the requirements specification in the right quantity, quality, and on time (E02; E09; E17; E20).

4.1.3. Challenges

The challenges confronting component manufacturers on their way to becoming a system supplier are numerous. The OEM experts include the following as the most important: managing complexity and variants (E02; E09), quality (E09; E20) and supply chain management (E09; E17; E20), development of core competencies (E02; E09; E17; E20), as well as customer focus (E09; E17; E20). In the view of the interviewed experts, one mandatory core competence of a system supplier is the ability to manage complexity, without building countless variants. Hence it is important to build a few clever variants that can fit with customer's requirements (E09). Such an approach furthermore supports the system supplier in balancing diversity and costs (E02; E09; E20). The following quote illustrates this:

"The challenge for a system supplier is always the dilemma between price and product quality" (E20:3).

Equally, the quality management of (sub) contractors (E20) will become a challenging task for the new system supplier. The system suppliers 2nd tier contractor is typically familiar with the system requirements, but 3rd tier subcontractors might lack the necessary knowledge (E20) and therefore their contribution might not correspond with system requirements. Hence system suppliers require a consistent value chain management (E02; E09; E20). Further, misinterpretation of market needs (E09; E17) might lead to unsuccessful system developments. System suppliers need to focus on future requirements of customers (E09; E17) and how to adopt capabilities according to future needs (E02; E09; E17; E20). The following includes some of the challenges that firms encounter when becoming system suppliers: the need of patience (E09); arranging long-term projects (E09; E17; E20); establishing in house competencies gradually (E02; E09; E17). The following statement illustrates this:

"The change from component manufacturer to system supplier in one single step, does not work in most cases […] overhasty actions - which absolutely should be avoided – direct beside the technical issues into topics concerning acquisition, employee integration, different cultures, and others, what complicates the change process additionally" (E09:3).

Each system consists of several elements, some of which are vital for the system´s purpose. Thus it is essential to ensure that these key components are delivered with the right quality, quantity and on time so as to avoid production bottlenecks for the OEMs. Therefore OEM expects the system counterpart to have a resident engineer on site for quick reaction in case of difficulties (E02). The experts also noted that OEMs hoped to improve flexibility and reduce risk through development agreements and warranty contracts (E02). Warranty contracts regulate claims in the event of product failure (E02). One expert noted that OEMs seek, with development agreements, not only to fix technical issues but also to share any patents that arise from the process. This allows OEMs to assign work to other suppliers to produce identical products and thereby remove over-reliance on one supplier (E02). With this tactic in mind, system suppliers need to find ways to avoid becoming easily replaced (E02; E17; E20). This can be done by cost sharing via agreements regarding minimum order quantities (E02) and/or by designing a system that cannot be easily replicated (E17), as specific core technology and knowledge is necessary. When evolving from a component manufacturer into a system supplier the danger of damaging the company's reputation (E17) should not be underestimated. The subsequent quote illustrates this point:

"All business ideas that a company approaches, initially build on the company's reputation, if the company fails when switching into system business, the entire company's reputation might be affected" (E17:3).

Finally, current customers might aim to hinder the company in its transition into a system business by freezing their orders (E02; E09; E17). Such a reaction and pressure on the establishment of a system business needs to be considered and balanced prior to the strategic implementation of mode switching into a system supplier (E17).

4.1.4. Definitions

According to the OEM respondents, the terms module and system are often used interchangeably in OEM automotive businesses (E09). However, some interviewed experts categorised modules in a higher and more complex class than systems (E02; E09; E20). Within this OEM specific definition, a module always includes a system, while a system is not automatically a module (E09). Components by contrast are elements used within a system or module (E09) defined by a part or item code number (E02), and specified per technical drawing (E09). The description of modules and/or systems takes place by characterisation of functions via requirements specification (E09). Due to the definition based on requirements specification, the exact meaning of individual terms can vary over time (E09) as indicated by the following quote.

"I agree with the statement, that the terms [component, module, and system] are not steady over time, they can and will change" (E09:5).

Definitions can also depending on a person´s perspective (E02; E09). The following quote illustrates this point.

"The definition [of component, module, and system] depends always on the customers point of view, even within one same company the meaning can vary between departments such as purchase and logistics" (E02:4).

OEM experts cannot provide a common definition of component, module or system. This is comparable with the responses from the other case interviews.

4.1.5. Organisational requirements

In the view of the OEM experts, the evolution from component manufacturer into system supplier should take place in parallel (E02; E09; E17; E20) with the component business in place. The organisational structure should be set up in such a way that it is capable of managing the existing business as well as the newly established system business efficiently without causing frictional losses (E02; E09; E17; E20). OEM experts agree with statements from the other interviewed experts that the same company might simultaneously be a 1st tier supplier as well as a 2nd or even a 3rd tier supplier, depended on the particular contract and agreed scope of supply (E17; E20). The starting point for such a business concept is the development of systems based on existing core competencies/products with step by step improvement (E02; E09; E17). By gradually adding features and broadening the scope of supply (E09) the firm can enhance its ability to deal with increasing complexity. To proceed with such an approach, the organisation requires knowledge, manpower and a structure that is tailored to deal with the uniqueness of a system business to solve challenges different than before (E02; E09; E17; E20). Expert interviewees suggest establishing a separate unit (E02; E09; E17) or project organisation (E02; E17; E20) that can drive the development of a system business beside the existing organisation (E02; E09; E17; E20) as a favourable structure.

Such a process would offer the most flexible approach of evolving into a system business in addition to the existing business fields. The advantage of doing so is the opportunity of growing pro-actively (E09) with increasing demands arising from a system business. Finally, the desired structure for a system business should be a separate unit within the organisation (E02; E09; E17), while using all available departments and functions of the company via a matrix management (E02; E20). In the view of interviewed experts, a key for similar success at both businesses is the segmentation of component and system business into different units (E02; E09; E17). The need for these different units arise from: differing processes (E02; E09; E17; E20), product and customer requirements (E02; E09; E17; E20), competencies (E02; E09, E17; E20) challenges (E02; E09; E20), and mindsets (E09; E17). In particular, R&D tasks (E02; E09; E17; E20) and sales activities (E17) differ in comparison with a component business. Therefore, respondents suggested, setting up R&D and a sales force that is focused on the requirements of a system business for a successful product development and market penetration. System R&D requires a mixture of competencies (E02; E09; E17; E20), with generalists (E09; E17) responsible for a holistic overview and project caretaking (E20) and interface management (E02; E09), as well as specialists within the different technical disciplines capable of in depth tasks (E02; E17). Additionally, an organisational transformation is required, with rethinking of the company's customer behaviour, because as a component manufacturer, the key mission is selling one product to as many customers as possible (E17). On the contrary, evidence suggests that at the system level, usually a one on one relationship dominates (E17), one product for one customer. Hence the company has to cope with an entirely different customer relationship structure.

4.1.6. Resources and competencies

The findings recognised that the development of systems is an expensive process (E02). Therefore the management of variants (E02; E09) and especially skills able to define the wellspring for building variants out of components/elements meaningful, in order to minimise complexity, is most important (E09). A well skilled purchase and logistics management (E09) that is able to deal with various interfaces (E02; E09) and able to cultivate different contacts and disciplines (E02; E09; E17; E20) is essential to accomplish this broad complexity. In comparison to the component manufacturer, the system supplier needs resources and competencies within R&D that are able to integrate and combine existing, newly developed and/or purchased components/elements into a viable system (E02; E09; E20) as the following statement illustrates.

"System development implies eliminating errors" (E20:3).

The study suggest that a system supplier must have a real understanding of the entire system (E02; E09; E20), including all subsystems and components (E09; E17). Moreover resources and competencies in technologies are required to develop and manufacture the system (E17; E20), as well as skills and knowledge to understand customers demand (E09; E17; E20). The following quote reflects this:

"System suppliers have to broaden their perspective and need to think holistic, as an example providing answers concerning gaining installation space and/or answering what additional functions need to be integrated within the system to achieve the most useful effect" (E09:2).

Thus, system supplier R&D employees should understand the OEMs modality looking at problems (E09) while thinking and acting in a holistic manner (E09; E20), being competent to communicate on a par with their customers (E09; E17), in order to develop unique solutions. It is important to have knowledge of relevant principles, regulations and conventions particularly if the target market is not familiar (E17). Suppliers within system businesses will become more and more purchase driven (E09; E17), because of the extensive delivery content. Hence resources and competencies, especially in strategic purchase (E09), quality management (E09; E20), and supplier evaluation (E09) need to be expanded. The diversity of delivered content is not limited to purchased goods. Contractors and (sub) contractors and external development partners (E02; E17) are also included, which requires new competencies and cultural rethinking in terms of collaboration beyond company boundaries (E20). Furthermore, increased responsibility towards customers and product liability (E02; E09) was recognised as requiring reliable risk assessments (E02).

4.1.7. Approaches and methods

In the view of the interviewees, a meaningful process of conducting the transition into system business might be the establishment of a project department to drive the system business that would work alongside the existing organisation (E02; E17; E20). The company could therefore end the systems project development if necessary and still not interfere with the main company business (E02). The preferred roadmap identified by experts is developing a system business through project organisation (E02; E09;

E17; E20) and later on merging it with the existing organisation (E02; E09; E17; E20). The experts prefer a matrix structure (E02; E09; E17; E20). It makes sense to start a new system business in areas with low competition (E02) and then move from these niche markets into more contested areas. Concerning knowledge development and becoming acquainted with complexity, one respondent suggested initiating a system supply with less complex projects in order to increase familiarity with the challenges of system development and implementation (E09). Thereafter, more complex projects could be implemented. In the view of the interviewed OEM experts an approach such as this enables component manufacturers to have a pathway to evolve into system business using the projects as a reference point (E09; E17) and in addition utilising learning curve effects. Possessing successful reference projects is always important for gaining subsequent orders in the initial phase of the evolution into system supply. Regardless of which approach is chosen the commitment and active support of the management board is essential (E17) for a successful migration into a system business. The following quote illustrates this:

"If the development into system business plays that important role in companies' strategy, no question this project must be positioned at top management level" (E17:3).

In order to manage the transition into a system business with as few hurdles as possible, detailed customer analysis (E02; E09) focusing on their products and markets helps to avoid stumbling into competition with current customers. In the view of one expert applying the method of feasibility analysis might be a valuable way of figuring out how far a company dares to proceed when evolving in a system supplier (E09). Furthermore, some interviewed experts suggest conducting benchmarking (E02; E09) in order to answer issues regarding which products/solutions are offered by competitors and how these products could be improved. Additionally, identifying system potential by questioning what motivates the OEM/customer and/or what kind of long-term trends exist, might help at finding new innovation (E02; E09). Finally, respondent's comments suggest that controlling the methods of project management (E17; E20) is an important precondition when moving from component manufacturer to a system supplier.

4.2. Industry voice - Component manufacturer

Corresponding to the classification made in the methodology chapter, the statements of the interviewed experts are clustered into seven thematic categories (see section 3.4.1.1). As with the previous sections, the statements are sorted by reasonableness and frequency of response (see section 3.4.3).

4.2.1. Causes and benefits

Component manufacturers find themselves facing fast growing competition including competition from low cost countries (E01; E04; E12; E21). Furthermore there is an increase in complexity of products (E01; E06; E07; E12; E21) and customer requirements are changing towards the demand of delivering entire systems instead of single parts (E01; E04; E05; E12; E21). Consequently, present component manufacturers need to establish system knowledge (E01; E06; E07; E12) in order to stay ahead in business and to become less easy replaceable. The comment illustrates this:

"[…] thus, the company is following a market trend, to secure its market position in order to archive unique selling propositions" (E01:2).

The interviewed component manufacturer experts made clear that the main reason for a change into system supply in most cases is driven by external forces (E01; E04; E05; E12; E19; E21). One interviewee stated that the trigger for becoming a system supplier varied according to the stage of the macroeconomic cycle (E06). In boom periods the trigger was due to customer needs and market pressure while in an economic downturn it was the firms themselves that drove the change (E06). In both cases, though, the root cause of change was external forces. Findings indicate that the benefits expected by the evolution into a system supplier are less replaceability (E01; E05; E19), an increase in customer loyalty (E01; E04; E05), and customer interaction (E04; E19; E21), as well as expanding the own real net output ratio (E05; E06; E07). As illustrated in the following statement respondents (E04; E19; E21) consider being involved in the product planning and development process of the customer at an early stage brings several advantages.

"If system supplier are clever and manage to be included early in new customer developments, they make themselves part of customers product strategy, which strengthens their position, enables them to define requirements to their benefit and increase customer loyalty in a massive way" (E19:3).

Furthermore, another important benefit is the development of new business directions and activities that are capable of becoming the company´s core business and, perhaps, safeguarding its future (E01; E19).

4.2.2. OEM expectations

OEM expectations for their system suppliers are first and foremost, that they possess knowledge of the entire system with its interfaces concerning adjacent and prior units (E01; E04; E06; E07; E12). Moreover, project management skills (E04; E05; E06; E07; E12), process planning capabilities (E12; E19), and organised quality systems (E01; E06; E07; E12), as well as knowledge of relevant standards and regulations are considered important (E01; E06; E07). Additionally, methods and resources capable of developing complex systems (E01; E04; E05; E12; E21), control processes (E06; E07), managing the entire (sub) supply chain (E04; E05; E12), and manufacturing robust solutions are essential (E12; E19; E21). The following comments are representative.

"OEM expect the delivery of an all-round carefree package" (E06:4); "fit and forget solutions" (E07:4); "near term involvement [and] interactivity" (E05:4); "asking the right questions" (E01:4); "avoidance of over engineering [and] overall responsibility" (E04:4); as well as *"interconnectedness of disciplines [and] experienced management of the entire supply chain" (E12:7).*

The interviewees suggested that a prerequisite for a productive collaboration is the synchronisation of requirements specification and functional specification between the OEM and the supplier (E01; E05; E12; E21).

4.2.3. Challenges

Component manufacturer interviewees believe that the challenges on the way to becoming a system supplier are diverse, ranging from topics concerning tools and methods, to knowledge, resources, and organisational issues, and to questions of changes in mindset and rules of the game (E01; E04; E05; E06; E07; E12; E19; E21). Least appear particularly prevalent for companies that are to date manufacturing mechanical components, finding themselves challenged with new disciplines (E01; E05; E04; E12) like electronics, mechatronics, software, as well as regulations for example requirements concerning functional safety[20] (E01; E06; E07). The challenge with reference to norms and regulations is based mainly in their transition into understandable guidance and manageable processes for the company and its employees (E06; E07). Furthermore component manufacturers evolving into system business have to face an increase in complexity (E01; E06; E07; E12; E21) and related liability and warranty topics (E01; E04; E05; E06; E07; E12). In contrast to component manufacturing, where single components are examined, system development requires assessing the entire product situation with all interfaces and adjacent elements (E04; E05; E06; E07; E12; E21) to estimate possible risks. This circumstance increases necessary activities and resources exponentially (E06; E07). The following statement outlines the different approach to system development:

"Component manufacturer, used to developing their products yet in peace and quiet, will find it most likely strange, to operate and synchronise with many persons and disciplines, even before starting the real development" (E05:2).

With the challenge of rising product complexity (E01; E06; E07; E12; E21), technical (E01; E05; E12; E21), organisational (E01; E04; E05; E12; E19; E21), and legal issues (E05) also increase, hence strict observance of processes and regulations becomes more important (E06; E07). Beside the utilisation of new tools (E01) and applying different methods/processes (E05; E12; E21), system development requires employees with project management skills (E04; E05; E12; E21) who are able to coordinate and control the various functions, disciplines and matters arising. In addition, competencies in quality management (E01; E12), supplier qualification (E05), and system sales (E04; E05) are essential and become more important

[20] "Functional safety [IEC 61508 and ISO 26262] is a concept applicable across all industry sectors. It is fundamental to the enabling of complex technology used for safety-related systems. It provides the assurance that the safety-related systems will offer the necessary risk reduction required to achieve safety for the equipment", see International Electrotechnical Commission (IEC) www.iec.ch/functionalsafety (Accessed October 2012)

compared with component business. As the interviewees outlined, a successful evolution into a system supplier requires a common understanding and strategy (E01; E12; E19; E21); if the company does not have a serious approach or communicates insufficiently, then the danger of moving in different directions or accomplishing similar activities without knowing it might be high (E05; E12; E21). Hence, senior management is forced to define reasonable schedules to avoid over-extending the organisation and its employees on the way to becoming a system supplier (E01; E21). Change provokes fear and it is important that employees are encouraged to make change, hence an effective change management strategy is required (E21). Additionally, the implementation of new/different methods and approaches is required. Thus employees need to be convinced, that obvious additional responsibilities might be useful in order to support daily work more easily at a later stage (E01). Concerning market expansion, the future system supplier should take care and not unintentionally enter the business territory of customers, as illustrated by the following.

"If customers feel threatened by market actions of suppliers, they will break up purchasing products immediately, not to mention joint development activities [...] customer only share their [development] knowledge, if they feel certain, not building up a future competitor" (E21:3).

In the view of experts interviewed, a significant challenge for system suppliers is to convince potential customers of their competence. Hence a new system supplier needs a reference project and a success story (E21) as proof of competence.

4.2.4. Definitions

The definition of component, module, and system strongly depends on the viewer's standpoint (E04; E05; E12; E21). Even among experts belonging to the same company the use and interpretation of those terms vary (E04; E12; E21) as indicated by the following quote.

"The passage between the single terms component, module, and system is fluent and change over time" (E12:4).

The same product was termed by one expert as system, while another defined it as a subordinate component of a system (E04; E05; E12; E21). Interviewees suggested that a current module or system might change in the companies' internal wording into a component by the time it is standardised and/or integrated within a defined modular assembly system (E04; E05; E12). Replaceability, the level of interface complexity and functionality are important aspects, according to respondents that distinguish component, module and system (E01; E04; E05; E06; E07; E12; E21). Hence, components are technical products consisting of few individual parts that make a contribution to the functioning of a bigger unit (E01; E04; E05; E06; E21). Often components only perform one or two functions (E01; E21). A module is a technical product, assembled from different components, which feature a predefined interface that is connected with and integrated into a bigger unit (E01; E12; E21). Modules result primarily from the integration of functions and benefit the customer with lower mounting and/or handling effort (E01; E12). A system is a technical product, composed of several modules and/or components which are integrated into the superior unit by interfaces developed together with the customer (E01; E04; E12; E21). The interface configuration happens in tight collaboration – know-how transfer - with the customer (E01; E12). Therefore, the replacement of systems is difficult (E01; E12).

4.2.5. Organisational requirements

In the view of the respondents, the development into system supply should take place in parallel with the component business acting as a strong basis for system developments (E01; E04; E05; E06; E07; E12; E19; E21). The following quote indicates some issues that a company should address when becoming a system supplier.

"How can the company contribute its existing knowledge on products, subjects, disciplines into new business fields" (E12:4). […] "Where can the company further useful apply their competencies, knowledge, and skills" (E21:4).

In terms of preferred organisational structure, the firm should utilise a project based organisation (E04; E05; E06; E07; E12) initially, and after a period of successful project implementations, move toward the establishment of a separate department/unit (E01; E06; E07; E19) using central functions within a matrix management (E12; E21). The following statement is representative.

"At the beginning systems will take longer to become profitable, thus companies invest component earnings to finance system developments, but in the long run, every product independently if component or system must do well financially" (E06:3).

Hence, the development and/or recruitment of employees skilled in performing system development tasks (E01; E06; E07; E12; E19) is critical: perhaps even the collaboration with partners (E01; E05; E06; E07; E12) capable of system development - technical and operative - is necessary. At later stages regional system sales forces (E12; E19) should be installed as suggested by the following.

"If the sales force is organised product orientated, the terrain [region, customer, application, et cetera] needs to be defined in detail to avoid business conflicts" (E19:4).

As mentioned previously, it is important to establish a separate unit, equipped with a certain amount of creativity (E01; E12; E21).

4.2.6. Resources and competencies

The experts interviewed noted that additional disciplines become more important as a firm moves to become a system supplier. The additional disciplines required are diverse and depend strongly on the starting position of the company (E01; E05; E12; E21); possible examples are mechatronics, sensors, software, electronics, and hydraulics (E01; E04; E05; E12). Suppliers that try to develop systems without their customers input will be at a disadvantage (E01; E04; E05). At the system development stage the supplier needs to work closely with the customer (E01: E04; E05; E12; E21), hence project management (E04; E05; E06; E07; E12) skills are important. Project management is a key competence that synchronises all involved disciplines and interfaces (E12; E19), in order to develop, manufacture and supply a functional unit within the right time, quality and quantity (E05; E12; E19). A precondition for such an achievement is that all involved individuals act as a team (E05; E12). Within the project management team, system development (E01; E06; E07; E12; E21), system validation (E01; E06; E07), quality management (E01; E12), supplier qualification (E05), as well as purchasing and sales (E12; E19) becomes more sophisticated as the subsequent quote suggests:

"It is important, to cover all involved departments/disciplines with professional expertise, in order to comprehend and manufacture a functional reliable system" (E05:2).

In the view of the respondents, developing systems successfully requires R&D competencies at least one level above the knowledge necessary for the supply of the firm´s current products (E01; E06; E07; E12; E21). Equipped with such competencies, system suppliers have both, the comprehension and the capability to communicate on a par with their customers (E05; E06; E07; E12; E21). The following quote provides some context.

"A company only can deliver a good that performs its task, if the area of use [application range] is well known (no matter the level of complexity) therefore, possessing knowledge at least of the next value stage is crucial. Consequently, the suppliers should have notice, regarding their components implementation [module/system] and which function they feature […] doing so, the supplier needs knowledge of the superior system and its functions […] this implies, companies deciding to develop and supply systems require knowledge at least of the next value stage compared to their product" (E21:2).

The interviewees also mentioned a number of supplementary skills; these are integration ability (E01; E05; E12; E21), capability of managing complexity (E01; E06; E07; E12; E21), and knowledge of legal regulations that have to be complied such as functional safety, machine guidelines, and other (E06; E07).

4.2.7. Approaches and methods

The interviewees in the component manufacturer group all agree that the evolution from component manufacturer into a system supplier will take place gradually (E01; E05; E06; E07; E12; E21), by maintaining the existing component business (E01; E04; E05; E06; E07; E12; E21) as the following comment suggests.

"It is a multilevel approach, whereas the company will enhance from component, via module up to system supplier […] initially the effort will be equipping existing products [components] with additional functions in order to generate modules, and later on to advance those module into systems by further integrations" (E01:3).

Even with the movement into systems, the components do not become extinct (E01; E05; E6; E07; E12; E21), at the minimum they find integration within the system and contribute in that way to the value added (E01; E05; E06). A smart approach seems to be to utilise kit building based on standardised components (E12). This allows the company to integrate their components into the new systems (E05; E06; E07), while enabling the use of its component knowledge, as well as building up new knowledge at the system level (E12). Furthermore, the company may enter a position offering individual systems to their customers, by multiplexing their own standardised components (E01; E12). The following illustrates this point.

"In communication it must be absolutely obvious, that the established system business will be additional, complementing the existing components in a valuable manner [...] a company will not become a successful system supplier by leaving its existing component business, the focus of communication must be, the component remains important" (E12:3). [...] "Without components it is impossible to build a system [...] and if a company manufactures those system components, why should it not sell them separately as well if this does not harm the business?" (E01:3).

The approach should not be only to develop systems (E01; E04; E05; E06; E07; E12; E21), rather it should be about developing components while aiming to expend into modules or even systems development (E01; E04; E05; E12; E21). The system development process ought to include analysing actual product applications on a complexity and integration level one or even two levels above the current state (E01; E06; E07; E12; E21). It is also useful to examine the requirements of the end users of the product that the firm supports with their components (E12; E21). Furthermore, it is worthwhile to ask if today´s products will be needed in the future given the pace of change of technologies (E12). There are various useful methods for evolving into a system supplier and experts agree that the use of a defined and structured development process is completely necessary (E01; E06; E07; E12; E21). In that correlation the V- model[21] (E01; E06), offers a very good opportunity to illustrate system projects in a structured manner. Further beneficial methods and approaches are system analysis[22] (E01; E06; E07), operational research[23] (E12), requirements management (E01; E06; E12; E21), FMEA[24] (E01; E06; E07), and systems engineering[25] (E01; E06; E07; E12; E21).

[21] V - Model: international recognised standard for the development of systems, defining obligatory how to conduct system development, with its tasks methods and tools.
[22] Systems analysis is the fragmentation of a system into its single pieces in order to study their interaction.
[23] Operational research is engaged with applying sophisticated analytical methods to help making decisions.
[24] FMEA: Failure mode and effects analysis.

4.3. Industry voice - System supplier

In accordance with the classification made in the methodology chapter, the statements of the interviewed experts are clustered into seven thematic categories (section 3.4.1.1). As with the previous sections, the assortment of the statements takes place by means of reasonableness and frequency of occurrence (section 3.4.3).

4.3.1. Causes and benefits

It is accepted that companies seek growth opportunities; identifying new fields of activity embodies one possible option (E08; E13; E16). Thus the evolution into system supply offers a feasible solution, because of genuine growth limits in component businesses (E08; E13; E14; E15; E16; E18; E22). Furthermore, the need for differentiation (E08; E13; E14; E15; E16; E18; E23), and avoiding being caught within the price trap (E08) can also drive this decision, as indicated by the following.

"A component manufacturer is exchangeable, as system supplier rather not […] it is an aspect of safeguarding the business for the future, since unique and more vertically integrated a company, the more difficult the replaceability of its products" (E16:2). […] "If component manufacturers have ten or fifteen competitors within their area of activity, as system supplier they would have only between two or three" (E23:2).

Additionally, present customers shift their spectrum of supply upwards (E16), and, in doing so, enables a component manufacturer to develop into more complex supplies. Considering these points, the change from component manufacturer into a system supplier has to be termed as internally driven by firms´ decision (E08; E13; E14; E15; E16; E22; E24), in order to gain a competitive advantage. Customers and especially OEMs increasingly demand entire systems (E13; E14; E15, E18; E23), in order to reduce their own efforts at managing growing complexity (E23). Component manufacturers who already develop and deliver more complex components are required to have more extensive knowledge and associated skills/resources, even if this is not currently valued by the customers (E13; E14; E15; E22; E24). Evolving from a component

[25] "Systems engineering is an interdisciplinary approach encompassing the entire technical effort to evolve and verify an integrated and life-cycle balanced set of system, people, product, and process solutions that satisfy customer needs" (NASA 1995:16).

manufacturer in a system supplier might solve this issue (E13; E14; E15; E22; E24). The following is illustrative.

"If the company is already examining adjacent components and has system thinking available, it makes sense to shift the value creation as well into systems" (E24:2).

Only if a company exceeds its component boundaries can further growth potentials be exploited (E08; E13; E14; E15; E16; E18; E22). Each component by itself is exhaustively optimised, but to further increase final product performance, additional steps are required (E24). The following quote illustrates a prerequisite of becoming a system supplier.

"However becoming system supplier at all costs makes no sense. Such evolution always should embody an economic value added and enrich current R&D activities" (E24:3).

The benefits of becoming a system supplier mentioned by the system supplier experts interviewed were: the gaining of further growth opportunities (E08; E13; E14; E15; E16; E22; E24), the decrease or avoidance of exchangeability (E08; E13; E14; E15; E16; E23; E24), an increase in turnover and profit potential (E13; E14; E15; E18; E24), as well as the prevention of substitution (E13; E14; E15; E18). Further advantages noted, are the increase in knowledge (E18; E24), the opportunity to realise unique selling propositions (E08; E13; E14; E15; E16; E23), embracing innovative potentials (E16), as well as becoming more attractive for new employees (E16). In summary, respondents evaluate the evolution of an enterprise into a system supplier as the most beneficial option for seeking out growth opportunities.

4.3.2. OEM expectations

OEMs expect a complete, problem free (E13; E15) package with continuous support (E18), system advancement (E18), and guidance regarding performance development of OEM applications (E08; E18; E24). Moreover, the development of the entire system is expected to be faster and more effective than if attempted by the OEMs themselves (E08). Further expectations include that the system satisfies the defined technical requirements, features robust quality, be supplied on time, and perform without failure in the field (E08; E13; E14; E15; E18; E23; E24). To facilitate harmonisation and communication, the OEM expects system suppliers to have in-depth knowledge regarding the system and its components, adjacent elements, as well as the application the system is build-in (E08; E23; E24). The following comment illustrates this:

"OEM expects, mastering the entire system, by optimisation of build-in components. [...] Only somebody who is skilled controlling the system is capable understanding the single components" (E23:2).

In addition, OEMs desire a system supplier to be pro-active in developing and introducing solutions to the OEM, promising answers for unsolved problems, creating unique selling propositions, and enabling commercial success (E24).

4.3.3. Challenges

According to the experts interviewed, the challenges facing component manufacturers on the way to becoming system suppliers are several. The challenges can range from managing increasing complexity (E23) with all associated issues, including organisational aspects (E08; E13; E14; E15; E16; E22; E24), through to market acceptance (E08; E14; E18; E23) and the demand for proof of competence developing systems (E22; E23). In the view of experts interviewed, the first and most important challenge that arises prior to the evolution into a system business is a critical strategy assessment (E08; E13; E14; E15; E16; E24). A positive answer is needed for these key questions: Will these approaches generate added value for the company (E15; E16; E18; E24)? What are the unique selling propositions (E08; E13; E14; E15; E16; E18; E23)? What are obvious customer benefits (E08; E16; E23; E24)? Does knowledge of market characteristics and players exist (E13, E15; E18)? What is the potential of competition with current customers (E08; E13; E18; E22; E23; E24)? Are resource and competence issues resolved (E08; E16; E18, E22; E23; E24)? Subsequently, management requires moving the organisation into a state of readiness (E13; E14; E15; E18) to overcome the characteristic lethargy of successful organisations (E22). This notion is illustrated by the following:

"A huge challenge on the way to a system business represents top down communication, management need to make clear, that the current component business model as successful as it is, will not last for eternity. Hence with certain things and thoughts have to changed; and organisational changes for the purpose of

entering into a new, safe, and stable future are essential. [...] Most important in so doing, is creating a positive mood of change amongst the organisation" (E18:3).

The experts interviewed believe a separate brand needs to be created when a firm is moving from component manufacturer to a system business (E08; E18). This should happen so as not to jeopardise the existing component activities. In doing this, there is a challenge: insuring a consistent approach to the customer (E08; E18), and avoiding customer confusion, as indicated by the following.

"It is certainly a challenge, to position oneself at the market place, and not to endanger the core business/statement the company is well known for by parallel establishing a new business with perhaps a different essence" (E18:3).

To perform the mode switch to system supply successfully, employees skilled in system development (E08; E16; E23; E24), manufacturing (E13; E14; E15; E24), testing (E13; E14; E15; E16), and other activities need to be developed. According to the system supplier experts interviewed, one way to establish the required team is to train internal employees. However this was seen to be time consuming and not always promising. Therefore a two-track strategy of enhancing current employees from component to system specialists and, in addition, hiring external experts is more effective (E18; E24). Hence, it is essential for a system supplier to establish a network of external partners and to manage them efficiently and successfully (E13; E14; E15; E16; E18). The increased complexity of system development should not be underestimated (E23), and as a consequence, the additional effort required for documentation (E13; E14; E15; E16; E22) for example, ensuring compliance with regulations for functional safety requirements (E08; E16; E24). In contrast to the development of components, spending for developing systems increases exponentially and the customer/OEM does not always compensate adequately for this (E08; E22; E24). Therefore the knowledge gained with every new development project needs to be transferred across further products and departments in order to pay off the effort via synergies (E08; E22; E23; E24). Experts in system business advise, especially at the outset, keeping the number of variants and additional features small (E08; E23; E24) in order to stem complexity. Hence it is important that a comparison of cost and benefit at each development stage is completed, to avoid needles diversity of variants, as well as over engineering (E08; E16; E22).

4.3.4. Definitions

Similar to the experts interviewed in the other cases, there is a different understanding of the terms component, module, and system among the interviewees. Completely different to the other, one system supplier does not distinguish between component, module, and system, but rather differentiates between various value creation forms dependent on their complexity (E08). The other system suppliers view the definitions in a time-dependent context (E22), whereas the system is always the next step a company aims for, once the system of today is developed and industrialised, it will be re-termed into component (E22; E23). The following statement illustrates this:

"With the term system it is similar like the term age, when I was young, all people over thirty were crumbly, but now I growing older these people became young, hence the criterion regarding old changes permanent with each year of one's life. Now with 62, my definition of age is, all people older than me are old and all people younger than me are young, that implies the passage is fluent, and in the same way it is with systems. Ever that [supply] what a company is actual not capable to develop, it calls system, and if the company is able developing that kind of supply some years later, it will not be a system anymore, still the next complexity level will be termed as system" (E22:2).

The logic of this implies that all products/solutions a company holds in his portfolio, no matter at what complexity level may be termed components (E22). An additional explanation is illustrated by the following.

"Component manufacturers are characterised by their outstanding product competence, the solution expertise refers to satisfying given product specifications, the product portfolio consist of components. […] Subsystem [or module] supplier offer further solution expertise regarding the overall system, for this purpose they possess interface knowledge in order to evaluate interactions between components/modules, the portfolio contains components, modules, and minor services. […] System supplier additionally offers solutions for tasks regarding the superior system, their system expertise includes apart from system development skills, disciplines like scenario and trend analysis, as well as services, the product portfolio usually contains components, modules, systems, and services" (E24:7).

The majority of experts suggested that components are elements usually fulfilling a single function (E13; E14; E15; E16; E23; E24), while modules represent an assembly of components (E13; E14; E15; E16; E18; E23; E24), and systems are the integration of all components and/or modules necessary for the fulfilment of the required functionality (E16; E18; E23; E24).

4.3.5. Organisational requirements

All of the system supplier experts interviewed (E08; E13; E14; E15; E16; E18; E22; E23; E24) confirm that the coexistence of component and system businesses represents the most effective and popular approach. They suggest that a useful step in this respect involves building systems predominantly using existing components (E08; E18; E22; E23; E24) as indicated by the following.

"The system should build on [existing] components, and not alone the system, even more the components building the systems backbone ought to be cherished" (E22:5).

In this approach the coexistence of component and system businesses is not contradictory, but rather the system will be the main customer of the component business (E08). In fact, a system business can create valuable feedback for the component business (E08). Further, if a sophisticated modular product architecture is available, both businesses can cross-fertilise in a highly effective manner (E08). Initially, the organisational structure favoured by experts is a project-based organisation (E08; E22) and thereafter the establishment of a separate business unit responsible for systems (E08; E18; E22; E23; E24), integrated within a matrix organisation (E08; E16). The subsequent system business unit created should be equipped with all the competencies necessary to facilitate the entire process from system development through to its industrialisation (E08). As illustrated by this quote:

"The entire setting of the company needs to be adapted to the new task - system supply" (E08:2) […] "A brilliant system engineering is of no benefit, if the company has no sufficient sales force. A brilliant sales force or system solution is of no benefit, if the company subsequently cannot offer services. Equally it is of no benefit, if the company is managing the lot in Germany, but goods are exported and the employees on site do not know the subject" (E08:4).

Hence, existing and/or new processes need to be established in accordance with the needs of a system business (E08; E16; E24). Furthermore, launching measures for the traceability of supplied parts is most important in case there is a claim issue (E13; E16). The switch into system business may be perceived as successful when there is a shift in the mindset of all people involved, from thinking in terms of components to instead think in terms of system comprehension and holistic approaches (E08; E13; E14; E15; E22; E24). In conclusion, the coexistence of a component and a system business within one company is agreed by the respondents. However as success becomes evident the segmentation into independent acting units is regarded as reasonable in order to manage the specialities of each business effectively.

4.3.6. Resources and competencies

In the view of the experts interviewed, knowledge of system engineering is essential to carry out the change necessary to become a system supplier successfully (E08; E16; E18; E23; E24). Alternatively, engineering knowhow and development skills regarding the firm´s own system must be in place, thus R&D requires knowledge of the specific customer applications as well as the higher-level unit to supply appropriate system solutions (E08; E13; E14; E15; E16; E18; E23; E24). Another competency needed by a system supplier is the ability to communicate on equal terms with customers (E08; E13; E14; E15; E16), in order to develop customised solutions as indicated by the following.

"For system supply it is mandatory to speak the language of the ones who the company is selling solutions to. […] System suppliers always have to be one step ahead, thinking of how tomorrow´s system might look like […] furthermore they have to understand their market, customers, customer of customers, as well as the customers distribution model" (E14:3).

In addition, resources capable of manufacturing, assembling, testing and finally delivering those systems are critical (E08; E13; E14; E15; E16; E18). It is important for the realisation of system development that employees are able to think in holistic dimensions, with an understanding of related systems and interfaces (E08; E16; E22; E23; E24). Equally it is necessary that employees are in place with specific in-depth knowledge of the various disciplines required for a system development as well as central functions like quality and (sub) supplier management (E08; E16; E22; E23; E24). Additionally, expertise in collaboration with and coordination of external resources are helpful to ensure access to required resources (E16; E18;

E22; E24). The availability of an external network enables the company to become a system supplier more effectively, as supplementary experience and knowledge can be added to existing resources.

4.3.7. Approaches and methods

The system supplier experts interviewed suggest that, the most effective approach to evolving from a component manufacturer into a system business is growing by enhancing existing components (E08; E18; E22; E23; E24). It requires a step by step approach (E16; E18; E22; E23) ideally initiated via pilot projects (E08; E13; E14; E15; E16; E24). When establishing a system business, the milestones are similar to project management (E13; E14; E15; E18; E22; E23) and include proposal generation, concept elaboration, calculation of profitability, conduct the business case, realisation planning, and conduct realisation, with parallel constant monitoring of target costs (E16). Prior to starting this, the firm must identify and assess market potential (E16; E18), performance rating of companies' capabilities (E08; E16; E22; E24), and finally the creation of a strategy (E08; E13; E14; E15; E24) how to establish the business, committed and supported by the senior management (E24). The initial move into a system business should focus on areas that are not currently critical to the company. The intention here is keeping core areas untouched, as long as the success of the system business is not clear (E13; E14, E15; E18). Experts suggest that the evolution into a system business represent a continuous circle of progression, where the iterative steps should not be too wide (E15; E16; E23). Experience suggests that it is not unusual to perform several loops before the first acceptable insights come to light (E16; E23). These insights not only enable the company to develop a system business, they equally support and benefit the component business as indicated by the following:

"It is extremely important to use and establish system competencies in order to optimise the components, [...] we do not primarily build up our system knowledge selling systems to OEMs, although this is quite an important partial aspect, but the main aspect was improving our system understanding in order to advance and optimise the components". (E23:5). [...] "In our view system competence is as well the enabler to sell components" (E23:2).

Experts noted that the ideal conditions for the evolution from component manufacturer to a system supplier involve continuously expanding the firm´s knowledge one level above current supply (E18; E22; E23). The companies that follow this approach will always have the required knowledge and resources for the next product hierarchy and can complete the evolution into the subsequent value stage at any time (E22). Where the company has not continuously developed its competences, missing capabilities and resources need to be acquired. If the relevant core competencies are totally absent, then the acquisition of a company possessing these competencies might be prudent (E16; E24). Evolving into a system supply requires a significant change in corporate culture (E08). Therefore the strong commitment of the senior management is essential for a successful transition (E08; E13; E14; E15; E24). Early communication concerning the aim and direction of the change is important to bring along all people involved (E08; E24). In the view of system supplier experts interviewed, mode switching from component into a system business should happen gradually (E16; E18; E22; E23; E24), initiated and performed by a small number of specialists as the following comment suggests.

"An approach, enabling the entire organisation and its employees at a stroke is not successful, instead a carefully selected team should be empowered as nucleus of a new system unit" (E24:5).

The identification and development of essential competencies for a system supplier ideally takes place through knowledge maps (E24), asking what disciplines are necessary, which competencies are required, and where to find them. Further useful methods and approaches include the analysis of customers' value chains (E08), in order to identify starting points for unsolved customer needs, project management (E13; E14; E15; E16; E18; E22; E23) to coordinate the different disciplines required, simulation (E15) to reduce cost and time, QFD[26] (E16), requirements engineering (E16), system FMEA (E16; E23; E24), system analysis (E23), and the use of development procedures according to the V-model (E24). Furthermore, production process development (E08; E16) was seen to be as very important. Equivalent to the development of new products, requiring an advance development, the development of new production processes require an advance (process) development (E24). Hence, having sufficient ahead-of-schedule work to assure learning curve effects is essential (E24). Furthermore it could potentially be useful in order to avoid/lower difficulties when establishing a production process to conduct pre-series and training activities approximately one year ahead of the ultimate series start (E24).

[26] QFD: Quality Function Deployment

4.4. External perspective - Academia

The classification and analysis of the respondent statements took place as defined in the methodology chapter (see section 3.4.3), similar to the previous sections 4.1 - 4.3. As already mentioned in section 3.4.2, the academic case, with its external perspective, was drawn from two respondents. This was deemed sufficient based on the knowledge and expertise provided by the two academic experts. This additional perspective broadens the view on the research topic as well as providing a complementary contribution to verifying and enhancing the credibility of findings within the cases representing the industry voice. The primary research focus with respect to contribution to knowledge and practice resides on the three previous cases representing industry voices.

4.4.1. Causes and benefits

Academic experts see the initiation of the transition from a component manufacturer to a system supplier starting at the OEM (E03; E10). They suggest that the OEMs face pressure to reduce complexity (E03). This is because it is both very expensive and nearly impossible, for the OEM to be almost perfect in all areas and disciplines that are necessary to develop and manufacture a final product on their own. The following illustrates this point:

"It is like sports when looking at decathletes, they are indeed very good in all ten disciplines, but they never will be as perfect in each single discipline as athletes just focussing on one specific discipline" (E03:2).

Equally, the OEM is focussing on only a few disciplines whenever the firm simplifies their internal processes by outsourcing whole assemblies to system suppliers (E03). As a consequence of this market development, the responsibilities of former component manufacturer's increase and the structure of the whole supply chain changes (E10). Therefore, the reason most component manufacturers evolve into a system business is external forces (E03; E10), even though pushing to the top of the supplier pyramid will increase demands and complexity (E03). Academic experts in this context point out becoming a system supplier is not necessarily the solution for all component manufacturers. A firm may remain a component supplier, because despite system supply, 2nd and 3rd tier suppliers are still necessary (E03). Turning to the benefits, the most obvious one is the opportunity to create a unique selling propositions (E03) and as a consequence becoming less easily replaceable (E03; E10) with other suppliers. In this context, the development of systems enables the supplier to establish barriers (E10), which increase customer connectivity (E03). A further positive outcome is the increase in the firm´s knowledge base through the transfer of know how from sub suppliers and through close cooperation and system development with the OEM (E10). Such close cooperation enables system suppliers to influence the OEM to a certain extent and enables them to increase their own depth of value creation (E10).

4.4.2. OEM expectations

The academic respondents suggest that the important expectations that OEMs have of their system suppliers include accepting system responsibility (E10), possessing knowledge of the entire supply chain (E10), long lasting cooperative partnership (E03), and cost reduction capabilities (E03). The following quote illustrates this clearly:

"As OEM my expectation on system supplier would be, that he is able to control the entire supply chain concerning his system inclusive of all sub suppliers, knowledge regarding adjacent systems and possible interferences with them, as well as responsibility for the scope of delivery in its entirety" (E10:5).

One of the academic interviewees (E03) made an interesting comment concerning cost-cutting programs. The academic suggested that OEMs would take advantage of their auditing power to review system suppliers´ calculations (so called open book calculations), and directly interfere and influence system suppliers purchasing policy. The following statement outlines this:

"Some OEMs use their knowledge to specify the sources of supply for the system supplier, indeed several not only define the sources of supply, they even hold the contracts directly" (E03:7).

Due to greater purchasing volume, the OEM often negotiates better conditions than the system supplier (E03). Further issues mentioned are: adherence to schedules, amount of delivery, and location close to the OEMs plant (E03; E10).

4.4.3. Challenges

The evolution into a system supplier puts greater pressures on the entire value chain of the company (E10). R&D and purchasing departments, especially, need to acquire new capabilities to understand the increased product complexity and diversity of variants (E10). Hence, new dynamic competencies need to be established (E03) to manage and control interfaces (E03; E10), the quality of (sub-) supplier goods (E10), as well as development outcomes delivered by external partners (E03). Moreover changes in companies' culture (E10), as well as employees' mindsets (E03) are necessary, as indicated by the following.

"One must say goodbye to the imagination of 'knowledge is power', but rather increasing the knowledge of the entire company and its employees by sharing individual knowledge and information" (E10:2).

In addition, a system business requires a different approach with development outcomes like patents (E10), because OEMs expect participation in order to pass them to additional suppliers to spread their own risk and lower costs (E10). In order to overcome this conflict, a separation of development efforts and sales of developed products is required (E03; E10). Another challenge is product responsibility, system suppliers need to accept responsibility for the entire supply chain, quality and function of the system (E10). In this context, the system supplier needs to question in-depth what kinds of misuse of their systems might occur (E10). As the evolution to systems happens alongside the supply chain, the firm should not underestimate the possibility of ending up in competition with present customers, something that will damage relationships and lead to a decline in sales (E03; E10). Component and system business can exist simultaneously within one and the same company (E03; E10), but following such an approach, organisational challenges must be overcome as the following comment illustrates:

"Those companies act as hybrid, the positions component versus system changes order depended, which means that in one agreement the firm acts as 1st tier, while in another contract the company is acting as 2nd or even 3rd tier" (E03:3).

Beside organisational issues, the challenge includes having available all necessary technologies (E03), the ability of being flexible for delivering new and unique solutions/products (E03; E10), as well as identifying synergies amongst the product portfolio (E03). In particular the identification of synergies along with the different characteristics of components and systems, for example by a combination of ideas, existing solutions, employee skills and mindsets might produce new innovations (E03; E10).

4.4.4. Definitions

Similar to the industry voices, the academic respondents found it difficult to explain the differences between component, module, and system or to provide a generally accepted definition. The academic interviewees tried to explain the differences between component, module, and system in terms of its level of integration (E03; E10) as indicated by the following:

"The lowest level in this view is covered by raw material, the next level are single parts like springs, screws, simple metalwork, et cetera, followed by components which are assemblies of parts, hereafter the passage is fluent, and depends heavily on the viewer´s perspective" (E03:7) [...] "From OEMs standpoint module and system are both black boxes only differing in complexity and number of integrated components" (E10:6).

Other suggestions to distinguish modules and systems include installation space (E03), number of interfaces (E03), and kind of function (E03; E10). Hereafter, modules are described as limited in installation space (E03), linking several functions, with distinct interfaces (E10). In contrast, systems overlap installation spaces, embody one superior function, and serve various interfaces (E03). In the opinion of the respondents, because the interpretations depend heavily an individual´s perspective, other definitions would be forward when asking people belonging to different departments, like development or purchasing, or different industries and tiers (E03; E10). This illustrates very effectively how openly each term is interpreted at present and how difficult it is to provide a common definition.

4.4.5. Organisational requirements

In the context developing a company into a system supplier, the preferred approach is to maintain both the component business and the system business in parallel (E03; E10). In terms of organisational structure, a project organisation (E03; E10) is favoured combined within a matrix management (E03) as the following suggests.

"The functional responsibility must be maintained in order to assure the professional competence of the employees, to bring in into the project" (E03:5).

A split between a component and a system business appears useful, because of the different requirements and competencies necessary (E03; E10). How this is organised varies from company to company. Several firms manage this by building different project teams, others establish separate units, but in both options central functions are shared (E03; E10). Within such an organisation, major challenges will be to separate the required skills/specialists from the line organisation for the entire project duration and form a cross-departmental team (E03). In comparison to component business, functions like project management, development, supply chain management, purchasing, quality management and sales have much wider relevance (E03; E10). As illustrated by the following:

"Project management becomes more complex, diverse, and long-termed, where formerly specialists with in-depth knowledge were required, now leadership personalities with skills managing cross-departmental functions, abilities dealing with resource shortage, broad communication competencies, and beyond that also having in-depth development experience, are necessary " (E10:5).

Quality management in a systems business requires employees able to communicate in different languages (for example Chinese, Russian, Spanish, and other) to supervise and develop (sub-) suppliers (E10). At the same time development engineers need to be much more market-focused and innovative, in order to identify trends and requirements suitable for new systems/solutions/businesses (E10). System development engineers need to detect and define system requirements on their own to a certain extent, because in the early stages of an innovative and new system no customer is involved (E03; E10). The respondents suggest that the success factors at the transition to a system supplier involves the further development of existing products (E03; E10), a change in development culture (E10), adjustment of sales and distribution (E10), R&D segmentation (E03), implementation of interface management (E03; E10), increase in project management (E03), and the build-up of skills to manage external resources (E10).

4.4.6. Resources and competencies

The academic interviewees indicate that the key resources and competencies of system suppliers include sales, delivering customer requirements, product development or more effective project management, turning customer requirements into technical solutions, and strategic purchase sourcing goods from suppliers and subcontractors (E03; E10). Sales in relation with system business (E10) necessitates close connection with the customer which requires salesmen speaking the customers' language (E03) with the ability to discuss technical terms at eye level[27] as indicated in the following:

"As system supplier a different way looking at customer requirements is essential, not every technical sophistication in its depth is important, rather providing a faultless concerted system solving customers demand efficiently is required" (E10:6).

Project management (E03) in terms of managing interfaces (E03; E10) turns into one of the most important resources and competencies on the way to becoming a system supplier. Interface management (E03; E10) turns into a core competency, because the development of systems takes place as a cross functional process, which demands the ability of connecting different fields of expertise and complexity like design, calculation, simulation, testing, mechanics, electronics, mechatronics, software, quality, as well as contractors, suppliers and other external resources (E10). Likewise, skills including product or solution know how, as well as associated process knowledge play an important role (E03). System suppliers need to strengthen strategic purchases, because collaboration with suppliers and subcontractors will increase dramatically and become an important dimension within the value creation process (E03). In particular, the purchase of bought-in parts requires the capability to understand the production processes, in order to recognise manufacturing expenses involved to evaluate the real value and purchase price of a good and not to be dependent on the honesty of the subcontractor (E10). Academic respondents point out that besides human resources (E03; E19), financial power (E03) is an important resource on the way to becoming a system supplier that should not be underestimated. In advance of any sales for new products, system suppliers have to make investments in terms of advanced developments (E03). It is self-evident that not each quotation will result in an order; hence the system supplier will need to be in a position to absorb the cost of such lost orders (E03).

[27] Eye level is understood as being on a par with the OEM concerning technical issues

4.4.7. Approaches and methods

In the view of the academic respondents, the most prudent method to complete the transition from a component manufacturer into a system supplier is by developing the system out of the companies´ own components (E03; E10) and thereafter developing the systems business from this position into new and alternative solutions and applications (E10). This idea is supporting by the following quote.

"Doing so is for sure the safest option, because the company builds its system business on something [their component knowledge] where it has lots of experience" (E10:3).

In addition, interviewees suggest starting the development of systems within a small and defined area/unit (E03). Initiating the transition at small volumes provides the opportunity to change things far more effectively and at lower risk, than starting at full volume and main markets/types (E03). This standpoint is supported by the subsequent statement:

"In automotive business, new systems are usually tested within the premium segment, because it is known that new systems are fault-prone, and in premium segments the volumes are low, it is not as price sensitive, and hand craft is not unusual, what facilitates adjustments" (E03:4).

As already mentioned, the transition from component manufacturer into a system supplier should take place using a step-by-step approach (E03; E10), ideally by broadening the products in the own component portfolio (E03; E10). At the initial transition into a system supplier, an important step is the identification of core competencies, so as to describe the company's development abilities and matching them with the required competencies within the system business (E10). Recognised gaps need to be filled (E10); opportunities for addressing limitations in knowledge, technology, skills, or resources include acquisition and cooperation, in its different shapes (E03; E10). Moreover organic growth by developing the company´s own resources and competencies are further options to overcome such limitations (E03). Which approach should be chosen - internal or external knowledge setup - depends on each company's individual strategy (E03; E10). In addition to the identification of a company's internal abilities (E03; E10), it is essential to analyse the external market and its requirements (E03; E10). Therefore, conducting market analysis (E10) that answers questions concerning the kind of products/systems required is crucial. Further, the company should be assess if there is enough space for another system supplier (E03), as well as being sensitive to whether the OEM will accept the company as a 1st tier supplier (E10). In addition, an awareness of the firm´s own USPs[28] (E10), customer access (E03; E10), and knowledge concerning competition is critical.

4.5. External perspective - Business consultancy

Comparable to the prior section and discussed in the methodology chapter section 3.4.2, the business consultancy case was based on one interviewee. The rationale for this was to provide an additional perspective but also to broaden the collected views on the research topic and to enhance the data verification and the credibility of findings. It is important to note that the interviewed business consultancy holds key expertise in the development and implementation of new processes and supporting companies at organisational changes. Nevertheless, the primary research focus of this thesis resides on the main cases representing industry voices.

4.5.1. Causes and benefits

The business consultant interviewed stated that economic issues were the main driver of the efforts of component manufacturers to develop into system suppliers. The respondent suggested that a reason for this is the aim to become less replaceable, especially in the context of facing growing competition from Asia and India, which offer comparable products and solutions at lower prices. The following comment is illustrative.

"Companies at component manufacturer level try to become non-interchangeable […] because as ´sole screw manufacturer´ they easily can be exchanged, in marked contrast to being system supplier" (E11:2).

The interviewee also identified that the end product manufacturer expects and pressurise their suppliers for the delivery of entire systems. Bearing this in mind, the efforts of various component manufacturers to develop into system supply must be interpreted as being driven by external forces, as indicated by the following.

[28] USP: unique selling proposition

"One should not imagine, but in fact it is the demand pull, that forces most of such developments, but this is not a promising way in obtaining competitive advantages [...] rather a company should challenge this development pro-actively, already well before customers start forcing this step" (E11:2).

The respondent suggested that to adopt a reactive mindset confident that the status quo will continue unchanged is an unrealistic and dangerous strategic option. In contrast, a pro-active approach promises a range of advantages as the subsequent statement indicates.

"The spur to developing pro-active systems is the opportunity to generate higher returns, being more flexible at product offerings, and increasing customer connectivity" (E11:2).

A key advantage of being a system supplier highlighted by the respondent was flexibility in product offerings and customer connectivity. Once contracted as an OEM system supplier it is unlikely that the firm be dropped during a running production series, because this is associated with huge efforts and costs (E11). Inherent flexibility as a system supplier can be seen in the way that the components building the system can be combined and sold in different configurations to different customers. However, this is dependent on the ability of mastering variant diversity. In summary, the respondent suggests that the reasons to develop into a system supplier are demand pull, avoiding replaceability, and the pro-active search for competitive advantage. The benefits include more flexible offerings, increased customer connectivity, and the opportunity for higher returns.

4.5.2. OEM expectations

In the view of the consultancy respondent, the two main expectations of OEMs are the utilisation of synergies associated with economies of scope and additionally the delivery of zero defect systems, as the following suggests:

"The requirement of delivering zero defect systems currently shows up as one of the biggest challenges, because of the complexity and error-prone nature of systems" (E11:5).

In addition, system suppliers are expected to generate synergies by developing and realizing similar systems for different customers, and of course sharing those economies of scope with the OEM. The following quote underpins this expectation:

"If I as customer knew, that my supplier is selling similar systems to others clients, I assume him to develop and produce them at lower cost, and for sure I expect a certain proportion of this savings. Exactly this is one of the OEMs motivations to cooperate with system suppliers" (E11:5).

Therefore OEMs collaborate with system suppliers so as to obtain advantages compared to competitors. Hence, system suppliers must deliver the goods reliably at the correct place, in the defined quality, at the ordered quantity, precisely on time, and at costs lower than if produced by the OEM itself (E11).

4.5.3. Challenges

The challenges which will confront enterprises during the transformation from component manufacturer to a system supplier are various. The consultancy respondent subdivides the challenges into mastering methods and tools, employee information and motivation, possessing required knowledge, change management and defining the appropriate organisational configuration. Requirements such as functional safety demand specific methods and processes, like the V – model, to be managed and applied at developing systems. The following comment illustrates this:

"Topics like functional safety contain the need to think in hardware – software correlations, and at this challenge whole industries lag behind currently" (E11:2).

The consultant believed that the involvement of all employees is needed to overcome the challenge. He recommends that as a first step it is necessary to address potential barriers and communicate the intended direction to all stakeholders. Equally, knowledge sharing among employees is important as the following quote suggests.

"In the early stages it will take time and money [to convince and train employees], but later on it will eject the whole organisation on a sharply higher performance level" (E11:3).

The respondent believes that the transition to a system supplier is a most complex change management process. It encourages the entire enterprise; its organisational concerns, composition of knowledge, experiences, disciplines, and ways of thinking, as well as organising the business. The following illustrates this perspective:

"One key aspect at the transition to system supplier is changing from departmental thinking to process organisation, what might be a long and rocky road but a very valuable one. Methods like Kanban[29] and JiT[30] most companies naturally use at shop floor must be transferred to research and development" (E11:3).

The interviewee indicated that aiming to develop complex systems coupled with departmental thinking will not lead to sustainable achievements. The appropriate organisational structure for developing systems depends on each specific company and its individual history and products as indicated by the following statement:

"There are company's successfully developing systems within a matrix organisation, other prefers variable teams or organises alongside processes, and still others work within a project organisation. However without anchorage and commitment within senior management, such an organisational development never will be successful" (E11:3).

The respondent suggests that there is no predominant way to design the organisational structure for a system supplier. The structure will depend on the individual business model, corporate culture, skills, and resources of the company. However, regardless of organisational conditions senior management backing is necessary for success (E11).

[29] Kanban: Method to coordinate production flow
[30] JiT: Just in Time

4.5.4. Definitions

The differentiation between component, module, and system was, according to the respondent linked with attributes like complexity, functionality, autonomy, and intelligence (Table 4.1). In this framework, components are parts with minor complexity, delivering low functionality, not usable independently, and possessing no intelligence of its own. Modules are interactions of different components, representing mean complexity, delivering partial functionality, with possible autonomous usage, also possessing own intelligence. Systems are complex joints of components and modules, delivering stand-alone functionality, with entire autonomous usage and often possessing intelligence of its own. As illustrated by this quote:

"Systems are complex assemblies, providing stand-alone functionalities, by rendering services, such as audio systems" (E11:5).

Attribute	component	module	system
complexity	minor	mean	high
functionality	low	partial	stand-alone
autonomy	none	possible	entire
intelligence	none	possible	often

Table 4.1 Comparison component, module, and system

4.5.5. Organisational requirements

The organisational requirements for system development are unique, there is no favoured method, and every company must identify its own suitable structure dependent on historical path, current portfolio, business model, corporate culture, skills, and resources (E11). There is no reason to organise in a manner similar for all system suppliers: instead for one firm, a matrix organisation fits, while for others a project organisation or process structure may fit. There is no contradiction in being engaged in a component business, as well as a system business simultaneously, the only advice the interviewee offered was to run them in separate units, as the following suggests:

"There are companies, which established entire units or organisations, for the system business, and the remaining company further on concentrates on the component business. Such companies behave as 1st tier in one business area and 2nd or 3rd tier in other business areas" (E11:4).

Nevertheless, in the respondent´s view, traditional cross-departmental functions like sales need to be trained in selling complex systems as far as practicable. If this is not suitable, a separate system sales force needs to be established, because system selling requires a different customer - supplier relationship than the component businesses (E11). On the R&D side, system suppliers have to be able to manage multi stage processes which enable set building and platform development. Further, the consultancy expert noted that the management of diverse variants and expertise in interface interactions are required. Again in the respondent´s view, possessing those R&D skills or more effective core competencies must be counted as a prerequisite to being successful in system development. Within system development, it is essential to be in the position to manufacture and deliver the developed goods in the required quantity and quality. Independently from the choice of organisational structure, the most important element is the transformation in mindset from departmental thinking to systems thinking, and the strong involvement and commitment of senior management throughout this process.

4.5.6. Resources and competencies

The most relevant skills to carry out the change to system supplier successfully in the view of the business consultant interviewed are threefold: firstly, the ability to think in systems; secondly, mastering software engineering[31]; and thirdly interface interaction expertise or as he described it *"system of systems"* (E11:2). The development of and thinking in systems requires competencies in different areas, especially disciplines beyond classic mechanical engineering like mechatronics, electronics and software, because most systems are by nature electro mechanic or electronic and contain software, as emphasized by this quote.

"Especially the specific software in such systems covers up to 70% of the innovation" (E11:2).

Consequently, a key competence in the view of the respondent is the ability to master and develop industrial software. According to the IEEE[32], software engineering comprises the following competencies or fields of knowledge: software requirements (definition of performance), software design (definition of architecture), software construction (implementation), software testing (error detection and debugging), software maintenance (service und further development), software configuration management (revision

[31] Software Engineering "The systematic, disciplined, quantifiable approach to the development, operation and maintenance of software", see www.ieee.org (Accessed October 2012).
[32] IEEE: Institute of Electrical and Electronics Engineers

control), software engineering management (project management), software engineering process (process optimisation), software quality (measurement and improvement), as well as software engineering tools and methods. Therefore, the development of complex systems with its interactions and different disciplines require well established product development processes as underpinned by the following:

"The development of systems is by dimensions more complex [than the development of single components] and hence it is essential to master the entire research and development process: starting with idea generation right up to series production of the entire system" (E11:2).

Furthermore, as noted by the consultant, because of the different challenges concerning safety, reliability, error rates, and complying with various international standards, a different set of employee resources with different capabilities is required. In this context, capabilities to understand the system of systems are essential. This involves skills to identify and analyse interfaces and interactions of the system with all other components, assemblies, and systems joined together into the final product (E11).

4.5.7. Approaches and methods

According to the consultant, defined processes are the primary precondition for successful organisational evolution into a system supplier. This is reinforced in the following comment:

"Most important for success at organisational changes is the existence of defined processes and the capability to satisfy and interlink these processes" (E11:4).

Consequently, the consultant recommends the establishment of processes in three steps. The starting point is the establishment of basic processes enabling the company to merge mechanics, electronics, mechatronics and software into one shared system. Therefore, a common project management, material management and logistics management process must be developed and implemented. The next step is to get into a position of being able to develop and manufacture reproducible systems. To achieve this purpose the company needs standardised processes, which are relatively simple to control and can be interrupted without difficulty. The final step according to the respondent is continuous improvement and further development of the processes. The following quote provides context:

"Putting emphasis on processes coupled with continuous process optimisation and enhancement, as well as broaden system thinking are significant prerequisites approaching system supply" (E11:4).

The consultant viewed the CMMI[33] model, with its five maturity levels as an excellent approach for process definition and optimisation. Hence, the CMMI model with its different maturity and capability levels is recommended as a valuable assistance on the mode switch from component manufacturer to system supplier. However, the model is highly sophisticated, in contrast to other process models the respondent notes, because CMMI define criteria for excellent organisations (the *what*) but not the single steps (the *how*) to accomplish. The precise configuration and application of the method is part of the optimisation process and rests on the organisation itself - or its consultant.

4.6. Cross case synthesis

This section cross compares the previously discussed five case perspectives (namely original equipment manufacturer, component manufacturer, system supplier, academia and business consultancy) to synthesise the issues identified in the five cases, as outlined in the methodology chapter sections 3.3.3 and 3.4.3 . The approach of using multiple cases from different perspectives on the similar topic, *mode switching from component manufacturer to system supplier*, allows achieving a holistic analysis of the parties involved. For more effective interpretation and evaluation of the diverse opinions (with reference to the cross case synthesis), an aspect-model (Figure 4.1) illustrating the array within the value chain among the five cases and their relation regarding system supplier was developed. The model enables consideration of the evidence from the case representatives concerning the seven thematic categories.

[33] CMMI: Capability Maturity Model Integration, process model based on ISO 12207 and ISO 15288.

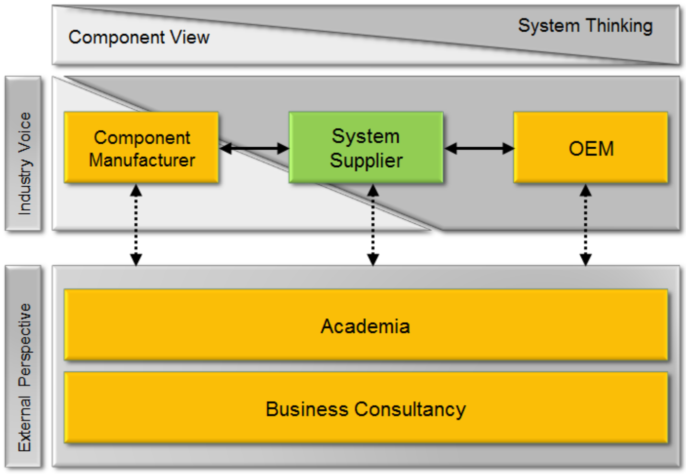


Figure 4.1 Aspect-model, showing the relation of parties involved

The OEM views the topic from a perspective of an affected customer and should provide valuable input at the thematic categories OEM expectation, requirements, as well as resources and competencies. The view of the component manufacturer illustrates the initial point; hence valuable input regarding motivations for the change into a system business should be present. The system supplier depicts the actuality relating to system businesses, and hence especially valuable and first-hand input concerning cause and benefits, challenges, organisational requirements, resources and competencies, OEM expectations, as well as approaches and methods should be provided. The academic views the subject more holistically in relation to research and academic aspects being relevant in literature. Hence, the academic should provide valuable support for building a theoretical framework and reference to relevant literature. The business consultancy perspective allows observing the topic from a perspective of professional support and method supply, as they possess a background of consultancy with component manufacturers, as well as system suppliers and OEMs. The business consultant´s view can support, with extensive and intimate knowledge of the entire value and supply chain of component manufacturers, system suppliers, and OEM. Hence business consultancy statements should provide especially valuable input at the themes challenges, as well as approaches and methods. Comprising, OEM respondents report from the point of view of an affected customer. Component manufacturer respondents as well as system suppliers' respondents report from the ´frontline´. The academic respondents report from the point of view of research and theory and the consulting expert reports from the point of view of a professional accompaniment.

As defined in the methodology chapter section 3.4.3 the records of the transcripts were sorted and placed into thematic categories. The data allocation basically achieved by cutting and pasting the relevant transcript data. Subsequently the sorted data was content analysed to identify common themes and coded by using keywords for contrasting the findings. In the following sections (4.6.1 - 4.6.2) all case statements corresponding to the thematic categories (T1) causes and benefits, (T2) OEM expectations, (T3) challenges, (T4) definitions, (T5) organisational requirements, (T6) resources and competencies, and (T7) approaches and methods are compared and key similarities as well as key differences are addressed. The single statements (coded key words) are tabularised in terms of their cases origin, and additionally segmented into the categories strong and minor support based on its frequency of occurrence. Starting from those results and under consideration of the aspect-model (Figure 4.1), a cross case synthesis for each thematic priority is stated.

4.6.1. Causes and benefits

This section identifies the main points suggested by the five cases in relation to the drivers to change from a component business into a system business (see methodology chapter section 3.4.3). The response to the key question: *In your opinion, what causes many enterprises to transform from being a sole component manufacturer to a system supplier?* is shown in Table 4.2. The basic rationales of the individual cases are cross compared and allocated into the categories strong and minor support depending on frequency of mention. Subsequently, building on the individual findings and considering first-hand insights a detailed cross case synthesis is constructed. The described procedure is used similarly for all the key questions that were analysed.

	Causes
OEM	• demand pull / customer driven • outsourcing of entire systems • increase in complexity at customers • safeguarding market position • avoiding replaceability • facing economic crises
Component Manufacturer	• demand pull / customer driven • outsourcing of entire systems • avoiding replaceability • safeguarding market position
System Supplier	• pro-active search for competitive advantage • identification of growth potential and new business fields • avoiding replaceability • increase in complexity at customers • reducing competition • safeguarding market position

Academia	• demand pull / customer driven • increase in complexity at customers • outsourcing of entire systems
Business Consultancy	• demand pull / customer driven • avoiding replaceability • pro-active search for competitive advantage
Strong support	• demand pull / customer driven • avoiding replaceability • outsourcing of entire systems • safeguarding market position • increase in complexity at customers
Minor support	• pro-active search for competitive advantage • facing economic crises • identification of growth potential and new business fields • reducing competition

Table 4.2 Response regarding causes

Among the interviewees a solid majority saw external forces as a main trigger for the evolution of an company from a component manufacturer into a system supplier, as illustrated by the statements demand pull and customer driven, shown in the Table 4.2. A key element of such a decision is the aim to avoid being replaced by fast growing competition offering comparable products at a more favourable price. A further element is customers´ emphasis on reducing complexity and focussing on core disciplines by outsourcing entire assemblies to a system supplier. Confronted with such circumstances, various companies aim to extend their product portfolio into system supply in order to safeguard their market position. However, in addition to this reactive course of action where companies respond to demand pull, the business consultant and system suppliers propose searching pro-actively for competitive advantages (Table 4.2), already well before the market starts demanding this. Their central idea is preparedness. Following the pro-active approach enables the company to safeguard their own business for the future on an even more robust basis. Established system knowledge ahead of market demand can help identify new business fields as well as supporting the optimisation of the existing component business. Concerning first-hand insights, the demand pull confronting a component manufacturer in the present state, should be anticipated by preparedness and (following a pro-active approach) be compliant with experiences already made by system supplier and business consultancy.

The following section illustrates the main suggested benefits that derive from the change from a component business into a system business. The response to the key question: *What would the benefits be for an enterprise experiencing such a change?* is shown in Table 4.3.

	Benefits
OEM	• opportunity for higher returns • opening new business fields • opportunity creating unique selling propositions • increase in knowledge • obtaining customer insights • increase in customer connectivity
Component Manufacturer	• opportunity creating unique selling propositions • increase in customer connectivity • obtaining customer insights • opportunity for higher returns • opening new business fields
System Supplier	• opening new business fields • opportunity for higher returns • increase in knowledge • opportunity creating unique selling propositions • vitalising innovative potential • obtaining more attractiveness for new employees
Academia	• opportunity creating unique selling propositions • opportunity establishing entrance barriers • increase in customer connectivity • increase in knowledge • opportunity for higher returns
Business Consultancy	• more flexible offerings • increase in customer connectivity • opportunity for higher returns
Strong support	• opportunity for higher returns • opportunity creating unique selling propositions • increase in customer connectivity • increase in knowledge • opening new business fields
Minor support	• obtaining customer insights • more flexible offerings • opportunity establishing entrance barriers • vitalising innovative potential • obtaining more attractiveness for new employees

Table 4.3 Response regarding benefits

The incentive for most enterprises to develop into a system business is the opportunity of obtaining higher returns, as shown in the Table 4.3. Nevertheless, this benefit should not be interpreted to mean that enhanced efficiency and effectiveness lead to greater profitability in general. On the contrary, systems generate lower margins compared with components generally. However, establishing a system business allows the company to create unique selling propositions, which as a consequence enables generating additional returns. Other positive consequences of becoming a system supplier are an increase in knowledge through know how transfer from (sub) supplier and through close cooperation and development with customers. Being involved in system developments with customers allows a much closer connectivity and enables an influence over customer decisions to a certain extent. In addition, by establishing the business into system supplier, the company obtains the opportunity to expand into new business fields. Further benefits as mentioned by the system supplier interviewed, are the vitalisation of innovative potential and increasing the firm´s attractiveness to new employees (see section system supplier, Table 4.3).

Especially when discussing missing capabilities, the attractiveness of a company to potential new employees is an important factor for success.

4.6.2. OEM expectations

This section highlights the key OEM expectations regarding the system supplier, the evidence is analysed and compared in order to frame a robust cross case synthesis (see methodology chapter section 3.4.3). The response to the key question: *What expectation do you have/would you have as OEM regarding your own system supplier?* is shown in Table 4.4.

	OEM expectations
OEM	• knowledge of system and prior system • reliability • understanding OEMs challenges and strategic direction • delivery of systems containing required functions • openness in case of problems • all-round carefree package • cost reduction • system responsibility • managing complexity • exclusive delivery – no alternative distribution • reliable risk management • with OEM corresponding processes
Component Manufacturer	• knowledge of system and prior system • project management skills • process planning capabilities • organised quality systems • knowledge of relevant standards and regulations • managing complexity • knowledge of the entire supply chain • manufacturing of robust system solutions • all-round carefree package • system responsibility
System Supplier	• all-round carefree package • continuous support and system advancement • guidance for performance of OEM applications • cost reduction • reliability • knowledge of system and prior system • pro-active development of solutions • delivery of systems containing required functions
Academia	• system responsibility • cost reduction • cooperative partnership • knowledge of the entire supply chain • reliability • side located close to OEM plant
Business Consultancy	• delivery of systems containing required functions • cost reduction
Strong support	• cost reduction • delivery of systems containing required functions • knowledge of system and prior system • all-round carefree package • system responsibility • reliability

Minor support	• managing complexity • knowledge of the entire supply chain • side located close to OEM plant • understanding OEMs challenges and strategic direction • openness in case of problems • exclusive delivery – no alternative distribution • reliable risk management • with OEM corresponding processes • project management skills • process planning capabilities • organised quality systems • knowledge of relevant standards and regulations • manufacturing of robust system solutions • continuous support and system advancement • guidance for performance of OEM applications • pro-active development of solutions • cooperative partnership

Table 4.4 Response regarding OEM expectations

The key OEM expectations of the system supplier (see Table 4.4) are technical understanding of the system, and its superior unit and interfaces. In addition, the OEM would expect skills to manage system complexity, reliability in cooperation, openness in case of problems, as well as the capability to understand and support the OEM to confront challenges (see section OEM, Table 4.4). Other important OEM expectations include the adoption of system responsibility, having a reliable risk management, and having processes in line with OEM ones (ibid). Finally, expectations would include, cost reduction capabilities and certainly the supply of systems in accordance with the requirements specification in the right quantity, quality, on time, and at the right place (see section strong support, Table 4.4). In summary, the OEM expects an all-round carefree package from their system supplier (ibid).

4.6.3. Challenges

This section identifies and compares the main challenges confronting component manufacturers when they try to evolve into system suppliers (see methodology chapter section 3.4.3). In response to the key question: *What challenges will enterprises face during the transformation from component manufacturer to system supplier?* is shown in Table 4.5. A cross case synthesis is completed by building on the individual findings and first-hand insights.

	Challenges
OEM	• system thinking and interface management • possessing required knowledge / resources • managing complexity • managing diversity of variants • quality management of (sub) contractors • increase in product liability • risk of competition with current customers • share of intellectual property • demand for patience • obtain knowledge of target market • finding ways repaying development expenses • active involvement of senior management
Component Manufacturer	• mastering methods and tools • possessing required knowledge / resources • change in mindset • obtain knowledge of target market • managing complexity • increase in product liability • system thinking and interface management • quality management of (sub) contractors • employee information and motivation • active involvement of senior management • change management • convincing potential system customer / reference projects • risk of competition with current customers
System Supplier	• managing complexity • convincing potential system customer / reference projects • conducting a critical strategy assessment • possessing required knowledge / resources • obtain knowledge of target market • risk of competition with current customers • change in mindset • necessity for cultural change • establishing a separate system brand • managing external partners • finding ways repaying development expenses • cross departmental collaboration • active involvement of senior management • increase in product liability • system thinking and interface management • employee information and motivation • managing diversity of variants
Academia	• possessing required knowledge / resources • managing complexity • managing diversity of variants • quality management of (sub) contractors • managing external partners • system thinking and interface management • change in mindset • necessity for cultural change • cross departmental collaboration • share of intellectual property • increase in product liability • risk of competition with current customers
Business Consultancy	• mastering methods and tools • employee information and motivation • possessing required knowledge / resources • change management • system thinking and interface management • change in mindset • cross departmental collaboration • active involvement of senior management

Strong support	• possessing required knowledge / resources • system thinking and interface management • change in mindset • managing complexity • increase in product liability • risk of competition with current customers • active involvement of senior management • employee information and motivation • cross departmental collaboration • quality management of (sub) contractors • managing diversity of variants • obtain knowledge of target market
Minor support	• mastering methods and tools • change management • managing external partners • necessity for cultural change • share of intellectual property • finding ways repaying development expenses • convincing potential system customer / reference projects • demand for patience • conducting a critical strategy assessment • establishing a separate system brand

Table 4.5 Response regarding challenges

There are numerous challenges which will confront companies in the transition from component manufacturer to system supplier. There is consensus among all experts regarding these challenges, including possessing the relevant knowledge and resources to accomplish a system business, the ability to develop system thinking, as well as the management of various interfaces in system development (see section strong support, Table 4.5).

It is important to manage complexity, but without building numerous variants. To balance diversity and cost, a suggestion is to develop a smart modular kit able to fit various customer requirements. Due to increased product responsibility, further challenges include the need to review deliveries of (sub) contractors and development outcomes of external partners more intensely. Moreover changes in the companies' culture, as well as employees' mindset are essential, in particular, the adjustment from departmental thinking to cross organisational collaboration. Honest and clear top down communication is important to create a positive mood of change in the organisation, inspiring and motivating the employees to support the company's goal.

A further challenge of evolving into a system business is the potential to become the unintentional competition for current customers. Therefore, knowledge of market characteristics and incumbents is important. In the eyes of the system supplier it is important not to underestimate additional challenges such as the need to cooperate with and the management of external partners, the importance of reference projects and pilot customer to convince and prove the company's skills, as well as finding ways of recouping development expenses (see section system supplier, Table 4.5). However, a well-defined strategy and the active involvement of senior management is most important to minimise the risk of failing (Table 4.5).

4.6.4. Definitions

This section illustrates and analyses the main interpretations regarding the terms component, module and system in order to frame a robust cross case synthesis (see methodology chapter section 3.4.3). The response to the key question: *What do you understand by the terms; component, module, and system?* is shown in Table 4.6.

	Definitions
OEM	• module and system are used interchangeable • component low, system mean, module high • classification via requirement specification • terms/definition are not steady and vary over time • classification depends on the eye of the beholder
Component Manufacturer	• classification depends on the eye of the beholder • component low, module mean, system high • classification of an object in relation to the attributes complexity, functionality, autonomy, and intelligence • classification on level of integration/replaceability • term component = standardised/industrialised object • terms/definition are not steady and vary over time
System Supplier	• classification depends on the eye of the beholder • terms/definition are not steady and vary over time • term system = next value level a company aspires • term component = standardised/industrialised object • component low, module mean, system high
Academia	• classification on level of integration/replaceability • component low, module mean, system high • classification depends on the eye of the beholder
Business Consultancy	• classification of an object in relation to the attributes complexity, functionality, autonomy, and intelligence • component low, module mean, system high
Strong support	• component low, module mean, system high • classification depends on the eye of the beholder • terms/definition are not steady and vary over time
Minor support	• classification of an object in relation to the attributes complexity, functionality, autonomy, and intelligence • classification on level of integration/replaceability • term component = standardised/industrialised object • module and system are used interchangeable • component low, system mean, module high • classification via requirement specification • term system = next value level a company aspires

Table 4.6 Response regarding the terms component, module, and system

As already identified in the single cases (see section 4.1.4, 4.2.4, 4.3.4, 4.4.4, and 4.5.4), there are too many different interpretations and no common understanding among experts regarding the definition of component, module, and system (Table 4.6). This suggests, that the classification of component, module, and system strongly depends on the individual (see section strong support, Table 4.6). Nevertheless, consensus among experts (except OEM representatives) about the order of these terms, in relation of complexity exists. Within this sequence, components depict low complexity, modules mean complexity, and systems high complexity (in OEM terming, the order of module and system is reversed). Furthermore, the suggestion that the terms/definitions vary over time is strongly supported by the experts (ibid).

4.6.5. Organisational requirements

This section identifies the main organisational requirements and issues when component manufacturers try to evolve into system businesses (see methodology chapter section 3.4.3). The response to the key question: *Is there a need for organisational change? If so, what?* is shown in Table 4.7. Subsequently a cross case synthesis building on individual findings and first-hand insights is developed.

	Organisational requirements
OEM	• coexistence of component and system business • project organisation - within matrix management • separate units • joint use of traditional cross functional departments • adjustment of sales force • R&D segmentation
Component Manufacturer	• coexistence of component and system business • project organisation - within matrix management • separate units • joint use of traditional cross functional departments • collaborate with and management of external resources • adjustment of sales force • R&D segmentation
System Supplier	• coexistence of component and system business • project organisation - within matrix management • separate units • joint use of traditional cross functional departments • change in development culture - system thinking • processes to manufacture and industrialise systems • collaborate with and management of external resources
Academia	• coexistence of component and system business • project organisation - within matrix management • separate units • joint use of traditional cross functional departments • change in development culture - system thinking • adjustment of sales force • R&D segmentation • managing cross-departmental functions • collaborate with and management of external resources
Business Consultancy	• coexistence of component and system business • separate units • joint use of traditional cross functional departments • adjustment of sales force • R&D segmentation • processes to manufacture and industrialise systems • change in development culture - system thinking

Strong support	• coexistence of component and system business • separate units • joint use of traditional cross functional departments • adjustment of sales force • R&D segmentation • project organisation - within matrix management • collaborate with and management of external resources • change in development culture - system thinking
Minor support	• processes to manufacture and industrialise systems • managing cross-departmental functions

Table 4.7 Response regarding organisational requirements

The preferred organisational approach is the coexistence of a component business parallel with a system business (Table 4.7). The organisational structure should be designed so as to be capable of managing the existing business, as well as the new established system business efficiently, and tailored to deal with system business characteristics. The suggested structure for a system business would involve a separate unit (preferentially project based) within the existing organisation, while using traditional cross functional departments and functions of the company via a matrix management (see section strong support, Table 4.7). Crucial for success is the necessity to change the development culture from departmental thinking to system thinking. In particular, system business R&D tasks and sales activities differ in comparison to a component business, hence setting up R&D and a sales force focussed on system business requirements is essential for system development and successful market penetration. System supplier experts additionally suggest setting up the system business unit in such a way, that the division is able to perform the entire process from system development through to its industrialisation on its own (see correlated section, Table 4.7). Moreover, the system unit requires a broad network of partners and the capability to manage and collaborate with external resources.

4.6.6. Resources and competencies

This section identifies and compares the resources and competencies relevant when becoming a system supplier (see methodology chapter section 3.4.3). The experts' response to the key question: *From your point of view, what resources and competencies are relevant to carry out the change to system supplier successfully?* is shown in Table 4.8. Similar to previous sections a detailed cross case synthesis is subsequently framed.

	Resources and competencies
OEM	• variant management • system development • strategic purchase • mastering the entire supply chain • system thinking and understanding • supplier evaluation • quality management • knowledge at least one level above own supply • communication on a par with customer • managing complexity • knowledge of relevant legal regulations • managing external resources
Component Manufacturer	• project management • mechatronics, electronics, and software • system sales • system thinking and understanding • system development • strategic purchase • supplier evaluation • quality management • knowledge at least one level above own supply • communication on a par with customer • interface management • managing complexity • knowledge of relevant legal regulations
System Supplier	• system engineering • knowledge at least one level above own supply • communication on apar with customer • mastering the entire supply chain • system thinking and understanding • system development • strategic purchase • supplier evaluation • quality management • interface management • managing external resources
Academia	• system sales • system development • strategic purchase • project management • interface management • mechatronics, electronics, and software • financial power • managing complexity • managing external resources
Business Consultancy	• software engineering • mechatronics, electronics, and software • system thinking and understanding • interface management
Strong support	• system thinking and understanding • interface management • system development • strategic purchase • mechatronics, electronics, and software • managing complexity • managing external resources • supplier evaluation • quality management • knowledge at least one level above own supply • communication on a par with customer
Minor support	• system sales • project management • mastering the entire supply chain • knowledge of relevant legal regulations • software engineering • variant management • financial power • system engineering

Table 4.8 Response regarding resources and competencies

The most relevant resources and competencies necessary to carry out the change to a system supplier, according to the study, are the ability to think in systems, an understanding of adjacent systems and interfaces as well as a superior system (Table 4.8). Moreover, interface management will turn into a core competency, because system development takes place as a cross functional process. This will demand the ability to connect different fields of expertise and complexity, like supplier evaluation, quality management, mechatronics, electronics, and software, as well as external resources (see section strong support, Table 4.8). Hence, strategic purchasing requires strengthening, because collaboration with suppliers and subcontractors will increase dramatically and become an important dimension within system development. If the company has available knowledge and resources at least one level above the one necessary for developing the present supply (ibid), then ideal conditions for the evolution into system supply are in place. Being in such a position enables the company to migrate into the next value creation stage easily at any time. Furthermore, system suppliers require competencies managing complexity as well as skills and knowledge necessary to communicate on a equal level with customers (see related section, Table 4.8). Other competencies and knowledge required by system suppliers include knowledge of relevant legal regulations, skills in system engineering, a smart variant management, and capabilities to manage the entire supply chain (see related section, Table 4.8).

4.6.7. Approaches and methods

This section identifies and compares the approaches and methods utilised when becoming a system supplier (see methodology chapter section 3.4.3). The response to the key question: *Which approaches would you classify as successful? Does the change have to take place gradually?* is shown in Table 4.9. Similar to previous sections, a cross case synthesis building on individual findings and first-hand insights is developed.

	Approaches
OEM	• gradually / step by step • building systems out of own component business • starting with small volumes in a defined area/niche • get started via projects • conducting loops increasing system complexity • manifesting the motivation via reference projects • positioning intention at top management level

Component Manufacturer	• gradually / step by step • building systems out of own component business • conducting loops increasing system complexity • get started via projects • set building on standardised components • constant expanding system knowledge • cooperation in its different shapes • acquisition • manifesting the motivation via reference projects
System Supplier	• gradually / step by step • building systems out of own component business • get started via projects • definition of a obvious strategy • positioning intention at top management level • starting with small volumes in a defined area/niche • conducting loops increasing system complexity • constant expanding system knowledge • cooperation in its different shapes • acquisition
Academia	• gradually / step by step • building systems out of own component business • starting with small volumes in a defined area/niche • get started via projects • conducting loops increasing system complexity • identification of required core competencies • cooperation in its different shapes • acquisition
Business Consultancy	• gradually / step by step • establishing standardised processes • continuous process improvement
Strong support	• gradually / step by step • building systems out of own component business • conducting loops increasing system complexity • get started via projects • starting with small volumes in a defined area/niche • cooperation in its different shapes • acquisition
Minor support	• constant expanding system knowledge • manifesting the motivation via reference projects • positioning intention at top management level • set building on standardised components • establishing standardised processes • continuous process improvement • identification of required core competencies • definition of a obvious strategy

Table 4.9 Response regarding approaches

All experts interviewed agree that the evolution from component manufacturer into a system business should take place through enhancing existing components, using a step by step approach, ideally initiated by means of pilot projects (see section strong support, Table 4.9). An effective approach would initially involve using kit building based on standardised components, so the company can leverage their own components, as well as intensifying knowledge improvement at system level. However, a prerequisite for enhancing into a system business must be the creation of a clear strategy, committed and actively supported by senior management (see section system supplier, Table 4.9). The business consultant additionally strongly suggests facilitating such a change via establishing and satisfying standardised development processes (see correlated section, Table 4.9). In terms of developing knowledge and getting familiar with complexity in order to reduce risk, the experts propose establishing a system business in a defined area/niche with small volumes, and later more complex projects can be performed (Table 4.9). The evolution into a system development represents a continuous circle of progression, thus the need to perform several loops until the first acceptable results occur is not unusual. Choosing such an approach enables the company to obtain learning curve effects and establish their ability to develop systems successfully via reference projects. In addition, various forms of external cooperation and even acquisitions are options for the company to support the emerging into system business.

The study also looked at the methods utilising on the journey to being a system supplier. The response to the key question: *Which methods do you regard as significant?* is shown in Table 4.9.

	Methods
OEM	• customer analysis • market analysis • systems analysis • feasibility analysis • benchmarking • project management
Component Manufacturer	• system analysis • operational research • requirements engineering • FMEA • project management • development procedures according the V-model
System Supplier	• project management • development procedures according the V-model • knowledge maps • customer analysis • QFD • requirements engineering • FMEA • system analysis • production process development
Academia	• market analysis • gap analysis
Business Consultancy	• project management • CMMI maturity model • development procedures according the V-model
Strong support	• project management • systems analysis • development procedures according the V-model
Minor support	• market analysis • customer analysis • requirements engineering • FMEA • knowledge maps • QFD • production process development • CMMI maturity model • gap analysis • feasibility analysis • benchmarking • operational research

Table 4.10 Response regarding methods

The methods capable of supporting the change into a system business are several (Table 4.10), and each method has its specific scope of application with its advantages and disadvantages. Therefore a clear recommendation is difficult. Nevertheless, there was consensus among experts that project management was an essential method to facilitate the evolution from a component manufacturer into a system supplier (see section strong support, Table 4.10). In addition, both the method system analysis and system development, corresponding with the V-model development procedure, are mentioned as relevant (ibid).

4.7. Conclusion data analysis

The thesis´ central focus is to provide a conceptual framework enabling organisations at the component manufacturer level, to become capable of to fulfil system supplier requirements. Statements provided by experts in 24 face to face interviews, containing 12 semi-structured questions, are the basis used to develop the framework. Exploiting multiple cases that have differing perspectives on the research topic achieved a more holistic view of the research questions.

RQ1: ***How should the company, and in particular R&D act - or more precisely how should it organise its resources - in order to support mode switching from component to system supplier successfully?***

RQ2: ***What is the most effective procedure for R&D to follow in order to support the organisations' objective to successfully evolve from component manufacturer to system supplier?***

With the purpose of providing a framework supporting *mode switching from component manufacturer to system supplier*, the responses of the interviewees were clustered into seven categories in thematic structure. In total five cases were undertaken and for a more effective interpretation and evaluation of the diverse opinions the cases were cross compared for cross case synthesis. The key findings based on the cases discussed in detail in the previous data analysis chapter (4.1 - 4.6) are outlined in the following.

Important in terms of providing a conceptual framework is that a common and uniquely defined understanding regarding the terms component, module, and system is missing at present. There are currently too many different interpretations of the terms (see section 4.1.4, 4.2.4, 4.3.4, 4.4.4, 4.5.4, and 4.6.4). Nevertheless, the data analysis strongly suggests that the classification of component, module, and system strongly depends on the individual, is not uniform and thus varies over time. This finding clearly underpins the need for a substantial explanation (definition) with respect to product hierarchy as part of the conceptual framework (see section 5.1.4).

On the basis of the findings, it can be concluded that the starting point for an evolution into a system business/system development should be a pro-active exploration of new business opportunities and not be the result of external market forces. Following the pro-active approach enables the company to safeguard their own businesses for the future while additionally optimising and improving the present component business. Nevertheless, the findings provide support for the suggestion that the key concern for most firms developing into system business is to avoid being too easily replaced by fast growing competition offering comparable products at a more favourable price. This issue is closely followed by the incentive to capture the higher returns associated with system supply. System developments embody a much closer connectivity between supplier and customer, what influences customer decisions to favour acknowledged suppliers to a certain extent.

The findings reported in the different cases (see section 4.1 - 4.6) as well as the tables of the cross case synthesis (see Table 4.2 - Table 4.10) show that system R&D activities differ in comparison with component businesses. The challenges which confront companies in the transition from a component manufacturer to a system supplier are diverse. The challenges include possessing the relevant knowledge and resources to accomplish a system business, the ability of system thinking, as well as the management of variants and interfaces in system development. Moreover changes in companies' culture, as well as employees' mindset are essential. The main element of this is the adjustment from departmental thinking to cross-organisational collaboration. Critical is the ability to manage complexity without building numerous variants. This can be facilitated by utilising modular product architectures able to fit customer requirements and thus balancing diversity and costs. The most favourable condition for evolving into a system business is when the firm has available knowledge and resources at least one complexity level above the firm´s own current supplied product. The mode switch into the next product hierarchy is even easier and can take place with greater efficiency and speed when a company is prepared and has such knowledge. In addition, the various forms of cooperation and acquisitions are options for the component manufacturer to support the emerging into system business.

The findings show that the evolution from component manufacturer into a system business should be achieved through enhancing existing components, using a step by step approach. Whilst the evolution into a system development typically represents a continuous circle of progression the need to perform several loops until the first acceptable results are present is not unusual. To develop knowledge, become familiar with complexity and reduce risk, the experts interviewed proposed setting up the system business in a defined area/niche with small volumes; thereafter more complex projects can be performed. However, the most important thing to minimise risk is a well-defined strategy and the active involvement of senior management. Findings suggest that the methods to support the change into system business are several; nevertheless, project management, system analysis and system development corresponding with the V-model development procedure are recommended as the most effective when evolving from component manufacturer into system supplier.

The findings indicate that the preferred business model is the parallel coexistence of the component business and the system supply, each tailored to deal with its peculiarities. The favoured structure for a system business is a separate unit (preferably project organised) within the existing organisation, using traditional cross functional departments and functions of the company through matrix management. Ideally once the system business is established; it should be able to perform the entire process from system development through to its industrialisation on its own. Moreover, the system unit will need to possess a broad network of partners and be capable of managing and collaborating with external resources. The findings reported in Table 4.4 show that the key OEM expectations regarding a system supplier are technical understanding of the entire system and the superior unit with its interfaces, skills to manage system complexity, reliability in cooperation, openness in case of problems, as well as the capability to understand and support the OEM when confronted with challenges. Further important OEM expectations include the adoption of system responsibility, having a reliable risk management, processes that are in line with OEM ones, cost reduction capabilities, and the supply of systems in accordance with the requirements specification in the right quantity, quality, on time, and at the right place.

In conclusion, the finding of this chapter provide significant evidence to address the research questions and to supports the development of a conceptual framework (see section 5.1.7) that aims to enable organisations on a component manufacturer level, to mode switch into a system business fulfilling OEM expectations. The next chapter will consider these findings in relation to the existing literature.

5. Discussion

This chapter discusses the findings of the single cases (section 4.1 - 4.5) and the cross case synthesis (section 4.6). The chapter contrasts the data analysis reported in chapter 4 with the existing literature reviewed in chapter 2. The discussion and critical reflection of the research findings are structured using the seven thematic categories (T1 – T7) identified to support the thesis research questions (RQ1 and RQ2). The themes are defined in the methodology chapter section 3.4.3 and illustrated in Figure 3.3.

(T1) Classifying the incentives for enterprises performing mode switching and their associated advantages.

(T2) Identifying customer expectations in order to satisfy market demand with mode switching.

(T3) Identifying challenges enterprises encountered when performing mode switching.

(T4) Developing a common definition of product hierarchy and its subdivision into component, module and system.

(T5) Classifying organisational requirements for mode switching and providing ways to link with a companies' history and path dependent organisation.

(T6) Identifying necessary resources and competencies required for an enterprise to evolve into a higher value-added stage.

(T7) Providing a framework that enables and guides enterprises that are mode switching to a higher value-added stage

The research questions RQ1 and RQ2 for this thesis were identified as:

RQ1: ***How should the company, and in particular R&D act - or more precisely how should it organise its resources - in order to support mode switching from component to system supplier successfully?***

RQ2: ***What is the most effective procedure for R&D to follow in order to support the organisations' objective to successfully evolve from component manufacturer to system supplier?***

The aim of this chapter is to contrast the thematic categories T1 - T7 identified with the existing literature supporting the thesis research questions. The chapter will then develop a conceptual framework enabling organisations at the component manufacturer level, to set up and operate as system suppliers. Firstly, the findings relating to causes and benefits with respect to the thematic category T1 are considered in the context of the relevant literature. Secondly, OEM expectations representing the thematic category T2, followed by challenges (T3) are discussed and contrasted with the existing literature. Thirdly, the thematic category T4 is discussed and a new definition with respect to product hierarchy is framed. Fourthly, the necessary organisational requirements congruent with the thematic category T5 are discussed, as well as the required resources and competencies (T6). Following this, the approaches and methods that may provide support for organisational mode switching (thematic category T7) are explored. Building on this a conceptual framework is presented, deriving from the evidence identified and discussed within the categories T1–T7. Finally, the general implications of the research questions RQ1 and RQ2 and the rationale for the conceptual framework are presented.

5.1. Reflection on findings

5.1.1. Causes and benefits

The implications of the data analysis findings suggest that without continuous advancement and questioning of expectations, companies might face an uncertain future. Staying in business, especially with growing global competition, is becoming increasingly challenging, and all industries are faced with potential transformation (McKinsey Global Institute 2012; Gassmann, Frankenberg and Csik 2013).

Examples of the continuous advancement and transition of enterprises preparing for uncertainty in the future include the 2009 involvement of the Schaeffler Group as controlling shareholder of Continental AG as well as the Daimler - BYD[34] joint venture in 2012. The impetus for both transactions was the need to prepare for the expected upcoming growth in the E- area[35]. Another example is the assembly of the sports cars Porsche Boxter and Cayman at the Finnish supplier Valmet Automotive through 2012, and thereafter by the Austrian supplier Magna Steyr. A further example is the worldwide production by KUKA Systems, a supplier, of the entire car body of the Jeep Wrangler. These examples and trends are reflected in theory, including Dierickx and Cool (1989), Herstatt and Lettel (2000), Valentin (2001), Danneels (2002), Vanhaverbeke and Peeters (2005), Schuh, Lenders and Schöning (2007), VDMA, WZL RWTH Aachen and Roland Berger Strategy Consultants (2007) and Zook (2007a). The findings indicate that the interviewed OEM, the component manufacturer, and the academic experts all predominantly view external forces as the main trigger that may cause component manufacturer to evolve into system suppliers (E01; E02; E03; E04; E05; E09; E10; E11; E12; E13; E14; E15; E18; E19; E20; E21; E23).

A key reason, firms evolve into system business, is to avoid being replaced (E01; E02; E03; E05; E08; E09; E10; E11; E13; E14; E15; E16; E17; E19; E20; E23; E24) by fast growing competition offering comparable products. Capon and Glazer (1987), Cooper, Edgett and Kleinschmidt (2001), and Danneels (2002) underpin this implication. Zook (2007b) traces the initiating circumstances explicitly back to the likelihood of facing fast growing competition and, as a consequence, the need to evolve into a new core business. A further reason underpinning this trend is the pressure to reduce product complexity (E01; E02; E03; E06; E07; E09; E12; E17; E20; E21; E23) and therefore focus on core disciplines at the OEM stage. The research literature (Teece 1986; Christensen 2003; Stefan 2005; Soppe 2007) suggests that this objective becomes more manageable by outsourcing whole systems to the system supplier. Consistent with the literature, this research illustrates that when confronted with such circumstances, companies extend their product portfolio into a ´system supply´ in order to safeguard their market position (E01; E02; E04; E05; E06; E07; E08; E09; E12; E13; E14; E15; E16; E17; E18; E19; E20; E21; E22; E23; E24). Difficulties and challenges arising in this regard are discussed in section 5.1.3. Deutsche Bank Research (2011b) identified, in their survey, that between 1999 and 2008 the real net output ratio of OEM in the machine building industry dropped by 22% and in the automobile production industry by 12%. Hild (2005)

[34] BYD (Build You Dream): Chinese battery and car producer

[35] E-area in this context is understood as the change from using organic fuels towards electricity for mobility

claimed that the average proportion of value creation in 2004 at OEMs in the production industry amounted to 33% and in the automobile production industry to 27%. This reinforces the view that the creation of value proceed with growing intensity outside the OEM sector. This study agrees with the literature that adopting a reactive mindset, confident that the status quo will continue, is an unrealistic and dangerous strategic option for organisations (Herstatt and Lettel 2000; Vanhaverbeke and Peeters 2005; McKinsey Global Institute 2012). Hamel and Prahalad (1994:124) call such companies *"a bystander on the road to the future"* and not up to date with industry realities. The following quote from a respondent illustrates the point:

"Either the supplier will be forced into the role of system supplier by the OEM, or the supplier decides to take this step on his own, in order not to be eliminated by a competitor" (E02:2).

The findings seem to provide additional evidence that a pro-active approach (E08; E11; E13; E14; E15; E16; E17; E19; E22; E24) when searching for areas of competitive advantages (Henderson and Clark 1990; Hunt and Morgan 1996; Danneels 2002; Christensen and Raynor 2003; Zook 2007b) is likely to be more effective than a reactive approach. Companies that follow this approach utilise the advantage of learning curve effects (Zook and Allen 2003) by continuously attempting to expand their own boundaries, and thus enabling them to systematise their growth. A further advantage of the pro-active approach is the establishment of novel in-house expertise, enabling the enterprise to search for new fields of activity (Edwards 2012). In conclusion, these findings suggest that following a pro-active approach enables the company to safeguard their own business for the future on a more sustainable basis.

Establishing system knowledge ahead of market demand might help identify new business fields and also be used to optimise and improve the existing business. Jaruzelski and Dehoff (2010) likewise support the pro-active approach in their global innovation 1000 study. They argue that enterprises that independently exploit market insights possess a detailed understanding of emerging technologies and trends, and are in an ideal position to consistently outperform. This study´s findings strongly suggest that for most enterprises the incentive to evolve into a system business is to avoid being relatively easy to replace (E01; E02; E03; E05; E08; E09; E10; E13; E14; E15; E16; E17; E18; E19; E20; E23; E24). The following statement illustrates the aim of component manufacturers to extend their product portfolio into system supply:

“A component manufacturer is exchangeable, as system supplier rather not […] it is an aspect of safeguarding the business for the future, since unique and more vertically integrated a company, the more difficult the replaceability of its products” (E16:2). […] “If component manufacturers have ten or fifteen competitors within their area of activity, as system supplier they would have only between two or three” (E23:2).

Barney (1991, 2009) emphasises that sustained competitive advantage arises when a firm implements a strategy which is not executed by incumbents and cannot be imitated easily as illustrated in his VRIN respectively VRIO framework (see Figure 2.3, Literature Review section 2.2.2.2). Findings also suggest that attaining the opportunity to get higher returns is significant (E02; E05; E06; E07; E09; E11; E13; E14; E15; E18; E24). However, it should not be interpreted that an enhanced product hierarchy leads to greater profitability in general. On the contrary, systems generated lower margins in general when compared with components (Dilk, Gleich and Staiger 2008), but evolving into a system business allows the company to create unique selling propositions (E03; E08; E13; E14; E15; E16; E17; E20; E23) and increases customer connectivity (E01; E02; E03; E04; E05; E11; E20). This has the consequence of generating additional returns. Regarding customer connectivity, Prahalad and Hamel (1990) hold the opinion that companies with effectively organised core competencies are in the position to affect or even specify the OEMs products. Prahalad and Hamel describe such an occurrence as *“core products”* (ibid. 1990:85). Mercer Management Consulting (2010) support this, arguing that these core products or key components are most important for safeguarding the organisation´s strategic advantage over imitators. The Deutsche Bank Research (2011b) survey, mentioned above, illustrates that the OEMs share of value creation is evidently declining. At the same time, Hild (2005) points out that the OEMs scope of supplies, and simultaneously the supplier’s scale of integration (increase in product hierarchy) is expanding. Taken together, these suggest an intense and long-term collaboration amongst system supplies and OEMs is now important. The following statement reinforces this suggestion:

“The replacement of a system supplier is always much more difficult and expensive than the replacement of a component supplier. This is the risk you take as OEM when relying on system supply” (E20:2).

The implications of the findings are that the evolution into a system business embodies an opportunity for enterprises to safeguard their future by developing new business directions (E01; E08; E09; E13; E14; E15; E16; E17; E19; E22; E24). In addition, it facilitates company´s development by attracting suitable applicants by means of offering challenging tasks (E16) especially in periods, when there is a ´war for talents´[36] (Beechler and Woodward 2009; Joshi and Agarwal 2011). The McKinsey Global Institute - MGI (2012:9) describes this trend as the *"growing scarcity of technical talent to develop and run manufacturing tools and systems, and the use of greater intelligence in product design and manufacturing to boost resource efficiency and track activity in supply chains"*. MGI (2012) forecast a lack of 40 million highly qualified employees by 2020.

The findings suggest that further positive consequences of the evolution into system supply are an increase in knowledge (E09; E10; E17; E18; E20; E24) and the vitalisation of innovative potential (E16). This conclusion is supported by Prahalad and Hamel (1990), Grant (1991), Christensen and Raynor (2003), Tidd, Bessant and Pavitt (2005), and Christensen (2006). Additionally, Deutsche Bank Research (2011a) identified, in a survey, that companies with intense R&D activities compared to the average generate a higher market capitalisation. Overall, the findings provide support for the suggestion that global competition and customer expectations force enterprises into continuous advancements very effectively. In conclusion, and with respect to the theme (T1) identified in the literature review (section 2.4), to address the following aim:

Classifying the stimulus of enterprises performing mode switching and thereby associated advantages.

The findings provide support that the evolution of an enterprise into system business can be caused by external as well as internal stimuli. Companies that are reactive, that believe they are being forced into system supply by external forces, and are attempting to stay in business by following their current customers at all costs, may lack a long term strategy. Enterprises performing mode switching to system supply as a reactive approach could risk long lasting economic dependence on the demands and expectations of their customers. In view of the fact that today's component manufacturers predominantly consider external forces as the main trigger for the evolution into system business, the findings strongly

[36] War for talents, was termed 1998 by Ed Michael, Director at McKinsey, USA. His key message was, "In order to keep the pipeline full of talented people, almost all of the companies are starting to take non-traditional approaches to recruiting".

suggest the need to establish a clearly defined strategy well before starting such a mode switch. Having such a strategy is important, as it prevents component manufacturers being pushed into organisational changes that are not in line with the company's long-term objectives. In contrast, the more promising and long-term approach is where companies shift into system business following a pro-active approach, seeking to explore and develop new markets, customers and/or applications. The advantages of evolving into a system business are predominantly associated with becoming more difficult to replace, obtaining the opportunity for gaining higher returns as well as safeguarding the future by developing new business directions.

The key findings of this section essential to be considered within the conceptual framework are:

- ☐ having employees capable of managing complexity
- ☐ possessing knowledge of system and prior system
- ☐ a culture of pro-actively searching for competitive advantage
- ☐ the existence of an obvious strategy (necessitating mode switching).

5.1.2. OEM expectations

The findings provide evidence that the key aspect for the OEM to collaborate with system suppliers is the continuous increase in product complexity (E01; E02; E03; E06; E07; E09; E12; E17; E20; E21; E23) of the final products, with the simultaneous demand for cost reductions. OEMs are able to reduce risks relating to quality and stock, as well as the cost of research and development when they shift the supply of entire systems to external suppliers (Soppe 2007). Consequently, OEMs expects and need to have system suppliers that are capable of understanding and supporting OEMs through challenges (E09; E17; E20). This finding is consistent with both Stefan (2005) and Soppe (2007). They conclude that OEMs intensify their co-operation rate with system suppliers in order to reduce the complexity of their product developments and concentrate on their core competencies. Co-operation, especially in the context of sharing knowledge is also discussed in the literature. Hamel, Doz and Prahalad (1989) suggest that to benefit from co-operation several issues should be considered, and learning from partners is the most important. More detailed aspects and implications with respect of co-operation are discussed in section 2.3.1.5.

The findings implicate that system suppliers especially require knowledge that allows them to comprehend the entire system with its superior units and interfaces (E01; E02; E04; E06; E07; E08; E09; E10; E12; E17; E20; E23; E24). Henderson and Clark (1990) support this finding. Therefore the system supplier must possess effective skills and knowledge to enable them to manage system complexity and consequently to develop suitable solutions (E01; E02; E03; E04; E06; E07; E08; E09; E12; E17; E20; E23; E24). This finding is supported by the RBV literature underpinning the importance of resources and effective skills in companies' success. See for example, Penrose (1959), Wernerfelt (1984), Prahalad and Hamel (1990), Barney (1991), Grant (1991), Mahoney and Pandian (1992), Kay (1993), Hamel and Prahalad (1994), Teece, Pisano and Shuen (1997), Priem and Butler (2001), Sun and Tse (2009). The following statement illustrates OEM expectations regarding system supply:

"We are aware of the complexity in system development and manufacturing, but these are challenges we will not be confronted with by the system supplier and for that reason we decided to supply the system and not perform it on our own" (E09:6). […] "Our expectation is a ′all-round carefree package′, up to now we have not got one in reality" (E20:4).

The findings indicate that OEMs are looking for a system supplier capable of solving their challenges (E09; E17; E20) and adopting system responsibility (E02; E04; E09; E10; E17; E20).The findings conclude that system suppliers need to address the associated risks (E20) by developing and delivering zero defect systems (E10; E11; E20) with enhanced efficiency (E03; E08; E11; E24), as discussed by Dougherty (1992) and Danneels (2002). Self-evident in this context is that the supply of systems is expected to be in accordance with the OEMs requirements specification, provided in the right quantity, quality, on time, and at the appropriate place (E02; E03; E08; E09; E10; E11; E13; E14; E15; E17; E18; E20; E23; E24). The next section 5.1.3 discusses the many challenges in satisfying these expectations. In conclusion, and with respect to the theme (T2) identified in the literature review (section 2.4), to address following aim:

Identifying customer expectations in order to satisfy market demand with mode switching.

The findings suggest that component manufacturers that evolve into a system business must reassess the availability of required core competencies to meet OEM expectations. In addition, the organisation should be able to understand the challenges faced by the OEM as well as its strategic direction. The findings suggest that setting up a reliable risk management is essential to meet the challenges of a system business, in particular, the growing amount of product responsibility and product reliability.

Key findings of this section essential to be considered within the conceptual framework are:

- ☐ having employees capable of managing complexity
- ☐ identifying required core competencies
- ☐ being prepared for system thinking and interface management
- ☐ possessing knowledge of system and prior system
- ☐ establishing required knowledge / resources
- ☐ establishing knowledge of the entire supply chain
- ☐ understanding OEMs challenges and strategic direction
- ☐ building capabilities to communicate on a par with customers
- ☐ being prepared to deal with an increase in product responsibility
- ☐ establishing a reliable risk management system.

5.1.3. Challenges

The findings indicate there are numerous challenges facing companies in the transition from component manufacturer to system supplier. All the experts interviewed agreed that one of the most important challenges for firms that mode switch into system supply is the need to possess the relevant knowledge and resources necessary to accomplish the system business requirements (E01- E24). Similarly, the literature also discusses comprehensively the implications of firms´ resources and the ability to address challenges; see for example Penrose (1959), Henderson and Clark (1990), Prahalad and Hamel (1990), Barney (1991), Grant (1991), Mahoney and Pandian (1992), Kay (1993), and Sun and Tse (2009). However, the literature (Hamel, Doz and Prahalad 1989; Hamel and Prahalad 1993; Zook and Rigby 2002; Lichtenthaler 2011) also recognises that it is expensive and almost impossible to be excellent in all the various areas necessary for developing and manufacturing such complex products. Tidd, Bessant and Pavitt (2005:286) explain *"one company's peripheral technologies are usually another's core activities, and that it often makes sense to source such technologies externally, rather than to incur the risks, costs and most importantly of all, timescale associated with-in-house development"*. Therefore, in addition to in-house activities, it is beneficial to utilise external support and cooperation. Capon and Glazer (1987), Cooper, Edgett and Kleinschmidt (2001), Vanhaverbeke and Peeters (2005) support this, concluding that collaboration, in its various configurations is a reasonable option. Potential challenges associated with collaborations were discussed in section 2.3.1.5.

In terms of challenges, the research findings suggest that the most important core competences required to evolve into a system supplier are system thinking (E04; E05; E06; E07; E08; E09; E11; E12; E16; E20; E21; E22; E23; E24) and the ability to control the various interfaces at system development (E02; E03; E04; E05; E06; E07; E08; E09; E10; E12; E16; E21; E22; E23; E24). Henderson and Clark (1990) highlight the need for companies to possess systems architectural knowledge when switching to a new mode. Furthermore, the findings suggest that an additional challenge facing enterprises when completing a mode switch into system supply is managing system complexity (E01; E02; E03; E04; E06; E07; E08; E09; E12; E17; E20; E23; E24), without building numerous variants (E02; E08; E09; E10; E23; E24). For example Zook and Allen (2003:2) report a comment by Peter Blunt the former deputy chairman of HBOS, *"the most important screen for new adjacencies is to limit the number of new variables we are managing to a small number: one"*. This is especially relevant, because system development expenditures are increasing significantly in contrast to those of components (E03; E09; E12; E20), but the increased development costs are not necessarily, or inevitably, covered by the customer (E02; E06; E07; E10; E12; E21). Consequently, system suppliers need to focus on core tasks and competencies, and utilise external resources for non-core tasks and deliverables (E10; E16; E17; E20; E22). The literature supports this conclusion, see for example Capon and Glazer (1987), Hamel, Doz and Prahalad (1989), Hamel and Prahalad (1993), Cooper, Edgett and Kleinschmidt (2001), Zook and Rigby (2002), Tidd, Bessant and Pavitt (2005), Vanhaverbeke and Peeters (2005), and Lichtenthaler (2011). Consequently, the research indicates that the expedient balancing of diversity and costs is important (E02; E08; E09; E16; E20; E22), for example, including developing a smart modular kit (E09) able to fit customer requirements. In particular, Kim and Mauborgne (2005) discuss the correlation of benefit and cost within their blue ocean theory.

The research findings also identify increased product liability issues (E01; E02; E04; E05; E06; E07; E10; E12) as further challenges in the evolution into a system supplier. This highlights the need to carefully audit deliveries of (sub) contractors and review the development outcomes of external partners (E01; E03; E05; E09; E12; E17; E20). The experts interviewed all agreed that collaboration with suppliers and subcontractors will increase dramatically and become an important dimension within system development (E02; E03; E04; E05; E06; E07; E09; E10; E11; E12; E13; E14; E15; E16; E17; E20; E22; E24). Hence, successful system development requires establishing a network of external partners and the ability to manage them efficiently and successfully.

The research also indicates changes in companies' culture, as well as employees' mindset are essential: a key aspect is a change from departmental thinking to cross organisational collaboration (E01; E03; E04; E05; E08; E10; E11; E12; E13; E14; E15; E16; E18; E19; E21; E22; E23; E24). When a firm evolves into a system business, a challenge it faces is the potential of becoming an unintentional competitor of current customers (E02; E03; E09; E10; E17; E21). Hence, knowledge of market characteristics and of incumbents, as also suggested by Prahalad and Hamel (1993), is important (E02; E09; E13; E15; E17; E18; E20). In particular, system supplier respondents emphasise the importance of not underestimating the challenges of collaborating with external partners, and the significance of having reference projects and pilot customers in place to illustrate the company's' skills (E01; E09; E13; E16; E17; E21; E24). The findings also indicate that another challenge faced is identifying ways of repaying development expenses (E02; E03; E08; E10; E17; E20; E22; E23; E24). The development of a system requires significant resources (human, monetary, and time), however the OEM might insists on having a second source supplier and may even obtain the product from an alternative competitor. For example, Hamel, Doz and Prahalad (1989:194) even claim *"ambitious OEM partners are not content with the old formula 'you design it and we'll make it'. The new reality is. You design it, we'll learn from your designs, make them more manufacturable, and launch our products alongside yours"*. Even if it is usually not that extreme, Jaruzelski and Dehoff (2010) highlight that strategies to repay development expenses is among the most important innovation capabilities. In conclusion and with respect to the uncertain point (T3) identified in the literature review (section 2.4), to address the following aim:

Identifying challenges enterprises are associated with at performing mode switching.

The findings illustrate that companies that seek to evolve into a system business face various challenges, including possessing required knowledge and resources, cultural and organisational changes, as well as the possibility of interfering with current customers and even becoming a competitor. In conclusion, the findings suggest that to address these challenges firms need to identify required core competencies, change organisational culture towards more system thinking, obtain knowledge about the target market, as well as convincing potential system customers to complete reference projects. Furthermore the firm evolving into system business should be prepared to deal with an increase in product liability, as well as finding ways to repay system development expenses.

Key findings of this section, essential to be considered within the conceptual framework are:

- ☐ establishing required knowledge / resources
- ☐ having skills to collaborate with and effectively manage of external resources
- ☐ changing development culture towards more system thinking
- ☐ having the capability to manage diversity of variants
- ☐ having employees capable of managing complexity
- ☐ finding ways repaying development expenses
- ☐ building systems out of own standardised components (modular product architecture)
- ☐ being prepared to deal with an increase in product responsibility
- ☐ having available a quality management system to examine (sub) contractors
- ☐ building up supplier evaluation systems
- ☐ possessing a usable network to facilitate cooperation in various forms
- ☐ possessing skills for managing cross-departmental functions
- ☐ obtaining knowledge of target markets
- ☐ convincing potential system customers to conduct reference projects.

5.1.4. Definitions

A conclusion of the research is that there is no commonly accepted understanding or definitions of terms such as component, module, or system; there are too many different interpretations (see section 4.1.4, 4.2.4, 4.3.4, 4.4.4, 4.5.4, and 4.6.4). This suggests that the classification of component, module, and system strongly depends on individual perspectives (E02; E03; E04; E05; E08; E09; E12; E21; E22; E23). Equally, within the literature and professional practice there is a lack of a clear definition of product hierarchy and the terms component, module and system. There is disagreement among respondents in relation to appropriate definitions and levels of complexity. The consensus among component manufacturers, system suppliers, academia, and consultancy experts is that components depict low, modules mean, and systems high in terms of complexity. In contrast, OEM representatives view modules as more complex than systems. If not currently able to develop a product, the firm will usually label it a system (E05; E12; E22), if the company is able to develop that kind of product some time later, the company will no longer call it a system (E22). This implies that the definitions component, module, and system subject to a time-dependent context (E04; E05; E09; E12; E22; E23) whereas the system is always the next step a company aims at. Once the current system is developed and industrialised, it will be re-termed into a component (E22; E23). In conclusion, the shift regarding the term system is fluent and strongly depended on capabilities, experiences and standpoint of the beholder (E02; E03; E04; E05; E08; E09; E12; E21; E22; E23).

Following this logic imply that all products/solutions a company has in its portfolio at present, no matter what its level of complexity, are termed components. Accepting this logic, the definition of the terms component, module, and system as an unchanging function of complexity, appears invalid. Rather, the definition of the terms depends substantially on the company's capabilities at present, their actual product portfolio, and their ability to standardise and industrialise new products. Henderson and Clark (1990:11) define component as the *"physical distinct portion of the product that embodies a core design concept and performs a well-defined function"*. This definition underpins the research finding that the terms component, module, and system are autonomous from complexity or product hierarchy. This relation is illustrated within the onion skin model (Figure 5.1) whereby the diameters of the different skins illustrate the change in product hierarchy over time. In this model, the centre spot always represents the current business of the company and is termed component, the next skin/level depicts the system or business of tomorrow, and all following skins/levels are seen as future systems. Since the term module is seen as some grade between component and system, or as a lower complex system, the expressions component and system are only used. In conclusion, and with respect to the theme (T4) identified in the literature review (section 2.4), to address the following aim:

Developing a common definition of product hierarchy and its subdivision into component, module and system.

The findings support the suggestion to define component and system as follows.

Generally, components are products that a company has already developed, industrialised and hold in their product portfolio, regardless of complexity level (product hierarchy). Systems are products that are the next development step for the company or that still have to be invented. Central to this definition is that the terms component and system have a time-dependent context; once the system of today is fully developed and industrialised, it will be re-termed ´component´.

This definition illustrates the continuous spiral of evolution from component to system and returning again to component. It is a process of steady enhancement regarding product complexity and the development of required capabilities in order to develop the next product hierarchy (that is, component to system), which itself will be labelled a component after a period of time again.

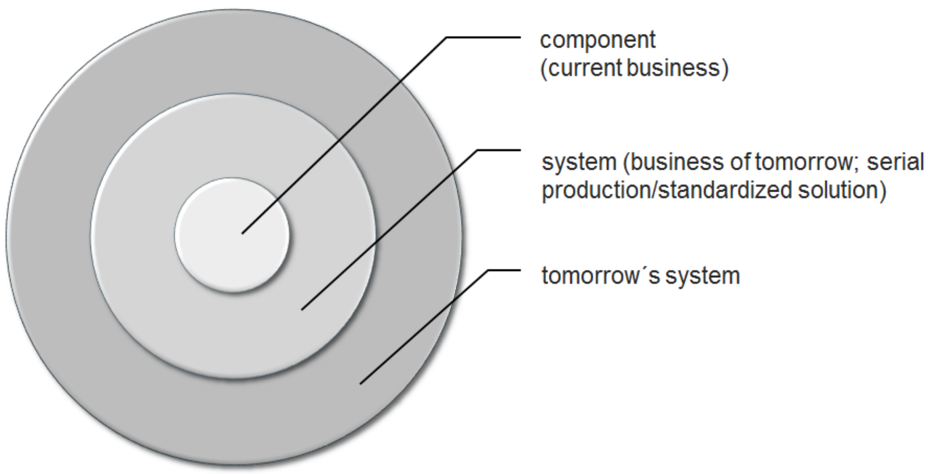


Figure 5.1 Onion skin model of product hierarchy

5.1.5. Organisational requirements

The findings suggest that the preferred approach is a coexistence of the component business and system supply side by side (E01 - E24), rather than focussing on either a component business or a system business individually. In the literature the organisational coexistence of mainstream businesses and new business development activities are also known as (internal) corporate venturing (von Hippel 1988; Block and McMillan 1993; Tidd and Taurins 1999; Tidd, Bessant and Pavitt 2005; Henderson 2006) or new business development (Vanhaverbeke and Peeters 2005). This coexistence approach enables the new business (system business) to be equipped with the assets of a big company, while having the benefits of a start-up company. Christensen and Raynor (2003:142) indicate in this context that *"a company that serves customers in multiple tiers of the market, managing the transition is tricky […]. Pursuing both ends at once and in the right way often requires multiple business units"*. The findings underpin this conclusion, and suggest that an organisational structure should be designed that is capable of managing the existing business, as well as the newly established system business efficiently. The organisational structure needs to be tailored to deal with the system business differences (E02; E09; E17; E20). Thus, the subdivision of component and system business appears useful (E01; E02; E06; E07; E08; E09; E17; E18; E19; E22; E23; E24), because of the different requirements and competencies that are necessary. The literature supports this conclusion (see for example, Campbell, Birkinshaw, Morrison and van Basten Batenburg 2003; Christensen 2006; Henderson 2006), and advises firms to separate companies businesses, if different types of thinking and organisational structure are required. How this is organised varies from company to company, as noted in the following statement:

"There are company's successful developing systems within a matrix organisation, other prefer variable teams or organise alongside processes, and still others work within a project organisation" (E11:3).

The literature supports this statement (Campbell, Birkinshaw, Morrison and van Basten Batenburg 2003; Zook and Allen 2003; Christensen 2006; Henderson 2006), also arguing that there is no single, accepted approach to organisational structure. Instead, it depends on the individual firm´s business model, corporate culture, skills, and resources (Penrose 1959; Porter 1980; Wernerfelt 1984; Prahalad and Hamel 1990; Barney 1991; Grant 1991; Mahoney and Pandian 1992; Teece, Pisano and Shuen 1997; Greiner 1998; Christensen and Raynor 2003; Gomez, Raisch and Rigall 2007). Equally Dierickx and Cool (1989), Valentin (2001), and Barney and Clark (2009) conclude that every company needs to identify its own suitable organisational structure, dependent on its historical path. However, the findings suggest that a common structural evolution involves a project-based organisation at the initial phase (E02; E03; E04; E05; E06; E07; E08; E10; E12; E17; E20; E22) and the establishment of a separate unit (E01; E02; E06; E07; E08; E09; E17; E18; E19; E22; E23; E24) to drive the development of the system business beside the existing organisation thereafter as a favourable structure (E02; E09; E17; E20). The literature supports this finding, suggesting the need to protect new and different products from the mainstream organisation (see for example Teece, Pisano and Shuen 1997; Buckland, Hatcher and Birkinshaw 2003; Campbell, Birkinshaw, Morrison and van Basten Batenburg 2003; Christensen and Raynor 2003; Tidd, Bessant and Pavitt 2005; Christensen 2006; Henderson 2006; Gomez, Raisch and Rigall 2007). Using this structural approach offers a most flexible means of evolving a system business beside the existing business areas. Christensen and Raynor (2003) state that almost all forms of change require a new set of core elements. They offer a framework as a means of recognising an appropriate organisational structure. Their organisational framework (Figure 2.14, literature review section 2.3.2.2) suggests a feasible organisational structure might embody heavyweight teams within the existing functional organisation up to establishing an autonomous organisation. The organisational framework (Christensen and Raynor 2003) will be strongly influenced by the level of technological change between the component at the present point in time, and the new system business, to determine the most appropriate organisational structure. Similarly, Gomez, Raisch and Rigall (2007) offer four organisational strategies (Figure 2.15, literature review section 2.3.2.2) as feasible structural options. The research findings suggest their strategies of parallel organisation with the allocation of employees via projects, and the integrated framework, as the most appropriate for mode switching from component into system business.

The findings indicate that the firm should set up a system business unit, allowing this business unit to perform the entire process from system development through to its industrialisation, on its own (E08). Teece (1986) agrees with this, stating that successful commercialisation of innovation requires the business unit to be equipped with all necessary capabilities and assets in question, inclusive of the requisite sales and manufacturing. Hamel and Prahalad (1993) in fact compare the business unit with a stool; it necessitates having legs of equal length for exploiting the investment sufficient. Moreover, the system unit should have a broad network of partners and be in the position to manage and collaborate with external resources. The supportive element of collaboration is widely discussed in the literature (see for example, Capon and Glazer 1987; Hamel, Doz and Prahalad 1989; Cooper, Edgett and Kleinschmidt 2001; Zook and Rigby 2002; Tidd, Bessant and Pavitt 2005; Vanhaverbeke and Peeters 2005; Chesbrough and Garman 2009; Gassmann, Enkel and Chesbrough 2010; Lichtenthaler 2011). The research suggest that, the starting point for such an evolutionary approach should be the development of systems based on existing core competencies/products with step by step advancement (E01; E02; E05; E06; E07; E08; E09; E10; E11; E12; E17; E18; E19; E21; E22; E23; E24). Zook and Allen (2003:2) reinforce this in their research on firms' specific growth claiming that *"most sustained, profitable growth comes when a company pushes out the boundaries of its core business into an adjacent space"*. Previously, Penrose (1959) indicated that the capabilities latently available in the company represent an incentive to extend the business, and in addition Wernerfelt (1984:171) claimed *"by specifying a resource profile for a firm, it is possible to find the optimal product-market activities"*. In conclusion, the findings suggest that the favoured organisational structure for a system business would be a separate unit, preferably project-based, within the existing organisation. It would then utilise traditional cross functional departments and functions of the company via matrix management (E02; E03; E08; E12; E16; E20; E21). In conclusion, and with respect to the theme (T5) identified in the literature review (section 2.4), to address the following aim:

Classifying organisational requirements for mode switching and providing ways to link with a companies' history and path dependent organisation.

The findings suggest that the requirements relating to a component business and a system business differ to a certain extent. Hence, it is suggested that separation is necessary for the effective coexistence of a component and a system business, to allow the individual units to focus on the distinctions and specifics of every business most efficiently. In particular, R&D tasks and sales activities differ between system business and component business (Danneels 2002; Tidd, Bessant and Pavitt 2005). Hence setting up R&D and sales force focussed on system business requirements is essential for system development and successful market penetration. In the initial phase it is recommended to start by utilising projects using matrix management, along with a high level of cross departmental collaboration. Thereafter, it is recommended to establish a separate unit, preferably project organised, and equipped with processes and competencies to manufacture and industrialise systems. An important recommendation in this context is to aim for modular product architectures enabling the enterprise to build/develop systems out of standardised components. To be successful, it is crucial to change development culture, with a transition from departmental thinking to system thinking.

The key findings of this section essential to be considered within the conceptual framework are:

- ☐ getting started via projects
- ☐ establishing a project organisation (also utilising matrix management)
- ☐ building separate units for the effective coexistence of component and system business
- ☐ establishing processes able to manufacture and industrialise systems
- ☐ possessing resources to master the entire supply chain
- ☐ having skills to collaborate with and effectively manage of external resources
- ☐ possessing a usable network to facilitate cooperation in various forms
- ☐ building systems out of own standardised components (modular product architecture)
- ☐ proceeding gradually / step by step
- ☐ embedding of cross departmental collaboration
- ☐ changing development culture towards more system thinking
- ☐ segmenting R&D
- ☐ establishing sales of system.

5.1.6. Resources and competencies

The findings clear illustrate that R&D activities and tasks differ at a system business in comparison with a component businesses (in particular sections 4.1.6, 4.2.6, 4.3.6, 4.4.6, 4.5.6 and 4.6.6). The findings show the need to change the development culture by altering the mindset from departmental-focused thinking to system thinking (E01; E04; E09; E10; E11; E12; E16; E23; E24) in order to cope with rising complexity (E01; E02; E03; E06; E07; E09; E12; E17; E20; E21; E23) without building numerous variants (E02; E09; E11). Henderson and Clark (1990) reinforce the necessity for a different kind of organisational thinking. The challenge for R&D in developing new innovative products of a higher complexity level is the need to develop and/or acquire resources able to comprehend and think in systems. Christensen and Raynor (2003) concluded that the capabilities are the result of an employee's work-related history, allowing them to hone individual and specific skills. Hence, to establish a new business such as system supply, employees possessing an appropriate work-related history, and thus skill-set, are essential. However, *"predicting future success from past success"* (ibid: 180) is not without problems because past successes might be the consequence of other interactions and circumstances. With this in mind, it is possible that a person managing a business unit very effectively might not have the required capabilities to establish a new venture such as the mode switch into system supply. This is because there is a difference between the experience of keeping a business running and establishing a new one. Employees that are able to learn and recover from their mistakes are very important when establishing a new venture or enhancing business complexity. These experiences and errors in the past allow the employee to grow *"an instinct for better navigation through the minefields the next time around"* (Christensen and Raynor 2003:180). Building on this, the findings show that the resources and competencies most relevant for the transition into system business, are employees with the ability to think in systems (E04; E05; E06; E07; E08; E09; E11; E12; E16; E20; E21; E22; E23; E24), an understanding of adjacent systems and interfaces as well as the superior system (E02; E03; E04; E05; E06; E07; E08; E09; E10; E12; E16; E21; E22; E23; E24). Moreover, interface management (E02; E03; E09; E10; E11;E20) and project management skills (E03; E04; E05; E06; E07; E10; E12; E13; E14; E15; E16; E18; E20; E21; E22; E23) turn into a core competency, because system development takes place as a cross functional process, demanding the ability to connect different fields of expertise and complexity, as well as external resources (E01; E03; E04; E05; E08; E10; E11; E12; E13; E14; E15; E16; E18; E19; E21; E22; E23; E24). The implications of intangible resources (competencies and skills) on a company's growth/success are discussed by Penrose (1959), Barney (1986), Dierickx and Cool (1989), Prahalad and Hamel (1990), Grant (1991), Hamel and Prahalad (1993), Kay (1993), and Teece, Pisano and Shuen (1997). In this context, there is an emphasis on strategic procurement, because collaboration with suppliers and subcontractors will increase dramatically and become an important dimension within system development (E03; E09; E10; E12; E17; E19). Teece, Pisano and Shuen (1997) conclude that companies' resources constantly require changing over time in order to remain relevant in the marketplace. The literature, usually using the resource-based view, widely discusses the relevance of resources and competencies, and their importance to the company's success (see for example, Penrose 1959; Wernerfelt 1984; Barney 1986; Dierickx and Cool 1989; Prahalad and Hamel 1990; Barney

1991; Grant 1991; Mahoney and Pandian 1992; Kay 193; Hamel and Prahalad 1994; Hunt and Morgan 1996; Teece, Pisano and Shuen 1997; Priem and Butler 2001; Barney and Clark 2009; Sun and Tse 2009).

Findings also suggest that system suppliers require competencies managing complexity (E01; E02; E03; E04; E06; E07; E08; E09; E12; E17; E20; E23; E24) as well as skills and knowledge necessary to communicate on the same level as customers (E03; E05; E06; E07; E08; E09; E12; E13; E14; E15; E16; E17; E21). The findings show that knowledge of relevant legal regulations (E02; E06; E07; E09; E17) and smart variant management (E02; E08; E09; E10; E23; E24) can make the enhancement easier. Overall, these findings support the suggestion that mode switching requires a substantial resource/competency culture, with consistent pro-active knowledge advancement, that aims to enhance existing capabilities towards a level equivalent to the customer. In agreement with Barney (1991, 2009) these resources/capabilities need to be in accordance with the attributes of the VRIN resp. VRIO framework (Figure 2.3, literature review section 2.2.2.2) so that they can contribute as a source of competitive advantage for the company. In this respect, it is ideal if the company already has available knowledge and resources at least one level above that necessary for developing the current products (E01; E06; E07; E12; E18; E21; E22; E23). Mahoney and Pandian (1992:366) support this, concluding that crucial for diversification is that the company´s capabilities are *"upstream from the end product"*. Being in such a position enables the company to develop into the next product hierarchy easily at anytime. Christensen (2006) supports this finding, claiming that the elements that most affect an organisation beside values and processes are their resources. This is especially the case in the founding/developing stages of the organisation. In conclusion, and with respect to the theme (T6) identified in the literature review (section 2.4), to address the following aim:

Identifying necessary resources and competencies required to evolve an enterprise into a higher value-added stage.

The findings suggest that most relevant resources and capabilities required for the transition into system supply are employees capable to think in systems terms, to connect different fields of experience and complexity, and to act efficiently within cross departmental functions. Ideal conditions are in place if the company already has available knowledge and resources at least one level above that necessary for developing the current products.

Key findings of this section, essential to be considered within the conceptual framework are:

- ☐ changing development culture towards more system thinking
- ☐ having employees capable of managing complexity
- ☐ having the capability to manage diversity of variants
- ☐ being prepared for system thinking and interface management
- ☐ possessing knowledge of system and prior system
- ☐ possessing project management capabilities
- ☐ having knowledge of system development
- ☐ having skills to collaborate with and effectively manage of external resources
- ☐ strategic procurement capabilities
- ☐ expanding constantly of system knowledge
- ☐ building capabilities to communicate on a par with customers
- ☐ possessing knowledge of relevant standards and regulations
- ☐ having available knowledge at least one level above own supply
- ☐ possessing skills for managing cross-departmental functions.

5.1.7. Approaches and methods

The research did not identify one clear or agreed supporting method to facilitate organisational change in business mode, rather the approaches/methods mentioned as suited were versatile (see section 4.1.7, 4.2.7, 4.3.7, 4.4.7, 4.5.7, and 4.6.7). Tidd, Bessant and Pavitt (2005:10) state *"innovation is about change and this can take place in different forms"*. Hence an impartial recommendation appears difficult to make and strongly depends on a companies' specific situation, resource capabilities and future strategy. Nevertheless, the findings highlight that certain elements, methods and preferences regarding the way to complete the change into a system business are relatively common. Project management is seen to be important in the evolution into a system supplier (E01; E02; E03; E04; E06; E07; E10; E12; E13; E14; E15; E16; E17; E18; E20; E21; E22; E23), equally system analysis techniques (E01; E02; E6; E7; E09; E11; E12; E23) and system development, particularly reflecting the V-model procedure (E01; E06; E12; E13; E14; E15; E24) are considered as essential for a successful change in business mode. Similarly, findings illustrate that, the evolution from component manufacturer into system business should take place incrementally (E01; E02; E05; E06; E07; E08; E09; E10; E11; E12; E17; E18; E19; E21; E22; E23; E24), ideally initiated through pilot or prototyping projects (E01; E02; E05; E06; E07; E08; E09; E10; E11; E12; E17; E18; E19; E21; E22; E23; E24). This reflects the conclusion made by Dierickx and Cool (1989) that continuous R&D outlays are more effective than occasional crash programs.

Findings indicate that the evolution into system development represents a continuous circle of progression (E15; E16; E23), thus the need to perform several loops until the first acceptable results are achieved is not unusual (E16; E23). Pursuing this approach enables the company to obtain learning curve effects and manifest their ability to develop systems successfully. In this regard, the findings indicate that to reduce risk more effectively, and develop knowledge to become familiar with complexity firms should launch a system business in a clearly defined area/niche and with small volumes (E03; E09; E13; E14; E15; E18). Wernerfelt (1984) supports this approach, suggesting that the firm should enter the market out of a position of strength, commencing in one single sector/industry, instead of several markets at once. In terms of a strategic roadmap, findings suggest the most effective approach is to develop through enhancing existing components and by building modular product architectures that can subsequently be used as a basis to diversify into new and alternative solutions and applications (E01; E04; E05; E06; E07; E08; E09; E10; E11; E12; E18; E19; E21; E22; E23; E24). This approach enables the enterprise to utilise existing components, as well as intensifying knowledge development at system level. This method is supported by Henderson and Clark (1990), who describe an architectural innovation approach, as well as Zook and Allen (2003). With respect to resources and competencies, the ideal situation is where the development enables the firm to continuously expand its knowledge base at least one level above the current supply (E01; E06; E07; E12; E18; E21; E22; E23). Additionally, the findings suggest the establishment of standardised development processes (E01; E06, E07; E11; E12; E21). The literature also supports this finding, for example see Teece, Pisano and Shuen (1997), Garvin (1998), Christensen and Raynor (2003), Zook and

Allen (2003), Tidd, Bessant and Pavitt (2005), and Christensen (2006). Overall, the findings indicate that evolving into a system business necessitates a significant change in corporate culture (E01; E03; E04; E05; E08; E10; E11; E12; E13; E14; E15; E16; E18; E19; E21; E22; E23; E24), hence the commitment and active support of the senior management is essential for a successful transition (E06; E07; E08; E11; E12; E13; E14; E15; E17; E18; E19; E24). Christensen and Raynor (2003), Gomez, Raisch and Rigall (2007), as well as Jaruzelski and Dehoff (2010) underpin this conclusion. In particular, the personal participation and accountability of senior management at mode switching is essential, since organisational changes in principle concern issues regarding path dependency (Dierickx and Cool 1989; Greiner 1998; Valentin 2001; Tidd, Bessant and Pavitt 2005; Barney and Clark 2009) and resource allocation (Bower 1970; Kim and Mauborgne 2005; Christensen 2006). Ultimately, to be successful, mode switching must be driven by the senior management. The challenges regarding path dependency and resource allocation in the context of organisational change are discussed in detail in section 2.3.2.1. In conclusion, and with respect to the theme (T7) identified in the literature review (section 2.4), to address the following aim:

Providing a framework that enables and guides enterprises at mode switching to a higher value-added stage.

The following pages will illustrate a new conceptual framework. This conceptual framework was developed from evidence discussed in this section, as well as the findings discussed in the previous sections (5.1.1 - 5.1.6).

Additional key findings of this section essential to be considered in the context of the new proposed conceptual framework are:

- ☐ proceeding gradually / step by step
- ☐ possessing project management capabilities
- ☐ getting started via projects
- ☐ expecting several loops at system development until becoming familiar with system complexity
- ☐ establishing development procedures according the V-model
- ☐ starting with small volumes in a defined area / niche

- ☐ building systems out of own standardised components (modular product architecture)
- ☐ having available knowledge at least one level above own supply
- ☐ establishing standardised processes
- ☐ actively involving senior management.

Conceptual framework – roadmap/approach to system business (a higher value-added stage)

This research was concerned with theory development, and in particular with presenting a conceptual framework to guide enterprises that wish to develop their current business and supply a higher level product. The conceptual framework discussed below was developed from the research findings illustrated in the data analysis chapter (section 4.1 - 4.6) in conjunction with the key issues addressed in the previous discussion chapter (sections 5.1.1 - 5.1.7). The spiral of continuous enhancement from component to system and returning again to component as discussed in the prior definition section 5.1.4 is illustrated in Figure 5.2. This illustrates the relationship between mode switching and the key factors: complexity, capabilities and time (t_1, t_2, t_3 and t_4)[37]. A company's ability to mode switch into the next product hierarchy strongly depends on their capabilities relative to the requirements of the next level. If such capabilities are not yet present, their development/acquisition has to take place over time. The first column t_1 shows the different level of complexity (product hierarchy) at an elementary stage, namely current business termed component, business of tomorrow termed system, and beyond that tomorrow's system. The second column t_2 illustrates the status after mode switching towards the next product hierarchy. Hence, capabilities required for system development are established and the former system (t_1) is standardised and industrialised and as a consequence re-termed into a (new) component (see definition section 5.1.4). The columns t_3 and t_4 demonstrate equivalent proceedings even on a more advanced level. The aim to enhance current product hierarchy (component to system) continuously implies a continuous education and/or development of essential capabilities to achieve the next level. As a consequence, mode switching from component to system takes place on each level anew. By the time the evolution from level t_1 to t_2 is

[37] t_1: current business (product hierarchy) of the company
t_2: status after mode switching towards the next product hierarchy
t_3 & t_4: status after a further mode switching towards a even more advanced level of product hierarchy

completed successfully, the former system will have become a component again and the mode switch to system can restart on the next level t_2 to t_3 and at some remote period t_3 to t_4 and so forth. Since, every new product level necessitates certain qualifications/capabilities that fit the prevailing requirements, it is most important for a company seeking to enhance its product hierarchy to have sufficient experiences/skills available to effectively evaluate what new capabilities are required at the next level (E02; E04; E08; E09; E10; E12; E13; E14; E15; E16; E17; E20; E23; E24). Jaruzelski and Dehoff (2010:1) support this conclusion, arguing *"what matters [are] the capabilities that successful companies put together to enable their innovation efforts, and thus create products and services they can successfully take to market"*. The variety and quantity of resource and capabilities that are necessary to develop in order to mode switch are defined ultimately by the product hierarchy requirements and the expectations of customers purchasing those goods. It is important for achieving and sustaining competitive advantage that the resources and competencies developed are unique (Barney 1986, 1991; Prahalad and Hamel 1990; Grant 1991; Mahoney and Pandian 1992; Kay 1993; Teece, Pisano and Shuen 1997; Priem and Butler 2001; Sun and Tse 2009). This was discussed in detail in section 2.2.2 of the literature review, where key proponents of the resource-based view were identified, as well as section 2.2.3 referring to systemising resources. Further, the explicit OEM expectations for system suppliers for different product hierarchies are discussed in detail and illustrated in terms of best practices and cross case synthesis in the data analysis chapter (see section 4.1.2, 4.2.2, 4.3.2, 4.4.2, 4.5.2, and 4.6.2). Similarly, resources and competencies considered from different vantage points important for the evolution into a system supplier are discussed and illustrated in detail (see section 4.1.6, 4.2.6, 4.3.6, 4.4.6, 4.5.6, and 4.6.6).

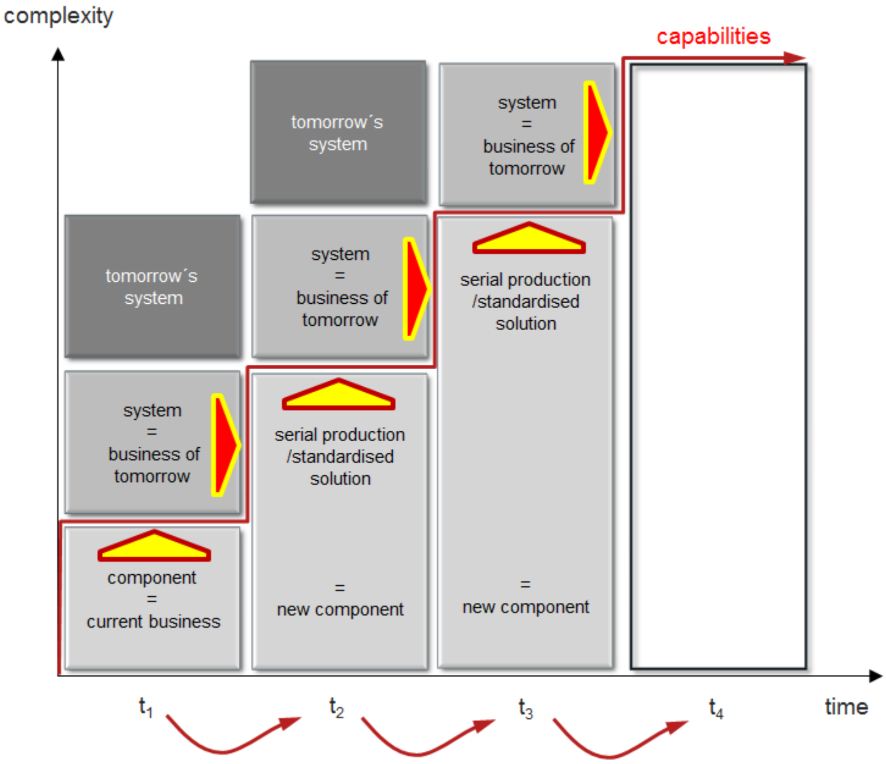


Figure 5.2 Spiral of continuous enhancement

Figure 5.3 illustrates the difference between incremental and disruptive innovation (business enhancement) using the onion skin model (Figure 5.1). Incremental business enhancement in this context occurs on the boundary of existing component business and refers to the effort of developing new systems from them (E01; E04; E05; E06; E07; E08; E09; E10; E11; E12; E18; E19; E21; E22; E23; E24) preferably through pilot projects (E01; E02; E05; E06; E07; E08; E09; E10; E11; E12; E17; E18; E19; E21; E22; E23; E24).

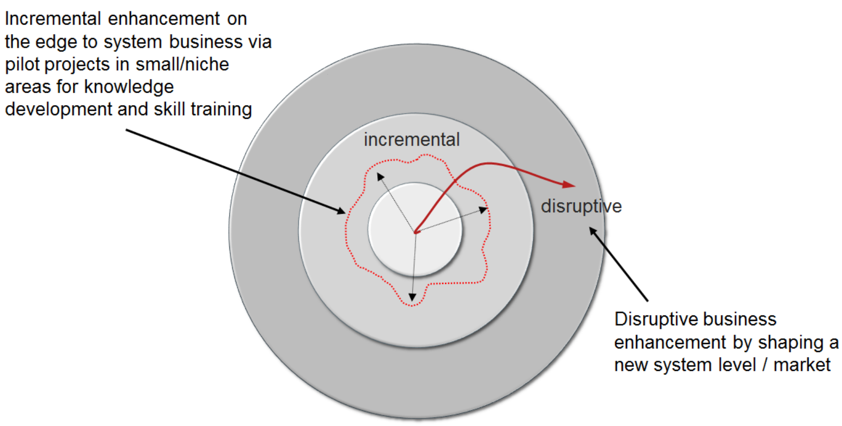


Figure 5.3 Incremental and disruptive business enhancement

By contrast, disruptive business enhancement originates by radical shaping of entirely new solutions (E03) or markets in unknown or unnoticed areas/applications. The different dimensions of innovation are discussed in detail within the literature review section 2.3.1. In addition, the spiral of continuous enhancement as pictured in Figure 5.2, illustrates that disruptive innovation occurs, if one entire loop of developing a component into a system is bypassed and thereafter ´tomorrow´s system´ is invented today (Christensen 2006). In terms of the time interval $t_1 - t_4$ (Figure 5.2) disruptive enhancement is present if the mode switch takes place from t_1 straight to t_3 or even t_4. However, the research findings reported in the data analysis chapter section 4.6.7 and Table 4.9, provides clear evidence that incremental, or gradual enhancement (E01; E02; E05; E06; E07; E08; E09; E10; E11; E12; E17; E18; E19; E21; E22; E23; E24) to the next level is the preferred approach for mode switching from component manufacturer into system supplier. Consequently, in the following sections an approach is developed that uses incremental enhancement to evolve into a system business. Hayes (1985) supports this research finding that continuous innovation, even if it is incremental, is an effective basis and starting position for the development of new and more complex products. Equally, Jones (2003) supports the concept of a well-balanced product development based on an existing architecture. Theories with respect to incremental or radical innovations/changes are widely discussed in the existing literature (Schumpeter 1950; Cooper and Schendel 1976; Daft 1982; Ettlie, Bridges and O´Keefe 1984; Hayes 1985; Rothwell 1986; Tushman and Anderson 1986; von Hippel 1988; Henderson and Clark 1990; Jones 2003; Kim and Mauborgne 2005, Tidd, Bessant and Pavitt 2005; Christensen 2006; Christensen and Bower 2008; Williams 2011). When considering further research, an issue that remains important to assess is whether the framework developed for this study reporting incremental mode switching, is capable of supporting and guiding enterprises at attempting disruptive mode switching. The findings (section 4.1.7, 4.2.7, 4.3.7, 4.4.7, 4.5.7, and 4.6.7) strongly suggest evolving from a component manufacturer into a system supplier using several steps (E01; E02; E05; E06; E07; E08; E09; E10; E11; E12; E17; E18; E19; E21; E22; E23; E24).

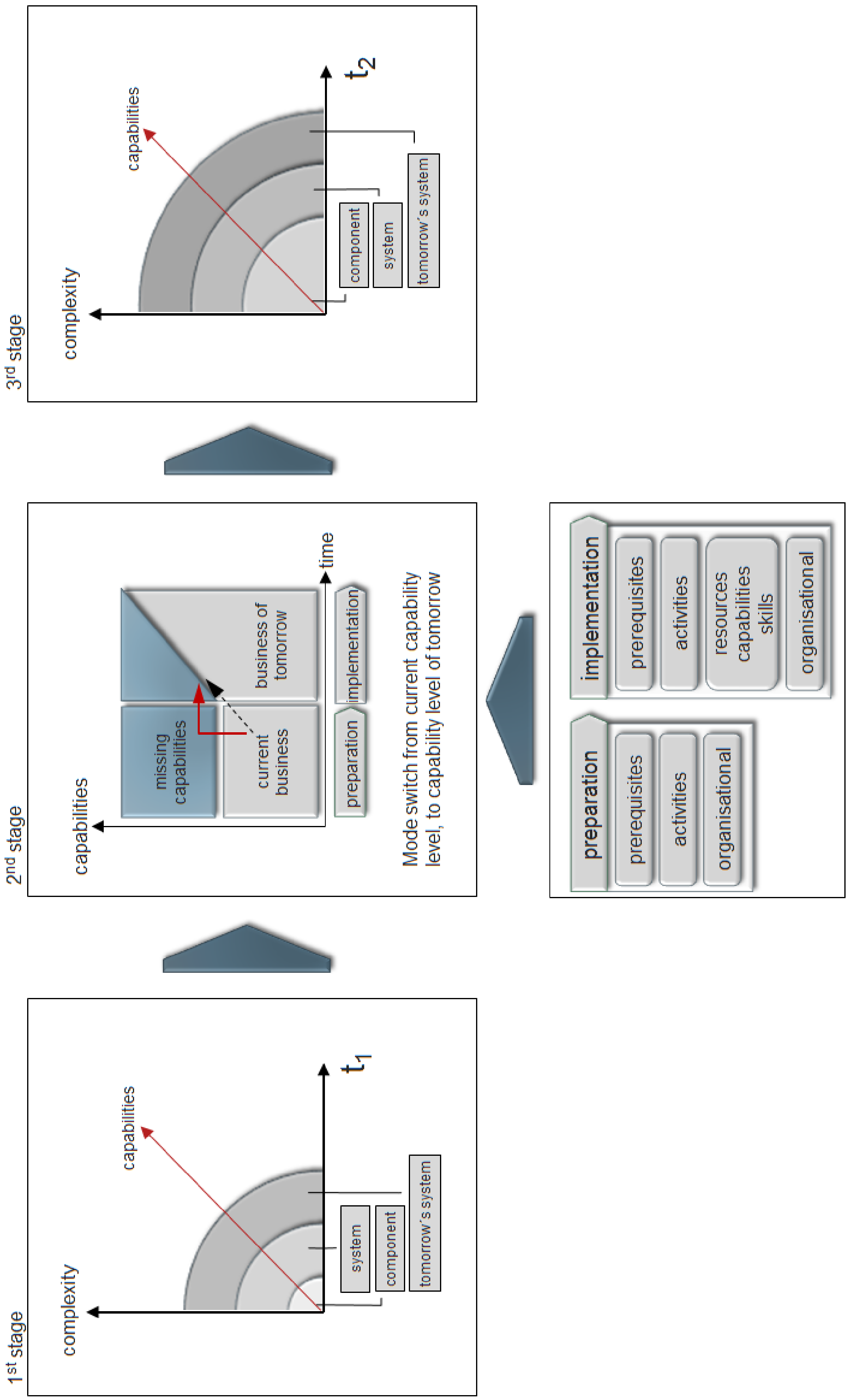


Figure 5.4 Conceptual framework for mode switching

Figure 5.4 illustrates the conceptual framework for mode switching, from component manufacturer to system supplier (the evolution into a higher product hierarchy). The first stage of this framework illustrates a company in its current state, in terms of complexity and capabilities, as suggested by the onion skin model (Figure 5.1). The complexity of the existing products (components) is lower compared to system and tomorrow´s system, hence capabilities (red arrow) required developing and industrialising such in contrast to system and system of tomorrow are minor. The second stage emphasises the necessity of building up new capabilities being competent to mode switch into the next product hierarchy and being able to deal with the increasing complexity. The process to mode switch from the present complexity level (1^{st} stage) into the next product hierarchy (3^{rd} stage) necessitates building up required but at current state missing capability's. The process for the establishment of capabilities for the next product hierarchy is subdivided into the stages, preparation and implementation. To enable the firm´s capabilities to evolve and to develop a new system business, each stage includes several prerequisites and activities that must be completed. The specific activities necessary for preparation and implementation are listed in detail subsequently. Finally, the third stage outlines the broader capabilities of the company and accordingly its ability to develop and manage more complex products that represent the new product hierarchy.

The measures outlined in the following pages represent a valuable procedure/checklist for any component manufacturer that intends to follow the path to system supply. The prerequisites and activities recommended within this framework derive from the best practice findings reported in the data analysis chapter section 4.1 - 4.6, and illustrated as key findings in the discussion chapter section 5.1. All of these measures have been previously discussed in detail (section 5.1.1 - 5.1.7).

Preparation stage

Mode switching from component manufacturer into system supplier requires a number of measures to prepare the organisation for such a change. Prerequisites for a company to evolve into the next complexity level are:

- the existence of an obvious strategy (necessitating mode switching)
- actively involving senior management
- having available knowledge at least one level above own supply
- a culture of pro-actively searching for competitive advantage
- building capabilities to communicate on a par with customers.

Further activities necessary to prepare for the evolution into a system supply are:

- identifying required core competencies
- change development culture towards more system thinking
- obtaining knowledge of target markets
- understanding OEMs challenges and strategic direction
- possessing knowledge of relevant standards and regulations
- convincing potential system customers to conduct reference projects
- starting with small volumes in a defined area/niche.

In addition, organisational measures need to be conducted:

- ☐ establishing standardised processes
- ☐ establishing development procedures according the V-model
- ☐ establishing knowledge of the entire supply chain
- ☐ getting started via projects.

Implementation stage

Having completed the preparation stage successfully, the company can then start the implementation stage. In the same manner as the preparation stage, the implementation stage has a number of prerequisites that are essential for successful evolution into a system supplier:

- ☐ being prepared to deal with an increase in product responsibility
- ☐ establishing a reliable risk management system
- ☐ possessing knowledge of system and prior system
- ☐ being prepared for system thinking and interface management
- ☐ establishing required knowledge / resources (details described below at key resources & capabilities).

Further activities necessary to successfully evolve into a system supplier are:

- ☐ finding ways repaying development expenses
- ☐ building systems out of own standardised components (modular product architecture)
- ☐ expanding constantly of system knowledge.

Additional organisational measures to be addressed are:

- ☐ proceeding gradually / step by step
- ☐ establishing a project organisation (also utilising matrix management)
- ☐ building separate units for the effective coexistence of component and system business
- ☐ expecting several loops at system development until becoming familiar with system complexity
- ☐ embedding of cross departmental collaboration
- ☐ segmenting R&D
- ☐ establishing processes able to manufacture and industrialise systems.

Key resources and capabilities required on system supplier level are:

- ☐ possessing project management capabilities
- ☐ having knowledge of system development
- ☐ having employees capable of managing complexity
- ☐ having the capability to manage diversity of variants
- ☐ possessing skills for managing cross-departmental functions
- ☐ strategic procurement capabilities
- ☐ establishment sales of systems
- ☐ building up supplier evaluation systems
- ☐ having available a quality management system to examine (sub) contractors
- ☐ possessing resources to manage the entire supply chain
- ☐ having skills to collaborate with and effectively manage of external resources
- ☐ possessing a usable network to facilitate cooperation in various forms.

The framework illustrated above represents an effective path for a firm to follow in its evolution from component manufacturer into system supplier. Completing the stages and measures outlined does not guarantee the successful evolution from component manufacturer to system supplier, however proceeding with such structured criteria significantly enhances the opportunities to achieve success. The substance of the conceptual framework presented is derived from the experiences of 24 senior business managers. Therefore the framework has definite potential applicability, based as it is on real life experiences.

5.2. Response to the research questions and summary

The aim of this thesis has been to develop a conceptual framework that enables organisations at the component manufacturer level, to evolve in such a way as to be capable of fulfilling system supplier requirements. In order to accomplish the thesis aim, seven thematic categories (T1 – T7) were identified and discussed in detail to support the research questions (RQ1 and RQ2). The discussion, in turn, provides a basis for the development of the conceptual framework supporting component manufacturer on their evolution to system supplier.

RQ1: ***How should the company, and in particular R&D act - or more precisely how should it organise its resources - in order to support mode switching from component to system supplier successfully?***

RQ2: ***What is the most effective procedure for R&D to follow in order to support the organisations' objective to successfully evolve from component manufacturer to system supplier?***

The rationale for the conceptual framework (see section 5.1.7 ´paragraph conceptual framework´) is the evidence provided by managers in five case studies and the consolidation of these in a cross case synthesis (chapter 4). The key findings and issues were discussed and illustrated in the discussion chapter section 5.1.

Additionally, this research's findings with its cases and their subdivision into thematic categories rests in the collected and edited data, which serves as a knowledge matrix (Table 5.1) that can be combined and contrasted in any possible arrangement as required by the thematic priority of the user.

	Thematic categories						
	Causes and benefits	OEM expectations	Challenges	Definitions	Organisational requirements	Resources and competencies	Approaches and methods
OEM	section 4.1.1	section 4.1.2	section 4.1.3	section 4.1.4	section 4.1.5	section 4.1.6	section 4.1.7
Component manufacturer	section 4.2.1	section 4.2.2	section 4.2.3	section 4.2.4	section 4.2.5	section 4.2.6	section 4.2.7
System supplier	section 4.3.1	section 4.3.2	section 4.3.3	section 4.3.4	section 4.3.5	section 4.3.6	section 4.3.7
Academia	section 4.4.1	section 4.4.2	section 4.4.3	section 4.4.4	section 4.4.5	section 4.4.6	section 4.4.7
Business consultancy	section 4.5.1	section 4.5.2	section 4.5.3	section 4.5.4	section 4.5.5	section 4.5.6	section 4.5.7
Cross case synthesis	section 4.6.1	section 4.6.2	section 4.6.3	section 4.6.4	section 4.6.5	section 4.6.6	section 4.6.7
Interpretation	section 5.1.1	section 5.1.2	section 5.1.3	section 5.1.4	section 5.1.5	section 5.1.6	section 5.1.7

Table 5.1 Knowledge matrix of mode switching

This knowledge matrix presented in Table 5.1 enables the selective consultation of particular perspectives and suggestions as required. Examining the matrix horizontally row by row, the correlated sections either provide best practice cases from different perspectives, offer a compressed overview of all findings within the cross case synthesis, or supply their contrasting and interpretation with the known literature. Investigating the matrix vertically column by column, the correlated sections exemplify the different perspectives regarding a thematic category. Equally the observation of distinct topics of interest is feasible. If the user for example is interested in the perspective of OEMs with respect to challenges, the intersection of the horizontal row OEM with the vertical column challenges identifies section 4.1.3 for delivering adequate support.

The general implications with respect to the research questions can be summarised as follows. The research findings illustrate that the starting point for an evolution into a system business/system development should be a pro-active exploration of new business opportunities and not the result of external market forces. The findings demonstrate that R&D activities differ in system businesses in comparison with component businesses. Consequently, for enterprises coping with mode switching into system development, it is essential to achieve a change in development culture from departmental perspective into systems thinking. The challenge to do so successfully is to develop and/or acquire resources able to comprehend and think in systems. Thus, interface and project management become core competencies in R&D, because system development takes place as a cross functional process, demanding the ability to connect different fields of expertise and complexity. In conclusion, the most favourable conditions evolving into system businesses involve having available knowledge and resources that are at least one complexity level above the current supply. The evidence strongly suggests that since a company is prepared and capable of such knowledge, the mode switch into the next product hierarchy is even easier and can take place with greater efficiency and speed. Additionally, the findings strongly suggest that the evolution should take place through enhancing existing components gradually, because the movement into system development usually happens as a continuous circle of progression, requiring several loops until acceptable results are available. In order to reduce risk and enhance the familiarity with development complexity, setting up a system business in a defined area/niche with small volumes is seen to be a reasonable approach. The preferred business model in line with the case study findings involves the coexistence of a component business and a system business, capable of managing the existing business, as well as the newly established system business, but tailored to deal efficiently with the difference inherent in each. The findings suggest that the required structure involves a separate unit, preferably project based, but organised within the existing organisation, using traditional cross functional departments and functions of the company via a matrix management system. The active commitment and support of senior management is critical to a successful evolution into a system business. The research findings were used to propose a framework (see section 5.1.7 ´paragraph conceptual framework´) to map a mode switch from component manufacturer into system supplier. The findings would suggest that the proposed framework provides significant and effective support for companies concerned with such a challenge. Additionally, the definition developed (section 5.1.4) contribute to improved communication and comprehension with respect to the terms component and system.

6. Conclusion

The findings of this research study represent a comprehensive analysis, from a professional or expert perspective, of how mode switching from a component manufacturer to a system supplier is enabled. This chapter provides an overall synopsis of the research. Firstly, the research aim and the circumstances driving the necessity for conducting this research study are considered. Also, the research questions and an outline of the research methodology applied are presented. Secondly, the implications of this thesis for practice and its relevance for enterprises that are considering mode switching into a higher product hierarchy are explained. Thirdly, the contribution to knowledge within this field of research is provided. Fourthly, the limitations of this research study are outlined. Fifthly, recommendations for further research arising from the research findings are identified. Lastly, the key contributions of this research study are summarised.

6.1. Reflection of the research aim

The manufacturing industry stands in the middle of a dramatic transition, many enterprises find themselves caught in rapidly changing and intensified competitive market structures with increasing pressure to develop innovative solutions in ever shorter timeframes (Herstatt and Lettel 2000; Vanhaverbeke and Peeters 2005). The forces behind this acceleration are for the most part well known; new technologies, shortened product life cycles, and new competitors are reinventing whole industries (Capon and Glazer 1987; Cooper, Edgett and Kleinschmidt 2001; Valentin 2001; McKinsey Global Institute 2012; Gassmann, Frankenberg and Csik 2013). Additional factors driving this process are the continuous increase in product complexity coupled with simultaneous demands for cost reduction (Soppe 2007; Thomas, Francis, John and Davies 2012). This situation is also evidenced by a Bain survey (Zook 2007a), analysing the fate of Fortune 500 companies within a ten year period. The survey showed that almost 60% of those companies faced serious threats and approximately 50% of them had to execute a fundamental shift in business mode to ensure their survival. In this context, Zook (2007b) claimed that companies, which in the past prospered by simply reproducing their business model, may face limited strategic opportunities for further development. The McKinsey Global Institute (2012) and Gassmann, Frankenberg and Csik (2013) support this position. As a consequence of these difficulties and to reduce the complexity and cost of product developments, OEMs intensify their co-operation rate with system suppliers to the disadvantage of sole component manufacturers (Hild 2005; Soppe 2007). This situation creates a considerable threat for the component manufacturer, since excellence in the development and manufacturing of technical components no longer guarantees maintaining their current business position (Deutsche Bank Research 2011b; McKinsey Global Institute 2012). Alternatively, this challenge offers a significant opportunity for the component manufacturer. One way of addressing this challenge is mode switching. Mode switching in the context of this research is understood as changing from one stage of a business model into a different one – usually at an advanced product hierarchy. Mode in this framework refers to the current business design of a company and to the one aspired to in the future.

However, if intending to perform such a change in business approach it is important to recognise that the challenges and requirements confronting a component manufacturer today are typically different compared to those facing a company supplying systems (Campbell, Birkinshaw, Morrison and van Basten Batenburg 2003; Christensen and Raynor 2003; Christensen 2006). Consequently, the aim of this research is to identify such differences and offer guidance for companies at component manufacturer level for successful evolution into the system supplier business. Key aspects to be considered when performing a mode switch to an advanced product hierarchy include the intended innovation mode, organisational structure, and the associated resources and competencies. There are a significant number of models and concepts relating to innovation mode and organisational structure, such as the framework defining innovation (Figure 2.8, section 2.3.1.1) by Henderson and Clark (1990); the 4Ps of innovation (Figure 2.6, section 2.3.1) by Tidd, Bessant and Pavitt (2005); the blue ocean strategy (Table 2.3, Figure 2.9 - Figure 2.10, section 2.3.1.4) by Kim and Mauborgne (2005); open innovation (section 2.3.1.5) by Chesbrough (2003), Gassmann, Enkel and Chesbrough (2010), Lichtenthaler (2011); the S- curve concept (Figure 2.12, section 2.3.2) by Höft (1992) and Christensen (2006), the five phases of growth (Figure 2.13 ,section 2.3.2.1) by Greiner (1998), the framework for finding the right organisational structure (Figure 2.14, section 2.3.2.2) by Christensen and Raynor (2003); and the organisational framework (Figure 2.15 and Figure 2.16, section 2.3.2.2) by Gomez, Raisch and Rigall (2007). There are also many other well-known approaches (Schumpeter 1950; Ford and Ryan 1981; von Hippel 1988; Deng 1995; Merkamm and Weber 1996; Bleicher 1999; Gomez and Zimmermann 1999; Fink 2000; Danneels 2002; Simon 2008; Herrmann 2010; Williams 2011). However, being successful as a company is a complex combination and linkage of different resources, capabilities, and knowledge sources in a flexible organisational framework. Companies´ success also requires the ability to respond to market and technology changes within the existing organisation or if necessary using new and different associations. In this regard the meaning of resources and competencies for company success and the ability to achieve competitive advantage are discussed comprehensively in the literature (Penrose 1959; Wernerfelt 1984; Barney 1986; Dierickx and Cool 1989; Henderson and Clark 1990; Prahalad and Hamel 1990; Barney 1991; Grant 1991; Mahoney and Pandian 1992; Hamel and Prahalad 1993; Kay 1993; Hunt and Morgan 1996; Teece, Pisano and Shuen 1997; Priem and Butler 2001; Sun and Tse 2009). To identify the resources/competencies necessary for a company to attain competitive advantage a number of models and frameworks are suggested, including the resource-product matrix (Figure 2.2, section 2.2.2.1) by Wernerfelt (1984), the VRIN/VRIO framework (Figure 2.3, section 2.2.2.2) by Barney (1991, 2009), the roots of competitiveness (section 2.2.2.2) by Prahalad and Hamel (1990), the five stage framework for strategy formulation (Figure 2.4, section 2.2.2.2) by Grant (1991), and the competitive position matrix (Figure 2.5, section 2.2.2.3) by Hunt and Morgan (1996). However, their application to mode switching is not appropriate, as these models can be quite abstract and/or lacking in operational validity (Priem and Butler 2001). Moreover, these models are mostly theoretical with limited application to practice and thus are not suitable for use in a business scenario. Furthermore, core competencies are generally not the result of a single activity (Grainer 1998) and thus are not easy to duplicate, especially since their measurability and verifiability mostly proceeds ex post (Tidd, Bessant and Pavitt 2005). Thus, regardless of how sophisticated the models/concepts for the identification and the development of enhanced products and solutions are, they are unlikely to be successful unless the required organisational framework fits (section 5.1.5). Moreover, new business approaches that involve an increase in product hierarchy require a company-wide change process, involving departments from R&D through sales, purchasing and production, and many others. Consequently there is additional pressure for organisational change towards more flexible business models. Due to the complexity of this change process companies require an appropriate framework for guidance (section 5.1.7 ´paragraph conceptual framework´). Differing types of product hierarchy require different organisational modes or frameworks, and changing existing and established structures is difficult because of resource allocation practices (Bower 1970; Prahalad and Hamel 1990; Kim and Mauborgne 2005; Christensen 2006) and path dependent reasons (Mintzberg 1987; Dierickx and Cool 1989; Barney 1991; Hunt and Morgan 1996; Teece, Pisano and Shuen 1997; Greiner 1998; Valentin 2001; Tidd, Bessant and Pavitt 2005; Barney and Clark 2009). Moreover, to be successful changes in the organisational framework have to face and overcome significant barriers; first, a new product/solution must prove its legitimacy against established products, departments and mindsets by convincing the company of its importance and its future (Tidd, Bessant and Pavitt 2005; Christensen 2006). However, product enhancement is often perception driven and what can be described as a new or even a radical innovation may already be familiar to others. Equally, the definition of product hierarchy depends on the perspective adopted; as a result, component, module and system have been not defined consistently in the current literature.

Due to the above circumstances, the research focuses on providing a professional view taken from real life, representing a comprehensive perspective of enabling *′mode switching from component manufacturer to system supplier′*. The aim of this qualitative case study research has been to investigate various views within the industrial industry for the purpose of developing an effective procedure to support enterprises at a component manufacturer level to enhance their R&D organisation so as to be capable of developing and supplying systems. The focus of this research has been to provide a professional view on the thesis issues that is able to support the research questions.

RQ1: H*ow should the company, and in particular R&D act - or more precisely how should it organise its resources - in order to support mode switching from component to system supplier successfully?*

RQ2: What is the most effective procedure for R&D to follow in order to support the organisations' objective to successfully evolve from component manufacturer to system supplier?

Therefore a multiple case study approach comprising senior management views from OEMs, component manufacturer, system supplier, academia, and business consultancy was conducted with 24 face-to face semi-structured interviews completed. More specifically, this research explores the requirements with respect to essential resources and competencies, organisational issues, and customer expectations, that arise when a firm intends to mode switch into a higher product hierarchy. Further research aspects include, identifying anticipated challenges and opportunities arising from such an evolution into a system business, as well as gaining knowledge of preferred approaches and methods. Finally, the research purpose has been to consider and relate these aspects to an effective procedure that will support companies evolving into the next product hierarchy - component to system. The concern has therefore been in providing a conceptual framework (section 5.1.7 ´paragraph conceptual framework´) that encourages organisations currently at the component manufacturer level to evolve into a system supplier and to fulfil the associated requirements. The dissertation seeks to contribute to the improved understanding and awareness of mode switching into a higher product hierarchy from the perspective of product development within the field of manufacturing industries.

With respect to the chosen research design (Figure 3.2 and Figure 3.3), firstly the cases were utilised illustrating best practice scenarios viewing the topic *´mode switching´* from the perspectives of different industrial tiers (section 4.1 - 4.5). Secondly, these five best practice cases were cross compared for cross case synthesis (section 4.6). The subdivision within the cases and the cross case synthesis was in line with seven thematic categories, identified in the literature review chapter (section 2.4); depicting important topics that are necessary to analyse and that contribute to knowledge. Thirdly, the seven thematic categories of the five cases and the cross case synthesis were contrasted with the known literature (chapter 2) in order to support the thesis research questions (section 5.1.1 - 5.1.7). Lastly, a conceptual framework (section 5.1.7 ´paragraph conceptual framework´) that provides a practical support to companies that are evolving into the next product hierarchy together with a novel definition of component and system (section 5.1.4) in an applied/practical context has been developed and introduced.

6.2. Implications of the research for practice

This research has significance for component manufacturers that are confronted with the demand to develop and supply more complex products and systems. The implication for practice consists in providing support by delivering an extensive knowledge base for mode switching into an advanced product hierarchy, illustrating best practices and observing important issues to consider, which are then condensed into a conceptual framework that guides enterprises who are evolving into an advanced business mode.

In detail the findings of this research provide a clear and holistic view of different concerned parties on the topic of mode switching into an advanced product hierarchy by supplying best practice perspectives subdivided into industry voices (section 4.1 - 4.3) and external perspectives (section 4.4 and 4.5). The industry voices are represented by interviewed OEM, component manufacturer and system supplier experts. The external perspective is represented by the interviewed academic and business consultancy experts.

The OEM best practice case (section 4.1) expands substantially the understanding of the research topic from the perspective of an affected customer and provides distinct expectations and determining factors for the evolution into a system supplier. The findings contribute to the existing knowledge (Dougherty 1992; Danneels 2002; Stefan 2005; Soppe 2007) by providing genuine requirements and expectations of OEMs regarding their system suppliers from a customer's point of view. The implication for practice is the possibility for a component manufacturer that is about to become a system supplier to mirror their strategy on a current real business scenario.

The findings of the component manufacturer best practice case (section 4.2) enhances the body of literature (Schuh, Lenders and Schöning 2007; VDMA, WZL RWTH Aachen and Roland Berger Strategy Consultants 2007; McKinsey Global Institute 2012) from the perspective of a enterprise imminently evolving into the next product hierarchy, supplying valuable insights regarding motivation. Moreover, expected challenges and approaching changes with respect to resources, competencies and organisational structure are illustrated thereby supporting and enhancing the existing knowledge.

The system supplier best practice case (section 4.3) provides improved understanding from the perspective of enterprises that have already evolved successfully into a system supplier. The findings contribute to practice and supplement the extant literature by providing insights with respect to challenges (Valentin 2001; Tidd, Bessant and Pavitt 2005; Christensen 2006), benefits (Zook and Allen 2003), required resources and capabilities (Penrose 1959; Henderson and Clark 1990; Prahalad and Hamel 1990; Barney 1991; Grant 1991; Mahoney and Pandian 1992; Sun and Tse 2009), organisational and culture aspects (Dierickx and Cool 1989; Greiner 1998; Christensen and Raynor 2003; Gomez, Raisch and Rigall 2007), in addition to strategies (Grant 1991, Zook and Allen 2003) and approaches (Tidd, Bessant and Pavitt 2005; Kim and Mauborgne 2005; Kotter 2013) used.

Supplementing the findings of the industry voices the academic best practice case (section 4.4) represents the perspective of research and theory, and supports the research topic from an external academic perspective. Additionally the business consultancy best practice (section 4.5) highlights the research topic from the perspective of a supportive professional, and contributes to practise by providing background with extensive and intimate knowledge regarding the entire value and supply chain of component manufacturer, system supplier and OEM.

The classification into thematic categories for the purpose of considering essential aspects at mode switching is significant for practice. The single categories are causes and benefits, OEM expectations, challenges, definitions, organisational requirements, resources and competencies, and approaches and methods. The implication for practice is increasing knowledge regarding mode switching and related subjects. The research contributes to practice by illustrating, from different vantage points (section 4.1.1, 4.2.1, 4.3.1, 4.4.1, and 4.5.1), the causes (Schuh, Lenders and Schöning 2007; McKinsey Global Institute 2012) and anticipated benefits (Zook and Allen 2003) that are the decisive factors for the evolution into system supply. Further, the study itemises OEM expectations (Dougherty 1992; Danneels 2002; Stefan 2005; Soppe 2007) regarding system supply. Consequently the findings offer valuable advice regarding the customer´s expectations to companies intending to supply systems (section 4.1.2, 4.2.2, 4.3.2, 4.4.2, and 4.5.2).

Anticipated challenges (Dierickx and Cool 1989; Prahalad and Hamel 1990; Barney 1991; Greiner 1998; Tidd, Bessant and Pavitt 2005; Christensen 2006; Gassmann, Frankenberg and Csik 2013) occurring when changing business mode were investigated, thus the findings of this research serve as guidance for companies concerned (section 4.1.3, 4.2.3, 4.3.3, 4.4.3, and 4.5.3). Moreover, the findings add substantially to knowledge and supplement the extant literature of the diverse interpretations regarding product hierarchy (section 4.1.4, 4.2.4, 4.3.4, 4.4.4, and 4.5.4) by providing a novel definition of component and system applicable for manufacturing industries (section 5.1.4). Thus the compiled definition contributes by improving communication and comprehension among the different tiers.

The research contributes to practice, by illustrating the organisational requirements that arise from mode switching from the perspectives of different tiers; in addition the favoured organisational structures are illustrated (section 4.1.5, 4.2.5, 4.3.5, 4.4.5, and 4.5.5). Moreover, explicit indications regarding resources and competencies, necessary for evolving into a higher product hierarchy are identified (section 4.1.6, 4.2.6, 4.3.6, 4.4.6, and 4.5.6). Lastly, the approaches and methods preferred for evolving into system supply are illustrated (section 4.1.7, 4.2.7, 4.3.7, 4.4.7, and 4.5.7), and a conceptual framework is provided (section 5.1.7 ′paragraph conceptual framework′), that represents an effective procedure for a company to follow in order to support the aim to evolve from component manufacturer into system supplier. The cross case synthesis (section 4.6), contributes to practice by illustrating major and minor aspects regarding the thematic categories, and thereby creating a helpful and compressed overview of the entire research findings. In conclusion, the relevance of this research for practice with its cases and their subdivision into thematic categories rests in the data, serving as a knowledge matrix (Table 5.1) that can be combined and contrasted in any possible arrangement as required by the thematic priority of the user. Beyond that, the knowledge matrix in its entirety represents the foundation to respond to the thesis research questions and form the conceptual framework.

The most significant findings regarding implications of this research for practice in agreement with the research question RQ1 are as follows.

RQ1: H*ow should the company, and in particular R&D act - or more precisely how should it organise its resources - in order to support mode switching from component to system supplier successfully?*

The findings in this research study indicate that possessing knowledge of the target market, in order to understand OEMs challenges and strategic direction (Hamel and Prahalad 1989) is a prerequisite for evolving into a system business successfully. Beyond the awareness of important market and customer issues, characteristics such as knowledge are an important factor for the identification of required knowledge/resources (Grant 1991; Kay 1993; Barney and Clark 2009) necessary to mode switch into a higher product hierarchy. This research finds that the most favourable circumstances for advancing into a higher product hierarchy occur when the enterprise in question possesses knowledge and resources required for developing and supplying products at least one level above their current level. Further, evidence is provided that R&D activities in a system business differ greatly in comparison to those in a component business (Campbell, Birkinshaw, Morrison and van Basten Batenburg 2003; Christensen and Raynor 2003;

Christensen 2006). Thus a change in the development culture towards system thinking and the establishment of cross departmental collaboration is vitally important. The findings add substantially to the understanding that interface and project management skills turn into core competencies (Prahalad and Hamel 1990), because system development takes place as a cross functional process, demanding the ability of connecting different fields of expertise and complexity. In this regard, the capability to collaborate with and the management of external resources, represents a prominent role within system development, because not all resources required need to be built up internally (Chesbrough and Appleyard 2007; Gassmann, Enkel and Chesbrough 2010; Lichtenthaler 2011). Further important issues identified within this research are the necessity of being prepared to deal with an increase in product liability which involves possessing knowledge of relevant standards and regulations', consequently having available a reliable risk management structure is highly recommended.

The most significant findings characterising implications of this research for practice in accordance with the research question RQ2 are as follows.

RQ2: ***What is the most effective procedure for R&D to follow in order to support the organisations' objective to successfully evolve from component manufacturer to system supplier?***

The research findings explicitly identified that prior to initiating mode switching into a higher product hierarchy the development of a concise business strategy requiring such a mode switch is a central issue. The research findings indicate that the presence of a pro-active corporate culture in terms of exploring new business opportunities and competitive advantages are very helpful when mode switching into an advanced product hierarchy. The present research study provides evidence that the evolution from a component manufacturer into a system business ideally takes place through enhancing existing standardised components (Zook and Allen 2003); these components are preferably designed as modular product architecture (Henderson and Clark 1990). The change should take place as a step by step approach (Dierickx and Cool 1989), ideally initiated via pilot projects. The findings suggest that the system business should initially set up in a defined area/niche producing small volumes and thereafter move to more complex projects in order to become familiar with system business specialities.

A key finding of this research, that has an implication for business practice, is that the preferred approach is the coexistence of the component business and the newly established system business in parallel, rather than focussing on either a component business or system business individually. This finding supplements the existing literature (Campbell, Birkinshaw, Morrison and van Basten Batenburg 2003; Christensen and Raynor 2003; Christensen 2006). The findings show that the organisational structure for the system business needs to be capable of managing the existing business as well as the newly established one. The research findings provide evidence that the preferred organisational structure for a system business in coexistence with a component business is the establishment of a separate unit (Buckland, Hatcher and Birkinshaw 2003; Campbell, Birkinshaw, Morrison and van Basten Batenburg 2003; Christensen and Raynor 2003; Tidd, Bessant and Pavitt 2005; Christensen 2006; Henderson 2006; Gomez, Raisch and Rigall 2007). This unit is preferentially project organised within the existing organisation using traditional cross functional departments and functions of the company via a matrix management. Such configuration is known in literature as corporate venturing (von Hippel 1988; Block and McMillan 1993; Tidd and Taurins 1999; Tidd, Bessant and Pavitt 2005; Henderson 2006) or new business development (Vanhaverbeke and Peeters 2005). Key domains within this system unit are R&D and a sales force that are aligned to the system business requirements. Findings in this regard suggest that a standardised process, in particular the development of systems in accordance with the V-model procedure, is essential. Furthermore, the system business unit should be capable of performing the entire process from system development through to its industrialisation. Finally, the findings indicate that a broad network of partners for potential cooperation is an important factor to balance rising expenses in a system business.

The overall implication for practice of this research has been the development of a conceptual framework (section 5.1.7 ´paragraph conceptual framework´) providing significant and effective support for companies concerned with evolving into the next product hierarchy. This conceptual framework has been designed as practicable approach, based on the research findings, to support companies on a component manufacturer level to enhance into a system supply, successfully. The findings of this study can be utilised as a guideline for enterprises intended to mode switch into the next product hierarchy.

6.3. Contribution to knowledge

This research study contributes new knowledge to the research literature and for other researchers by examining unacknowledged issues regarding the identified thematic categories (T1) causes and benefits, (T2) OEM expectations, (T3) challenges, (T4) definitions, (T5) organisational requirements, (T6) resources and competencies, and (T7) approaches and methods. The significant theoretical and practical implications of the findings are presented and discussed in the following.

Further, new methodological knowledge is contributed by applying an aspect model (section 4.6, Figure 4.1) improving evidence at data triangulation within cases analysed. This model enables a more effective interpretation and evaluation of diverse options illustrating the array within the value chain among the cases and their relation regarding the thesis aim. Additionally, the model ´4Ps of innovation´ (section 2.3.1) from Tidd, Bessant and Pavitt (2005) was broadend by a new 5^{th} P -category. The extended new P-category ´Partner innovation´ takes into account the increasing necessity of collaboration with different organisations and/or anonymous communities well beyond enterprises boundaries. Concidering such additional perspective facilitates a more extensive exploration of the different types of innovation.

(T1) Classifying the incentives for enterprises performing mode switching and thereby associated advantages.

The findings suggest that mode switching occurs because without continuous advancement every company might face an uncertain future, especially with growing global competition. This is well known and discussed in the literature (Danneels 2002; Vanhaverbeke and Peeters 2005; Schuh, Lenders and Schöning 2007; VDMA, WZL RWTH Aachen and Roland Berger Strategy Consultants 2007; Zook 2007a; McKinsey Global Institute 2012). Supplementing the literature, this research identified, that the stimulus for the evolution of an enterprise into system business could be caused by internal and external factors (Table 4.2, section 4.1.1, 4.2.1, 4.3.1, 4.4.1, 4.5.1, 4.6.1, and 5.1.1). Key aspects for such decisions are the attempt to avoid being exchangeable, therefore component manufacturers aim to extend their product portfolio into system supply in the hope of safeguarding their current market position. The research findings provide evidence that the cause for these contrasting triggers for mode switching predominantly results from the company's individual self-conception.

Those companies stimulated externally frequently have the sense of being chased into a system supply. The findings signify that the pressure to reduce product complexity at the OEMs is a dominant external trigger; consequently OEMs focus on core disciplines and pass the development and supply of entire assemblies to system suppliers. Existing literature (Teece 1986; Christensen 2003; Stefan 2005; Soppe 2007) underpins this finding. The findings of this research indicates that the main intention of enterprises following such a reactive approach is to attempt to stay in business by accomplishing current customers (OEMs) expectations. Given that the interviewed component manufacturers predominantly consider external forces as the main trigger for their efforts to evolve into a system businesses, these research findings strongly recommend establishing a clearly defined strategy well before starting such a mode switch. This is important so as to prevent the company being pushed into organisational changes not in line with their long-term objectives.

Additional evidence extending the research literature (Henderson and Clark 1990; Hunt and Morgan 1996; Danneels 2002; Christensen and Raynor 2003; Zook 2007b) is provided on the basis of the findings generated by this research; a pro-active approach in terms of searching for competitive advantages, prior to the point where the market starts predominantly forcing this, is suggested. Companies that follow a pro-active approach in terms of developing new markets, customers and/or applications when moving into a system business have the most promising future. The findings suggest that the pro-active approach enables the company to safeguard its business more effectively. This is because establishing system knowledge ahead of market demands helps identify new business fields as well as being valuable to optimise and improve the existing component business.

The associated advantages (Table 4.3, section 4.1.1, 4.2.1, 4.3.1, 4.4.1, 4.5.1, 4.6.1, and 5.1.1) of performing mode switching, underpinned by this research study, are predominantly associated with most enterprises becoming less exchangeable. The findings further contribute to knowledge and provide improved understanding for mode switching by suggesting that the establishment of a system business allows the company to create unique selling propositions and increase customer connectivity thereby generating additional returns. The implications of the findings and the contribution to knowledge are that the evolution into a system business embodies an opportunity for enterprises to safeguard their future by developing new business directions, and in addition attracting brilliant applicants by offering challenging tasks. Further associated advantages of a system supply evidenced by this research are the increase in knowledge and the vitalisation of innovative potential.

Overall, in conclusion and as a contribution to knowledge, this research provides support for the suggestion that global competition and customer (OEM) expectations force enterprises to continuously advance. Companies respond to this either by following a reactive approach predominantly initiated by external stimulus or pursuing a pro-active approach initiated internally to ensure the corporate strategy is achieved. The research findings suggest that the pro-active approach is the more reliable and future focussed one, satisfying the associated advantage of safeguarding the company's future sustainable.

(T2) Identifying customer expectations in order to satisfy market demand with mode switching.

Possessing knowledge regarding the expectations of prospective customers is very important when evolving into a system supplier. This research made a contribution to the improved understanding and awareness of a component manufacturer evolving into a system supply by identifying critical OEM requirements (Table 4.4, section 4.1.2, 4.2.2, 4.3.2, 4.4.2, 4.5.2, 4.6.2, and 5.1.2) to collaborate with system suppliers. The general expectation of OEMs with respect to their system supply is receiving an ′all round carefree package′, knowing fully, that this represents the ideal. More specifically, the research findings provide evidence that OEMs are searching for system suppliers capable of solving OEMs challenges, adopting system responsibility and covering associated risks by developing and delivering zero defect systems faster and more favourably than made by the OEM (Dougherty 1992; Danneels 2002). Supplementing the literature, this research identified that the ingredients required therefore are, in the first instance the capability to understand the challenges that OEMs are confronted with, in order to support them effectively. This research identified, that for this purpose a system supplier requires knowledge of the entire system with its superior units and interfaces. This necessitates being equipped with resources, skills and knowledge that can manage complexity to develop suitable solutions. The expected adoption of system responsibility demands capabilities to deal with an increase in product reliability. Therefore the existence or establishment of a reliable risk management system is recommended. With respect to customer expectations research findings verify that the delivered goods have to be in accordance with the requirements specification and be in the right quantity, quality, on time, and at the appropriate place.

(T3) Identifying challenges enterprises encounter when performing mode switching.

This research made a significant contribution to the improved understanding and awareness of mode switching into a higher product hierarchy by underpinning the challenges enterprises are confronted with. Moreover, the findings of this research study provide support to the belief, that companies aiming to evolve into a system business are confronted with various challenges (Table 4.5, section 4.1.3, 4.2.3, 4.3.3, 4.4.3, 4.5.3, 4.6.3, and 5.1.3). These challenges can be categorised in possessing required knowledge and resources, cultural and organisational aspects, market issues, and financial issues.

The impact of knowledge/resources on a company's ability to face challenges is discussed comprehensively in the literature (Penrose 1959; Henderson and Clark 1990; Prahalad and Hamel 1990; Barney 1991; Grant 1991; Mahoney and Pandian 1992; Kay 1993; Sun and Tse 2009). With respect to knowledge and resources, the findings identify rising complexity as a significant challenge that enterprises evolving into a system supplier are confronted with. This research indicates that responding to this challenge requires the availability of resources capable of system thinking in order to accomplish system development requirements, and the knowledge to control the various interfaces to manage arising diversity of variants efficiently. This supplements the literature and contributes to an improved understanding of the topic. A further challenge identified is the increasing demand of utilising external support, thus resources capable of managing and validating deliveries of (sub) contractors and development outcomes of external partners are considered as essential.

Regarding cultural and organisational challenges (Dierickx and Cool 1989; Prahalad and Hamel 1990; Hunt and Morgan 1996; Greiner 1998; Valentin 2001; Tidd, Bessant and Pavitt 2005; Christensen 2006; Gomez, Raisch and Rigall 2007; Barney and Clark 2009), this research indicates that changes in corporate culture, as well as employees' mindset are essential when mode switching. A key aspect in this respect constitutes the change from departmental thinking into cross organisational collaboration. As indicated, system development demands intensifying the collaboration with external partners, thus establishing a network of reliable external partners is important.

Challenges arising in the view of market issues consist of the possibility of interfering with current customers and becoming an unintended competitor, something that might negatively affect today's business relations. Further, being recognised and commonly accepted in the marketplace is an important prerequisite for enhancing the business mode into a system supply. Concerning this challenge, findings suggest conducting reference projects with pilot customers in the initial phase is useful to convince and to prove the enterprise´s qualities.

An implication with respect to financial challenges identified is that a system development requires extensively more expenses than a component development. It is not unusual that a system development has to be self-funded and there may be uncertainty as to whether the firm is awarded the contract. Thus, discovering supplementary measures to repay the system development expenses represents an essential challenge for enterprises evolving into a system business. In addition, research findings provide support that the evolution into a system supply results in an increase in product liability, and these forces enterprises into taking appropriate measures.

This research contributes to an enhanced awareness regarding challenges arising when mode switching, through identifying the major issues and outlining proposals in response. Summarising, the response to increased challenges included identifying required core competencies in order to deal with rising complexity, changing development culture towards system thinking, obtaining knowledge with respect of the target market, convincing potential system customers to conduct reference projects, as well as identifying measures minimising development expenses.

(T4) Developing a common definition of product hierarchy and its subdivision into component, module and system.

The findings of the reviewed literature provide support for the suggestion that there is a lack of clear understanding of product hierarchy and its subdivision into component, module and system in the literature.

Thus, the research intended to bridge the acknowledged gap in literature by compiling a common definition of terms that would be valid for enterprises at different tiers of the industrial value chain. Analysing the data, at first appearance, the research findings underpinned in accordance with the literature that a common understanding regarding the definition of component, module and system is missing, as there are too many different interpretations (Table 4.6, section 4.1.4, 4.2.4, 4.3.4, 4.4.4, 4.5.4, and 4.6.4). Surveying the interviewees' statements identifies some areas of conformity (section 5.1.4). Firstly, in terms of product hierarchy a component is less than a system. Secondly, products/supplies that a company is currently not able to develop are labelled a system. Thirdly, at that point where the company is able to develop and industrialise such product/supply, it is called a component. Fourthly, the term does not necessarily relate to the complexity of the product/supply. Fifthly, the terms component and system are subject to a time-dependent context. The essence of this rationale is shown in the definition that has been developed through this research process.

Generally, components are products that a company has already developed, industrialised and hold in their product portfolio, regardless of complexity level (product hierarchy). Systems are products that are the next development step for the company or that still have to be invented. Central to this definition is that the terms component and system have a time-dependent context; once the system of today is fully developed and industrialised, it will be re-termed ′component′.

In conclusion, the findings of this research provide a new understanding and make a significant contribution to knowledge by bridging the acknowledged gap in literature through compiling a novel definition of product hierarchy in an applied context.

(T5) Classifying organisational requirements for mode switching and providing ways to link with a companies' history and path dependent organisation.

The findings suggest that the requirements relating to a component business and a system business differ to a certain extent. Thus, this research study contributes to knowledge by classifying organisational requirements and providing practical ways to link the existing organisation with the effort required to mode switch (Table 4.7, section 4.1.5, 4.2.5, 4.3.5, 4.4.5, 4.5.5, 4.6.5, and 5.1.5). The research findings indicate that the preferred organisational approach for mode switching into an advanced product hierarchy is coexistence of the component business and the system supply, rather than serving either the component business or the system business individually. This implication is underpinned by the suggestion to set up the organisational structure such that the company is capable of managing the existing business, as well as the newly established system business efficiently, while tailored to deal with system business specialities. Thus, a subdivision of a component and a system business appears useful, because of the different requirements and competencies that each require (Teece, Pisano and Shuen 1997; Campbell, Birkinshaw, Morrison and van Basten Batenburg 2003; Christensen and Raynor 2003; Christensen 2006). The coexistence of mainstream businesses and new business development activities are commonly known in literature as (internal) corporate venturing (von Hippel 1988; Block and McMillan 1993; Tidd and Taurins 1999; Tidd, Bessant and Pavitt 2005; Henderson 2006) or new business development (Vanhaverbeke and Peeters 2005).

Supplementing the literature, the findings of this research suggests performing projects at the initial phase using matrix management with a strong foundation of cross departmental collaboration as an organisational approach. Thereafter, a separate unit (preferentially project organised) can be established which drives the development of system business beside the existing organisation (Buckland, Hatcher and Birkinshaw 2003; Campbell, Birkinshaw, Morrison and van Basten Batenburg 2003; Christensen and Raynor 2003; Tidd, Bessant and Pavitt 2005; Christensen 2006; Henderson 2006; Gomez, Raisch and Rigall 2007). This unit need to be equipped with processes and competencies required to manufacture and industrialise systems. In particular, R&D tasks and sales activities in a system business differ in comparison with a component business, hence setting up R&D and sales force focussed on system business requirements is essential for system development and successful market penetration. This offers the most flexible approach for evolving into a system business in addition to existing business fields. The research findings suggest that, the starting point for such an approach should be the development of systems based on existing core competencies/products with a step by step advancement. Most recommendable in this context is aiming for modular product architectures (Henderson and Clark 1990) enabling the enterprise to build/develop systems out of standardised components (Zook and Allen 2003). In conclusion, the findings of this research significantly enhances the understanding regarding organisational requirements at mode switching into system business and contributes to knowledge through illustrating a feasible approach to link the company's history with their potential future.

(T6) Identifying necessary resources and competencies required for an enterprise to evolve into a higher value-added stage.

This research contributes to knowledge by identifying necessary resources and competencies required for an enterprise to evolve into a higher value-added stage (Table 4.8, section 4.1.6, 4.2.6, 4.3.6, 4.4.6, 4.5.6, 4.6.6, and 5.1.6.). The findings provide robust evidence that R&D activities and tasks differ in a system business in comparison to a component business. Thus, the findings indicate that it is crucial for success at evolving into a higher value-added stage to change the development culture by altering the mindset from departmental focused thinking to system thinking in order to cope with rising complexity. The relevance of resources and competencies and their importance for the company's success in general are widely discussed in the literature (Penrose 1959; Wernerfelt 1984; Barney 1986; Dierickx and Cool 1989; Prahalad and Hamel 1990; Barney 1991; Grant 1991; Mahoney and Pandian 1992; Kay 1993; Hamel and Prahalad 1994; Hunt and Morgan 1996; Teece, Pisano and Shuen 1997; Priem and Butler 2001; Barney and Clark 2009; Sun and Tse 2009), and are recognised as the resource-based view.

With respect to the previous statement the findings provide evidence that resources and competencies most relevant for the transition into a system business are employees with the ability to think in systems, in example employees who have a comprehension of adjacent systems and interfaces as well as the superior system. Moreover, interface management and project management skills turn into a core competency, because system development takes place as a cross functional process, demanding the ability to connect different fields of expertise and complexity, as well as external resources. In this context, strategic procurement needs to be strengthened, because collaboration with suppliers and subcontractors will increase dramatically and become an important dimension within system development. Findings further suggest that system suppliers require the necessary skills and knowledge to communicate efficiently with customers. Overall, these findings suggest that mode switching requires as the most significant resource/competency, a culture of consistent pro-active knowledge advancement aiming to enhance existing capabilities towards a level on a par with customer perceptions. Ideal conditions are in place, if the company already has available knowledge and resources at least one level above that necessary for developing the current products. Being in such a position enables the company to enhance into the next product hierarchy easily at anytime.

In conclusion, this research contributes to knowledge through enhancing the existing RBV literature from the perspective of organisational change in business mode. The research findings provide evidence that the most relevant resources and capabilities required for the transition into a system supply are employees who can think in systems, connect different fields of experience and complexity, and act efficiently within cross departmental functions. A company is in an ideal position if it has available knowledge and resources at least one level above the one necessary for developing their own supply.

(T7) Providing a framework that enables and guides enterprises that are mode switching to a higher value-added stage.

Reflecting the research findings with reference to supporting methods for changes in business mode, the responses were varied (Table 4.9, Table 4.10, section 4.1.7, 4.2.7, 4.3.7, 4.4.7, 4.5.7, 4.6.7, 5.1.7), and consequently an impartial recommendation of a single method appears difficult (Tidd, Bessant and Pavitt 2005). A combination of several aspects emerges as a hybrid solution. This research contributes to knowledge by identifying supportive aspects of mode switching condensed into a conceptual framework. The findings illustrate that certain approaches, elements and preferences concerning the way to perform the change into a system business are common. For example, project management, and system development corresponding with the V-model procedure were considered essential for a successful change in business mode. Similarly, conducting the evolution as a step by step approach (Dierickx and Cool 1989) ideally initiated through pilot or prototyping projects was commonly supported. Further consensus was agreed regarding the enlargement through enhancing existing components by building modular product architectures (Henderson and Clark 1990; Zook and Allen 2003). In this regard, the research findings propose launching a system business in a defined area/niche with small volumes and thereafter disseminating the system business from this position into new and alternative solutions and applications. Beyond this brief extract illustrating common issues among findings, an extensive range of further important aspects essential when evolving into a system supply were identified (section 4 and section 5).

Providing a significant contribution to knowledge, the findings of this research study were related, building a conceptual framework (section 5.1.7 ´paragraph conceptual framework´). The approach of the conceptual framework (Figure 5.4) is subdivided into the two stages preparation and implementation. Each stage includes several prerequisites and activities necessary to accomplish in order to cover the required capabilities and organisational demands that are important for evolving into a system business successfully. The stages preparation and implementation of this conceptual framework are characterised as a tick box approach, thus the conceptual framework represents a valuable checklist for enterprises that are evolving into a higher product hierarchy to pursue. The conceptual framework with its practical approach is constructed in such a way that companies aspiring to evolve into a system business just need to synchronise their present configuration with the frameworks requirements.

In conclusion, this research has made a contribution to the improved understanding and awareness of enterprises evolving into a higher value-added stage by developing and providing a conceptual framework (section 5.1.7 ´paragraph conceptual framework´) originating from senior management experiences. The conceptual framework provides a roadmap guiding enterprises to enhance their business successfully to a higher value-added stage. Additionally, applying new methodological processes for analysing (section 4.6, Figure 4.1) and reviewing data (section 2.3.1) contributes and extends the research literature.

6.4. Limitations of the research

The aim of this thesis has been to provide a conceptual framework as a contribution to knowledge and practice that enables organisations on the component manufacturer level to set up in such a way as to be capable of fulfilling system supplier requirements. This research encompasses the field of product development within the field of manufacturing industries. The thesis was concerned with recognising requirements and issues in principle and providing general findings, with the purpose of uniting them into a practicable approach. Apart from the previously illustrated restrictions, several limitations to this research study need to be acknowledged. The limited sample size representing the external academic and business consultancy perspective with in total three respondents, as already mentioned in the methodology chapter (section 3.4.2) and the data analysis chapter (section 4.4 and 4.5), was recognised. Hence, the external perspective was designed as complementary cases to verify and enhance the credibility of the findings within the cases representing industry voices. Upper management were interviewed for the case studies due to their impact on long term strategic decision making, as discussed in the methodology chapter (section 3.4.1.2). The research could be supplemented by respondents representing additional hierarchical levels and disciplines for example members of the middle management and/or R&D specialists. In a further study this would enhance the perspective of this research and might contribute to further validation of this research's conceptual framework.

With respect to the applied case study research design, concerns regarding construct validity and subjective judgement might emerge. This circumstance is recognised and measures preventing this are utilised, such as the use of a multiple case study design including a sample size of 24 respondents representing different enterprises of different tiers, as illustrated in the methodology chapter (section 3.3.2 and 3.4.1.2). Further, the research study recognised the limitation, that the statements given by the respondents might represent a vivid picture of interviewees' perception of the questioned topic at the moment of the interview. To avoid receiving limited information an interview guide with the 12 open ended questions was sent to the interviewees for preparation in advance, as explained in the methodology chapter (section 3.4.1.3). Lastly, the research sample represented enterprises of the manufacturing industries (the academic respondents also worked in manufacturing industry prior to their appointment to the university) and caution must be applied as the findings might not be transferable to other/further industries/branches that aim to mode switch into a higher product hierarchy.

6.5. Recommendations for further research

This research was concerned with theory development to provide a conceptual framework that will guide enterprises aspiring to relocate their current business into a higher product hierarchy. The study´s focus of attention was the area of research and development within manufacturing industries in a resource-based context. Potential future research efforts could, in general address the limitations of this research study (section 6.4).

The conceptual framework presented is at an exploratory stage; the necessary prerequisites and activities presented by this framework are the essence of expert explanations arising from the research process. An important extension of this research would be the evaluation and validation of the conceptual framework within a real-life organisational change context. The data gathering process of this research was based on face to face interviews conducted within multinational enterprises, however, all respondents were German nationals. Further research could therefore concentrate on the investigation of respondents representing different business cultures so as to enlarge and validate the findings of this research from a global perspective. In this context it would be interesting to establish, which distinctions in mode switching are common among countries in Europe, as well as in North America or Asia. The starting position for such further research would be based on this research design and using its semi structured interview guide.

This study focussed an R&D related issues within a resource-based context. Further research enhancing the contribution to knowledge might be to investigate the topic with a market-based view and enlarge the field of research to adjacent disciplines, such as sales and customer service. Likewise, investigation of the current research field (manufacturing industries) could be enlarged to other industries/branches to assess to what extent the conceptual framework arising from this research study is transferable. Further potential for additional research includes investigating and verifying the compiled definition of product complexity and its variation from a component to a system and back to a component over time. Additional topics identified but not considered in this thesis are the examination of different forms of collaboration with external partners and the role of trust in this regard as well as contrasting incremental mode switching and disruptive mode switching through applying the conceptual framework. In this regard it would be interesting to assess if the framework supports and guides both change processes whether adjustments to the framework are necessary. Lastly, it would be important to assess the effects of a system business on the subject of development outcomes such as patents, and their impact on the success of the enterprises, relative to the earlier component business. Intensifying the research further, as suggested above will improve and extend the body of knowledge and provide further evidence regarding the process of mode switching from one product hierarchy into a higher one.

6.6. Conclusion

This research investigating the topic of ´*mode switching from component manufacturer to system supplier, requirements, opportunities and best practices*´ has made a significant contribution to improving the understanding and awareness of enterprises evolving into an advanced product hierarchy. The insights of this research enhance knowledge regarding this subject area and provide valuable support beyond the academic community. The research is particularly useful within the manufacturing industry where a company is currently a component manufacturer but is confronted with growing demand for developing and supplying more complex products and systems. The thesis contributes to knowledge and practice within its field of research - mode switching into an advanced product hierarchy - in four main ways: *fundamental, methodological, normative and conceptual*.

The *fundamental* contribution to knowledge and practice consists of providing support through delivering an extensive knowledge base in terms of mode switching into an advanced product hierarchy condensed in a knowledge matrix (Table 5.1). This knowledge matrix provides a clear and holistic view of different, concerned parties on the topic of mode switching into an advanced product hierarchy, by supplying best practice perspectives subdivided into industry voices and external perspectives. By considering essential aspects of mode switching, the perspectives are classified into seven thematic categories (T_1 – T_7), and both majority and minority supported views are illustrated. Thus, a compressed overview, applicable for enterprises within manufacturing industries seeking organisational change to enhance their present business mode into an advanced stage, is provided. In conclusion, the relevance for knowledge and practice is accounted for, by the collected and edited data serving as knowledge matrix, positioned to be combined and contrasted in any possible arrangement, as required by the thematic priority of the user.

The *methodological* contribution of this thesis for knowledge and practice has been the development and application of an aspect model (Figure 4.1) improving evidence at data triangulation. Moreover, the advancement of the 4Ps innovation model from Tidd, Bessant and Pavitt (2005) by the fifth category - ´Partner innovation´, considering the necessity to collaborate beyond enterprises boundaries.

The *normative* contribution to knowledge and practice is provided by the new understanding of product hierarchy terminology and its subdivision into component and system. This research has made a significant contribution to knowledge and practice by bridging the acknowledged gap in the literature and compiling a novel definition of product hierarchy in an applied context (section 5.1.4).

The *conceptual* contribution of this thesis for knowledge and practice has been the development of a conceptual framework (section 5.1.7 ´paragraph conceptual framework´) providing significant and effective support for companies concerned with evolving into the next product hierarchy. The conceptual framework has been designed as a practical approach, supporting companies at component manufacturer level to enhance into system supply, successfully. The key measures recommended provide valuable support for a component manufacturer on the pathway to becoming a system supplier. Overall, the findings of this research study significantly contribute to the improved understanding and awareness of mode switching into a higher product hierarchy within the field of manufacturing industries.

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8. Appendices

Appendix A: Interview guide

1. Was ist Ihrer Meinung nach der Auslöser dafür, dass sich so viele Unternehmen für den Wandel vom Komponentenlieferanten hin zum Systemlieferant entscheiden?
    - Externe Treiber?
    - Interne Treiber?
    - …

2. Welchen Nutzen kann ein Unternehmen durch diesen Wandel erfahren?
    - Kundenbindung
    - Alleinstellungsmerkmal
    - Sicherung Wettbewerbsposition
    - ...

3. Welche Ressourcen (materielle/immaterielle Vermögensgegenstände) und Fähigkeiten (in einem Unternehmen vorhandenes Wissen) sind aus Ihrer Sicht maßgeblich, um den Wandel zum Systemlieferant erfolgreich zu vollziehen?
    - Know-how
    - Systemverständnis
    - Führungsqualitäten
    - ....

4. Mit welchen Herausforderungen werden Unternehmen bei der Wandlung vom Komponenten- hin zum Systemlieferant konfrontiert?
    - Unternehmensgröße
    - Unternehmenskultur
    - Ehemalige Kunden wurden zu Wettbewerbern
    - Komplexität
    - Qualitätssicherung
    - Motivationsprobleme
    - Kompetenz- und Koordinationsprobleme
    - Informationsverluste / asymmetrische Informationsverteilung
    - Opportunistisches Verhalten und Geheimhaltung
    - Transaktionskosten bei Anbahnung/Durchführung, intern und extern
    - ...

5. Wie wird sich der Wandel hin zum System (Unterscheidung: integral/modular) mit den bereits bestehenden Komponenten vertragen?
    - Kannibalisierung-Effekt
    - Stärkung der eigenen Komponenten
    - „Aufblasen“ des eigenen Unternehmens
    - Probleme Organisation
    - ...

6. Welche Vorgehensweisen würden als erfolgreich und welche als eher ungeeignet einstufen? Muss der Wandel schrittweise erfolgen? Welche Meilensteine sollten mit eingeplant werden?
    - Vision
    - Umstellung der Organisation
    - Unternehmensberatung
    - Umstellung stufenweise?
    - ...

7. Welche Methoden sehen Sie dabei als maßgeblich?
    - FMEA
    - PESTE-Analyse
    - SWOT
    - Systemanalyse
    - TRIZ
    - V-Modell
    - .....

8. Waren organisatorische Veränderungen für diesen Wandel erforderlich? Wenn ja, welche?
    - Teamarbeit oder Abteilung?
    - Aufbau einer neuen Vertriebsstruktur? (Komponenten- und Systemvertrieb)
    - Umstellung der Produktlinien?
    - Wie geht man mit der Schwerfälligkeit einer bestehenden Organisation um?
    - Welche Rolle spielt die Unternehmensgröße?
    - ...

9. Wie musste sich die Forschung und Entwicklung verändern bzw. anpassen?
    - Personell?
    - Organisatorisch? ...
    - Aneignen weiterer Kompetenzen? Extern/intern? Wo liegen hier die Risiken?
    - Welche Art der Zusammenarbeit scheint Ihnen die sinnvollste? (Zulieferer, anderes UN, Institut?)
    - Lücken bei der Projektplanung?
    - Scheuklappen aufgrund der Unternehmenshistorie?
    - Einfluss Lebenszyklus einer Komponente?
    - ...

10. Wie würden Sie den Begriff „Komponentenlieferant" bzw. „Systemlieferant" definieren?
    - Teil, Komponente, Modul, System
    - Unterschied Komponenten- und Systemlieferant
    - ...

11. Welche Erwartungshaltung hätten/haben Sie als OEM an Ihre eigenen System-Zulieferer?
    - Rasches Einarbeiten in Systemproblematik
    - Übernahme der gesamten Entwicklungsarbeit
    - Abgabe der Verantwortung
    - JIT
    - Qualität als Grundvoraussetzung
    - Beratung
    - ...

12. Möchten Sie das Gespräch noch einmal kurz in drei Tipps zusammenfassen, die bei der Weiterentwicklung zum Systemlieferant unbedingt beachtet werden müssen?

Translation:

1. In your opinion, what causes many enterprises to transform from being a sole component manufacturer to a system supplier?
2. What would the benefits be for an enterprise experiencing such a change?
3. From your point of view, what resources and competencies are relevant to carry out the change to system supplier successfully?
4. What challenges will enterprises face during the transformation from component manufacturer to system supplier?
5. How the change to systems does tolerate with the already existing components?
6. Which approaches would you classify as successful and which as rather unsuitable? Does the change have to take place gradually? What milestones should be taken into account?
7. Which methods do you regard as significant?
8. Is there a need for organisational change? If so, what?
9. How did the research and development department have to change and/or adapt?

10. How would you define the terms ´component manufacturer´ and ´system supplier´? What do you understand by the terms; component, module, and system?
11. What expectations do you have/would you have as OEM regarding your own system supplier?
12. Would you be so kind as to summarise briefly, in your opinion, what are the three most important issues that must be considered during the transformation to system supplier?