**UNIVERSITY OF VAASA**

**DEPARTMENT OF PRODUCTION**

**INDUSTRIAL MANAGEMENT**

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# IMPROVING THE RESIDENTIAL PROJECT DEVELOPMENT PROCESS

**By Sustainable Competitive Advantage**

Master's Thesis in
Science of Economic and Business Administration

Industrial Management

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# TABLE OF CONTENTS

# ABBREVIATIONS

| | |
|---|---|
| AHP | The Analytical Hierarchy Process (AHP) method is a multi-attribute decision instrument that allows considering quantitative and/or qualitative measures and integrating the different measures into single overall goal. |
| BCFI | Balanced Critical Factor Index define the most critical factors which have significant influence on the overall organization's performance. |
| BSC | Balanced Score Card evaluates activities in a more general level: external- and internal structure, learning and growth, trust and business performance. |
| CV | The coefficient of Variation illustrates the homogeneity of the results. |
| CFI | Critical Factor Index is a measurement tool to indicate which attribute of a process is critical and which is not, based on the experience and expectations of informants. |
| K/T | Knowledge and Technology. |
| K/T Rankings | Knowledge and Technology rankings are a required section of the Sense and Respond method, in which an organization's share of technology is evaluated in terms of basic-, core-, and spearhead technology. |
| MAD | Maximum Deviation – the average distance of each data value from the mean. |
| MAPE | Mean Absolute Percentage Error – a measure of prediction accuracy of a forecasting method in statistics. |
| MSI | Manufacturing Strategy Index. |
| NSCFI | New Scaled Critical Factor Index is an improved model based on the earlier SCFI model. |
| OP | Operations Priorities evaluates division's daily operations: knowledge and technology management, processes and work flows, project, as well as organizational and information systems. |
| RAL | RAL model is a holistic and a multi-focused manufacturing strategies model based on business goals. RAL abbreviation comes from Responsiveness, Agility and Leanness. |
| RMSE | Root Means Squared Error – measure of the differences between values. |
| RPD | The case company's Residential Project Development-division. |
| SCA | Sustainable Competitive Advantages. |
| SCFI | Scaled Critical Factor Index. |
| S&R | Sense and Respond (S&R) philosophy is the implementation of the best action in a turbulent business environment by detecting changes (sensing) and reacting to them properly (responding). |
| WMT | Weak Market Test. |

# LIST OF FIGURES

# LIST OF TABLES

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## ABSTRACT:

In today's highly competitive and fast paced world it is important for a company to have a balanced strategy which is unified and precisely executed to gain a sustainable competitive advantage in order to outperform its rivals. The freedom of action of a company is limited to satisfying the needs of those entities outside the firm (customers and investors, primarily) that give the resources it requires in order to survive and to be successful.

The purpose of this research is to define and assess the sustainable competitive advantages and the direction of development, and potential improvements in a case company's Southern Finland Residential Project Development–division. The analysis of operational competitiveness focuses on detecting the right operational strategy and resource allocation by exploiting seven different kind of methodologies in order to gain an overall picture. The used theories and methodologies are: The Analytical Hierarchy Process, Critical Factor Indexes, Sense and Respond, the RAL–concept, Manufacturing Strategy Index, Knowledge and Technology, and Sustainable Competitive Advantage. The data for this research was gathered from 16 respondents by using two questionnaires.

The current operation and resource allocation support the operative strategy well and those resources which seem to be out of place are definitely heading in the right direction. Despite the fact that the direction of resource usage is mostly towards a decent overall balance, the results clearly indicate that a thorough resource reallocation should be taken into consideration. The results should be interpreted by the best experts in the case company in order to find improvements in practice by a reasonable level of investment.

**KEYWORDS:** Sustainable Competitive Advantage, Process Development, Critical Factor Index, resource optimization, strategic decision-making.

**VAASAN YLIOPISTO**
**Teknillinen Tiedekunta**
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**Tutkielman nimi:** Asuntoprojektikehitys-prosessin kehittäminen, hyödyntäen kestävää kilpailuetua

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## TIIVISTELMÄ:

Nykyajan erittäin kilpailullisessa ja nopeatahtisessa maailmassa on tärkeää, että yrityksellä on tasapainoinen strategia, joka on yhtenäinen ja täsmällisesti toteutettu, jotta voidaan saavuttaa kestävää kilpailuetua sekä paremmin erottautua kilpailijoistaan. Yritystoiminnan vapaus rajoittuu yrityksen ulkopuolisten yhteisöjen (ensisijaisesti asiakkaat ja sijoittajat) tarpeiden tyydyttämiseen, jotka mahdollistavat tarvittavat resurssit selviytymiseen ja menestymiseen.

Tämän tutkimuksen tarkoituksena on määritellä ja arvioida case-yrityksen Etelä-Suomen Asuntoprojektikehityksen kestävää kilpailuetua ja kehityksen suuntaa, sekä mahdollisia kehitysideoita. Toiminnallisen kilpailukyvyn analyysi keskittyy oikean operatiivisen strategian ja resurssien kohdentamiseen hyödyntämällä seitsemää erilaista menetelmää yleiskuvan saamiseksi. Käytetyt teoriat ja menetelmät ovat: Analyyttinen hierarkiaprosessi, Critical Factor Index:sit, Sense and Respond, RAL-konsepti, valmistusstrategiaindeksi, osaaminen ja teknologia, sekä kestävä kilpailuetu. Tutkimuksen data on kerätty 16:sta vastaajalta käyttäen kahta kyselylomaketta

Tutkimuksen tulosten mukaan nykyinen toiminta ja resurssien allokointi tukevat operatiivista strategiaa, ja resurssit, jotka näyttävät olevan kriittisiä, ovat menossa oikeaan suuntaa. Huolimatta siitä, että resurssien käytön suunta on hyvä ja enimmäkseen tasapainossa, tulokset osoittavat selvästi, että perusteltu resurssien jako olisi otettava huomioon vaiheittain. Tutkimuksen tulokset tulee tulkita parhaiden asiantuntijoiden avulla, jotta yritys kykenee löytämään kohtuullisen investoinnin vaatimia kehityskohtia.

**AVAINSANAT:** Kestävä kilpailuetu, prosessin kehittäminen, Critical Factor Index, resurssien optimointi, strateginen päätöksenteko.

# ACKNOWLEDGEMENTS

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Secondly, I would like to express my very great appreciation to Prof. Josu Takala for his valuable and constructive suggestions during the planning and development of this research work. His willingness to give his time so generously has been tremendously appreciated as well as his useful critiques of this research work. In addition, I would like to thank the University of Vaasa and its staff and professors for providing valuable courses and lectures.

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Vaasa, June 2017
Klaus-Erik Heimonen

# 1 INTRODUCTION

Strategy is one of the most important components of the modern corporate environment which is, in most cases, determines whether a company or organization survives or faces bankruptcy. Strategy is a gateway for any organizational development, modernization or competitive activities arrangement as well as the key to competitive advantages and reliability achievement. (Christensen 2011.) According to Si, Takala and Liu (2010), operational strategy can be seen as a pattern consisting of decisions affecting the ability to meet a company's long-term objectives. The aim of operations strategy is providing a broad framework for defining how it prioritizes and utilized its own resources to have sustainable competitive advantage in a marketplace. Furthermore, the future competitiveness of manufacturing operations under dynamic and complex business situations relies on forward-thinking strategies which should keep in balance with existing resources and use them towards creating advantages (Si, Takala & Liu 2010).

The world is changing every day and this unstable environment affects corporations on a huge scale. Among this turbulent environment, operations strategy is one of the most essential tools which can help manages to keep their position or even get more share in a nationwide market (Takala, Muhos, Tilabi, Serif & Yan 2013c: 55). Moreover, economic recessions that affect firms regardless of their location, increased competition, and changes in customer expectations, all contribute to disruptions that require firms to be resilient (Acquaah, Amoako-Gyampah & Jayaram 2011).

Construction development is surrounded by complex decisions and the increased significance of environmental issues has further complicated the situation. The construction industry is one of the largest end users of environmental resources and polluters of manmade and natural environments. Furthermore, society is not just concerned with economic growth and development, but also with the long-term effects on living standards for both present and future generations. Certainly sustainable development is an important issue in project decisions. (Ding 2008: 463.) The field of current research is relatively wide, as it touches theories from decision making and strategic planning to strategy selection and performance improvement areas.

## 1.1 Scope of the thesis

The general purpose of this research is to define and assess the sustainable competitive advantages and the direction of development in a case company's Southern Finland Residential Project Development (RPD) department, which is operating in the construction industry. Analysis of the operational competitiveness focuses on detecting the right operational strategy and resource allocation by exploiting seven different types of methodologies: The Analytical Hierarchy Process (AHP), Critical Factor Indexes (CFI), Sense and Respond (S&R), the RAL-concept, Manufacturing Strategy Index (MSI), Knowledge and Technology (K/T), and Sustainable Competitive Advantage model (SCA) in order to gain an overall picture.

A main aim of this research is to discover the current situation and assess the future direction of development. The research question and its sub-questions, which support the main research question, are presented below.

- How the case company's Southern Finland Residential Project Development can be improved in the perspective of operational strategy?
    - What are the case company's critical resources and how should they be reallocated to achieve better performance?
    - What are the case company's success factors compared to competitors?
    - What is the level of uncertainty in investment decision making?

In a perspective of Sense & Respond (S&R) and Critical Factor Index (CFI), the research will focus on BCFI- and NSCFI models, which are the most useful and used indexes in order to define the most critical factors, which have significant influences on the overall organization's performance. The research focuses only on the case company's Southern Finland Residential Project Development and on the previously-defined methodologies and models by which the results are obtained. Additionally, data is collected from a micro- and macro level will be excluded from the study. Furthermore, the impacts of technology and knowledge on uncertainty in the investment decision making process are modeled with the help of three methods: AHP, the Sand Cone model and the Knowledge

and Technology rankings. Zucchetti's (2016) master thesis explores the K/T-methodology and the Sand Cone model more comprehensively.

As a result of the research, the type of operational strategy is identified and the dominance order of strategy types is presented, as well as resource allocation and critical areas are discovered and suggestions for improvement are presented. Additionally, uncertainty in decision making is modelled and cause and consequences presented. Furthermore, employees who are working within the Residential Project Development will get insight information concerning the current situation and what resources are the most critical ones. In other words, the research gives an option to reallocate critical resources and an opportunity to gain increased sustainable competitive advantage.

## 1.2 Structure of the thesis

The thesis begins with an overview of the necessary theoretical background – description of the used concepts, models and topologies. Furthermore, the chapter "Theory and Research" contains a comprehensive view on a core idea of the research and it has been divided into two main sections: "The theoretical background" focuses on explaining concepts, and the "Research methodologies"– section conclusively explains the methodologies used in this research.

The following 'Empirical research'– chapter presents, describes and analyzes the Residential Project Development phases. The chapter has been divided to four main sub-chapters: "Overview of the research- and analysis process", "Data processing and analyzing", "Findings", and "Summary". The main role of the chapter is to demonstrate how the methods are utilized as well as to present the results of the research. The research is explained through step by step.

The "Discussion" – chapter aims to explain the results in an aggregate level. The chapter is divided to five sub-chapters: "Findings and contributions", "Theoretical and practical implications", "Validity and reliability", "Research limitations", and "Future research".

Moreover, it expresses the author's personal opinion regarding the research and the practical advice concerning the method implementation. The concluding chapter, "Conclusions", briefly describes the entire research process up to the achievements of the research and to the main findings drawn from them. Moreover, the chapter briefly describes whether the objectives and goals have been met and whether the research is carried out as planned.

# 2 THEORY AND RESEARCH METHODOLOGIES

The theory and research methodologies chapter contains a comprehensive view on the research background and on the methodologies used. The chapter has been divided into two main sections: Theoretical background focuses on explaining concepts, and the research methodologies section conclusively explains the methodologies used in this research.

## 2.1 Theoretical background

This sub-chapter focuses on the theoretical background in order to achieve a better understanding on the overall picture and the various factors affecting organizational performance and an organization's operational strategy. Subsequent subjects will be explained in this order: sustainable competitive advantage, operations strategies, business process improvement, and knowledge and technologies.

### 2.1.1 Sustainable competitive advantages

Competitive advantage has been studied extensively since the 1980's (Porter 1980, Porter 1985), when the notion of Sustainable Competitive Advantages (SCA) was developed for the first time by Porter (1985) and then completed within resource based strategy by Barney (1991). Furthermore, Barney Wright & Ketchen (2001: 645) completed it as a resource base view believing that the critical factors for success exist in the firm itself in terms of its resources and capabilities. According to Christensen (2011), an organization's capabilities define its disabilities. The perception of the SCA has changed over the years, from Porter's (1985) ideology on competitive business strategies which are based on differentiation by unique specialization in terms of quality, product, service technology or cost leadership to resource-based strategy ideology by Barney, Wright and Ketchen (2001: 643–650).

According to Wernerfelt (1984) and Barney (1991), the core concept behind a resource based strategy relies on SCA, when it is derived from the resources. The resource based strategy's capabilities must have four attributes: rare, valuable, imperfectly imitable and not substitutable. In addition, technology as know-how is a relevant part of the resource based strategy and therefore, Hayes and Wheelwright (1984) and Hayes, Wheelwright and Clark (1988) strongly recommended managers to be highly involved in the strategic planning process of business units in order to accomplish superior competitive performance. Furthermore, Avella, Fernández and Vázquez (2001:150–151) consider that the key decision areas and their internal coherence, which include the emphasis of certain manufacturing competitive priorities or capabilities and decisions or practices, can be the base for achieving a sustainable or lasting advantage over competitors.

The benefits of implementing sustainable competitive advantage are demonstrated in Figure 1. The SCA functionalities can be explained as a closed-loop system, which contains a measuring manufacturing strategy index, sense and respond, technology strategy, and transformational leadership within outcome, leadership, and resource. In order to find the critical factors, an organization should re-allocate resources and improve the lower level foundations, which in return improve the upper level strategies with the adjustments made based on the changes in situations in the business environment. (Liu 2013: 2829.) In other words, the organization should measure SCA functionalities and adjust these to dynamic decisions. Furthermore, all of these functionalities and factors, which are presented in Figure 1, affect an organization's sustainable competitive advantage.

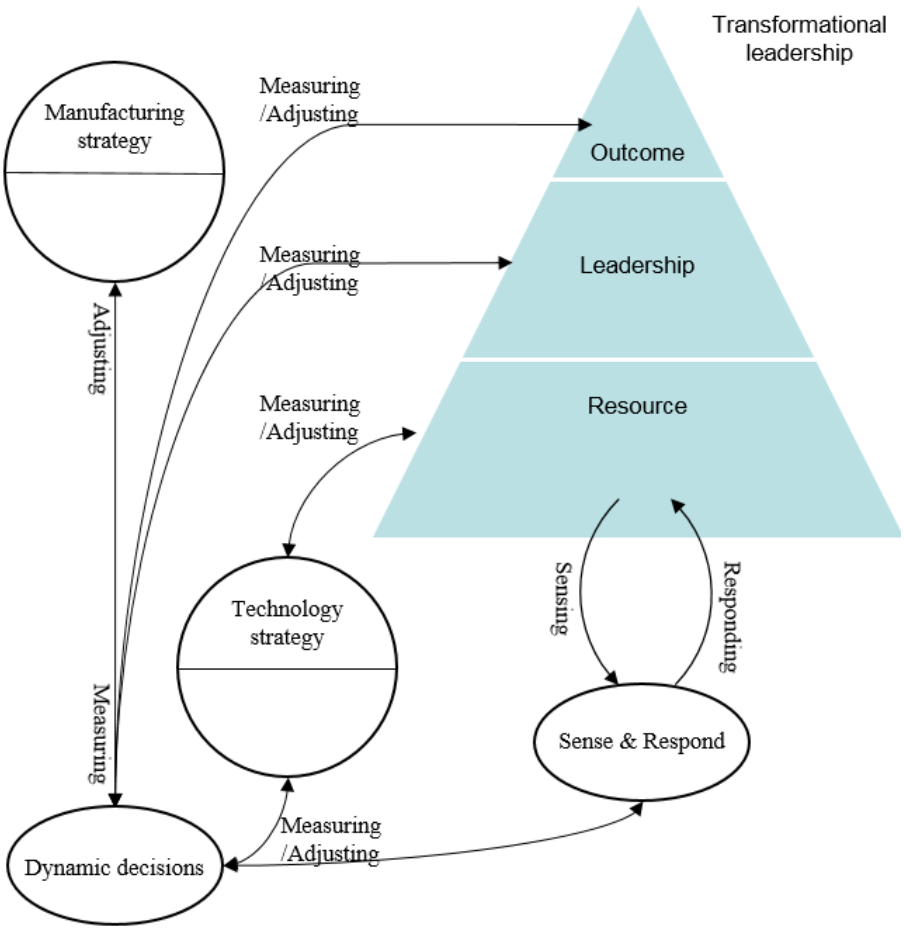



Figure 1. The benefits of implementing sustainable competitive advantage (Liu 2013: 2829).

According to Liu (2013: 2822), Manufacturing strategy, Transformational leadership, Technology strategy, and Sense and Respond are the key aspects to achieving an overall competitive advantage in the present business environment. Furthermore, the future competitiveness of manufacturing operations under dynamic and complex business situations relies on forward-thinking strategies. Firms that can sustain their competitive advantage are able to outperform others in the long run. (Liu 2013: 2822.) In this research, the SCA is proposed and identified as the advantage to create a resource-based strategy which is supported by the Sense and Respond idea of agile strategy implementations.

### 2.1.2 Operations strategies

Strategy does not have an unambiguous definition, thus according to Quinn (1980) strategy means "A pattern or plan that integrates an organization's major goals, policies and action sequences into a cohesive whole". In another aspect of Johnson, Scholes and Whittington (2007) strategy is "the direction and scope of an organization over the long-term, which achieves advantages in a changing environment through its configuration of resources with the aim of fulfilling stakeholder expectations". Operations strategy is defined as "the pattern of strategic decisions and actions which set the role, objectives and activities of operations", where patterns implies a consistency in strategic decisions and actions over time (Slack & Lewis 2014).

Miles and Snow (1978) topology is a dominant framework of the strategy types. They have developed a comprehensive framework which states that the strategy type can be detected depending on the fixed proportions between RAL Model elements (Quality, Cost, Time/Delivery, and Flexibility). The RAL abbreviation comes from Responsiveness, Agility and Leanness. By this framework, there are considered to be four different business strategy types in organizations. Three of the four types are stable groups, Prospectors, Defenders, and Analyzers. The fourth group is called Reactors, which is an unstable group. The instability of the Reactors group results in its exclusion from this research. (Takala, Koskinen, Liu, Tas & Muhos 2013b: 48.) The three stable business strategies in accordance to Mike and Snow (2003: 550–552) are defined below.

**Prospectors** is a strategy for an organization, where the organization continuously improves and innovates their products and services by discovering and exploiting new market opportunities. The Prospector's competitive strategy creates changes in the market place by responding quickly to existing or early signals concerning areas of opportunities (Flouris & Oswald 2006). In other words, this strategy is dynamic and looks forward for new opportunities in the organization's market, and products. Additionally, an organization takes risks, innovates in processes and furthermore focuses its efforts to lead their industry and is also keen to be the first in entering into a new market area. Quality is a crucial point for the current strategy type. (Mike & Snow 2003: 550–552.)

The Prospector's basic strategy set has been clarified by Mike and Snow (1978: 29), when an organization operates in a broad domain and in a continuous state of development. An organizations growth is uneven, it primarily comes from new markets and new products. They are also seen as creators of change in their industries and they monitor a wide range of environmental conditions, trends, and events.

The Prospector strategy's characteristics and behaviors are clarified by: the organization is frequently changing organization's product base structure and technology, without efficient benefits and having complex and expensive coordination. Technology is invested in people, not machines, and prototypes are frequently escorted to production using multiple technologies. The organization's dominant alliances are typically marketing, research, and development, when assuming that the managers' appraisal is effective. Planning is implemented extensively (non-intensive) and the controlling is results-oriented, as far as the information flow is decentralized to multiple decision-makers. Furthermore, conflicts are directly confronted and resolved. (Mike & Snow 2003: 550–552.)

**Defenders** is a strategy for an organization which has narrow product-market domains. These organizations are focusing on product maturity and market operations as well as cost efficiency and improving processes. Top managers are highly expertized in their organization's limited area of operation but do not tend to search outside their narrow domains for new opportunities. (Miles & Snow 1978.) Furthermore, Mike and Snow (2003: 550–552) continue that an organization, which has been classified as a Defender, does not prefer to take risks but instead they intensify their efficiency and maintain their current customers. In other words, Defender means a limited set of products, ignoring developments and trends outside of their domain, and maintaining a small niche industry. Defenders are mainly focusing on cost. (Mike & Snow 2003: 550–552.)

Defenders basic strategy set has been distinguished by Mike and Snow (1978: 29) as, an organization that penetrates deeper into the current market in order to aggressively maintain prominence within its chosen market segment. Normally, the organization ignores developments outside of its domain, which leads to growth occurring cautiously

and incrementally. Moreover, Defenders characteristics and behaviors are clarified as the organization invests in a single core technology, which is often vertically integrated. The functional structure and processes are stable, simple and inexpensive to coordinate, and their planning is intensive. The organization's control is centralized and the information flow is implemented vertically. Furthermore, managers compare their current efficiency to the past and they have an extensive division of labor and high degree of formalization. Dominant alliances are finance and production. (Mike & Snow 2003: 550–552.)

Organization with an **Analyzer** strategy is between the Defender and Prospector types. The analyzer is a unique combination of the Prospector and Defender types and represents a viable alternative to the two other strategies. An Analyzer organization attempts to minimize operational risk while maximizing the opportunity for profit by combining the strengths of two other strategies. The Analyzer strategy balances quality, cost and time, and does not focus on any specific attribute. (Mike & Snow 2003: 550–552.)

Analyzers basic strategy set has been distinguished by Mike and Snow (1978: 29) as an organization that has a mixture of products and markets, where some are stable and others changing. The growth normally occurs through market penetration as well as through product and market development. The organization keenly follows the changes in an industry. Analyzers characteristics and behaviors are recognized as: an organization's structure is matrix and controlling is difficult since it is able to trade off efficiency and effectiveness. Their coordination is both simple and complex, since their planning is both intensive and comprehensive. Furthermore, the organization is moderately efficient and their dominant alliances are marketing, applied research, and production. Managers compare their efficiency to similar organizations. (Mike & Snow 2003: 550–552.)

The manufacturing strategy is identified separately from the operations strategy since the differences between the two strategies are related to a plan of actions to achieve a new state of improved organizational structure and working practice in a manufacturing perspective. According to Jay and Arnold (1996: 49–50) a business strategy, which has a manufacturing strategy as one part of it, includes three objectives: competitive priorities, manufacturing objectives, and action plans. Competitive priorities are defined by the

organization, manufacturing objectives are defined regarding to the competitive priorities, and the action plan is defined and implemented to achieve the strategic goals. Figure 2 demonstrates the business strategy using the manufacturing strategy.

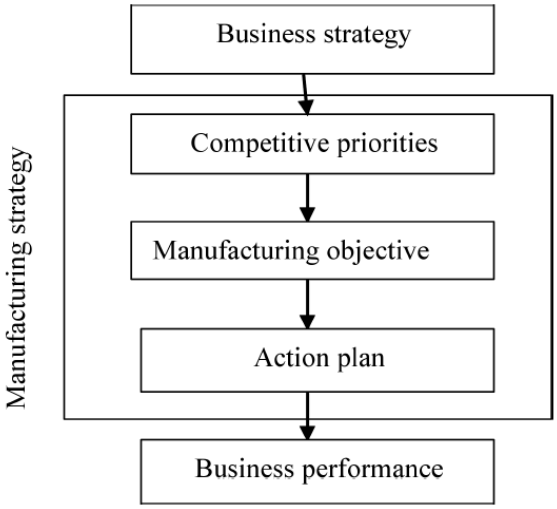



Figure 2. Process model of manufacturing (Jay & Arnold 1996: 49).

The manufacturing strategy includes three distinct stages of the process which are represented in the Figure 2. Each element differs from the others in the level of abstraction, with the competitive priorities being the most abstract and the action plans the most specific. Thus the operationalization of the manufacturing strategy requires multiple stages of iteration of highly abstract concepts to be more tangible. The first element, competitive priorities, describes what the manufacturing function should achieve with regard to cost, quality, flexibility and delivery, in order to subsidize the business strategy effectively. The second element, manufacturing objective, includes a selected set of a few objectives (e.g. delivery- or procurement lead time) and the organization focuses on achieving them. (Jay & Arnold 1996: 49–50.)

In order to achieve the selected set of manufacturing objectives, managers should determine the improvement methods, which will be implemented in the future. Over the last few decades, the practices in manufacturing management has seen numerous new

methods designed to improve manufacturing operations, such as Total Quality Management (TQM), Just in Time (JIT), Material Requirement Planning (MRP) to name just a few. Furthermore, since each method requires the allocation of scarce resources, it is critical to determine which methods should be adapted. The third element, action plan, defines these methods. In other words, prior to the adaptation of a particular method, managers should recognize its expected effects on specific operating objectives. (Jay & Arnold 1996: 49–50.)

Two different organizations with similar resources in the same industry will perform differently since the operations strategies and the manufacturing strategies in the organizations are distinct from each other. Therefore, no operating system is universally superior under all competitive situations for all organizations. Additionally, these strategies do not have simplified ways to reallocate restricted resources. In order to achieve improved performance, resource allocation must conform to the organization's strategy.

### 2.1.3 Business process improvement

A modern organization should be focusing on its process performance and quality matters in order to manage its functions as processes. Evaluations of these processes are essential for managing value chains and reducing costs. The quality and performance problems are estimated to contribute to the losses of approximately 20 ~ 30 percent of the gross sale. In order to improve the performance and quality of the processes, the current level must be analyzed and critical factors defined, resources must be allocated correctly, employees be trained, and organization's structure changes must be controlled. (Krajewski, Ritzman & Malhorta 2007: 206–207.)

Organization's resources are visible factors that contribute to what an organization can or cannot accomplish. Resources include people, equipment, technology, products designs, brands, information, cash, and relationships with suppliers, distributors and customers. Processes are patterns of interaction, coordination, communication, and decision-making

throughout an organization, where resources are transformed into services and products of a greater value. (Ding 2008: 463.)

Construction development is surrounded by complex decision-making. The increasing significance of environmental issues has further complicated the situation. "Society is not just concerned with economic growth and development, but also the long-term effects on living standards for both present and future generations. Certainly sustainable development is an important issue in project decisions." (Ding 2008: 463.) Moreover, the construction industry is both one of the largest end users of environmental resources and polluters of manmade and natural environments. "The improvement in the performance of buildings with regard to the environment will indeed encourage greater environmental responsibility and place greater value on the welfare of future generations." (Ding 2008: 463.)

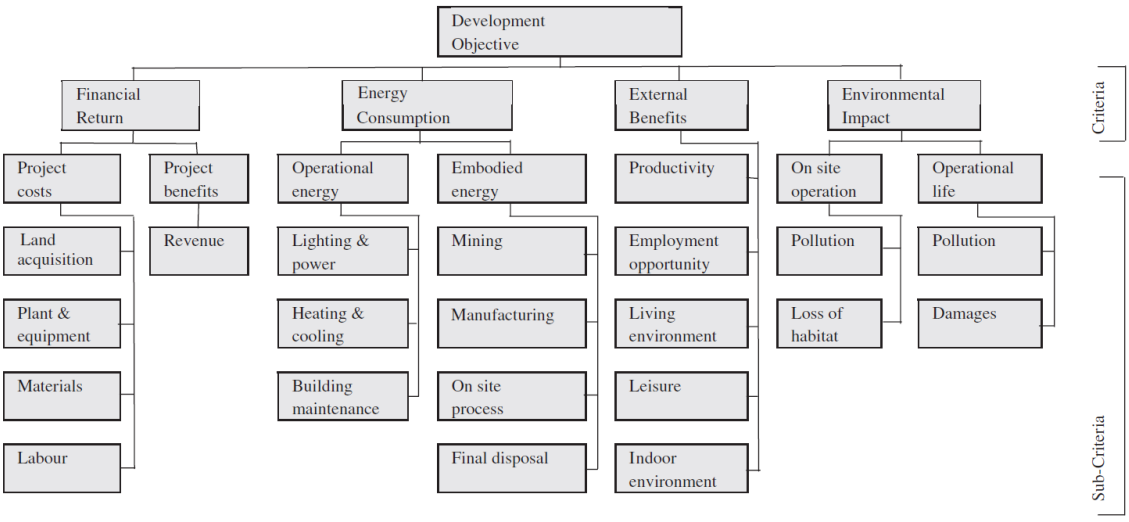



Figure 3. Sustainable project development for construction (Ding 2008: 461).

Figure 3 demonstrates the different development objectives for Residential Project Development in a single view by Ding (2008: 461). Development consists of four main categories within a broader perspective: Financial return, Energy Consumption, External

Benefits, and Environmental impact. Each of these development objectives can be implemented individually and the improvements positively contribute business processes.

All the business process improvement theories and methodologies, like Quality Control Circles, ISO 9000 standards, benchmarking, auditing, and continuous improvement, have the common goal of seeking better performance through improvement. Additionally most of these theories also exploit process thinking. In the past, development was based on organizational units and their tasks, which have changed with time to chains of activities, also known as processes. The process thinking concept is a more comprehensive view over the units' boundaries, which focuses on the action, i.e. on making things differently. Figure 4 presents how processes are a central part of the organization's operation and strategy. Creating operative strategies is a process itself but those strategies are also implemented through Manufacturing processes. (Laamanen & Tinnilä 2009: 7–15, 68.)

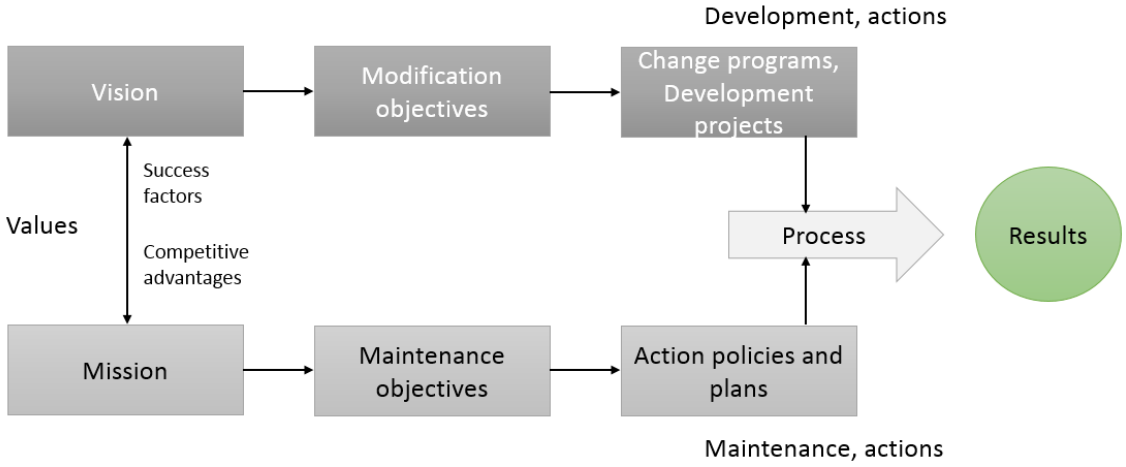



Figure 4. Processes as a part of implementing the strategy (Laamanen & Tinnilä 2009: 57).

The process differs from the project by having ongoing activity throughout the development of an organization's operations while the project has a definite starting and ending point. In addition, projects are defined as strictly organized and limited development targets with an objective, a result and a schedule in accordance with

available resources. Projects are also the way to execute and control processes. Within resource allocation a projects objectives can be achieved. (Laamanen & Tinnila 2009: 24.)

### 2.1.4 Knowledge and Technology

Technology does not have an unambiguous definition, since it should not be defined too narrowly as utensils and machines. According to Britannica (2008), technology is defined as "the application of scientific knowledge to the practical aims of human life or, as it is sometimes phrased, to the change and manipulation of the human environment". Alternatively, Braun (1998) defined the technology as "the material artefacts used to achieve some practical human purpose and the knowledge needed to produce and operate such artefacts". Given that aim, technology, as used in this research, means the processes by which an organization transforms labor, capital, material, and information into products and services of greater value.

The increasing role of technology brings vast opportunities as well as threats and substantial requirements to an organization since they must be able to continuously adapt to the technical requirements of the market. Technology has also been linked to an opportunity of gaining competitive advantage when the decision maker's improvement recommendations are integrated into the strategy. All things considered, it is a source of business development, growth, profit, and competitiveness. (Takala, et al. 2013b: 45–46.) According to Mäntynen (2009), four factors are playing a role in achieving sustainable competitive advantages: core competence, time compression, continuous improvement, and relationships. Core competence helps organizations to differentiate themselves from their competitors. Time compression means cutting, for example production and delivery times, to achieve the customers' expectations on fast delivery without the cost of lower quality of services. Continuous improvement comes from a mindset of "an organization can never be satisfied enough about its products and services because someone is always trying to do it better". Finally, relationship means networking due to the synergy benefits as well as in order to create even better services and products.

According to Lubit (2001: 166–167) knowledge is defined as information that is difficult to express, formalize or share and it can be related to intuition. Sustainable competitive advantage requires knowledge and intellectual capital as the primary basis of core competencies. Knowledge must be spread within the organization in order to achieve a sustainable competitive advantage, since poorly distributed knowledge has a limited impact on value creation. Knowledge is simultaneously always a risk since it can spread to other organizations and become the industry's best practice instead of one's own competitive advantage. Therefore, in order to achieve sustainable competitive advantage knowledge, skills, and resources should be relatively easy to share inside the company but difficult for other firms to copy. (Lubit 2001: 164–166.)

Different types of technologies are defined by the stage in their life cycle. According to Tuominen, Rinta-Knuutila, Takala and Kekäle (2004: 10–11), there are three different types of technologies: basic-, core-, and spearhead technology. Figure 5 illustrates the types of technologies with the connection between technology and its life cycle.

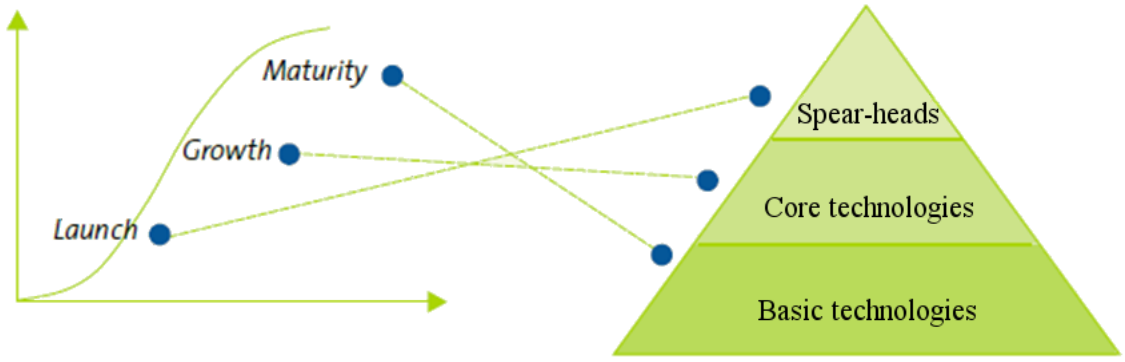



Figure 5. The linkage between the technology levels, technology pyramid, and technology life cycles (Tuominen et al. 2004: 10).

Basic technology is referring to the most critical technologies for a business and these are the key foundations of a business. To prevent the knowledge from leaking to competitors these kinds of technologies are kept inside a company. Core technologies include technologies that bring competitive advantages over competitors and enable an

organization to grow. The spearhead technology focuses mainly on future and it is the most potential for bringing successful business opportunities in the future. (Tuominen et al. 2004: 10.) For example, a car's engine is seen as basic technology, it is the foundation of the car. Environmental stewardship is the core technology, which brings competitive advantages in the present and a self-driving car is a spearhead which focuses only on the future.

## 2.2 Research methodologies

This chapter focuses on the main research methodologies, which will be used in the research. The following sub-chapters, strongly linked to previous chapters, explain what these methodologies are and how they will be used in order to analyze data correctly. The sub-chapters are: The Analytical Hierarchy Process, Sense and Respond Method, Knowledge and Technology, RAL-concept, Manufacturing Business Strategy, and Sustainable Competitive Advantage.

### 2.2.1 The Analytic Hierarchy Process

The analytical hierarchy process (AHP) method is a multi-attribute decision instrument that allows considering quantitative and/or qualitative measures and integrating the different measures into single overall goal. The method was developed by Thomas L. Saaty in the 1970s. (Saaty 1980.) The purpose of the AHP is to assist people in organizing their thoughts and judgements to make more effective decisions. Furthermore, Saaty (2008) states that to accomplishing an organized way to make decision, there is an inescapable need to determine and realize all the important factors affecting the decision. This means avoiding simplifying assumptions that leave out significant factors and taking all the controlling factors into consideration.

Saaty (2008) decomposes the decision into the following four steps in order to make an organized decision to generate priorities.

1. Define the problem and determine the necessary knowledge.
2. Structure the decision on hierarchy from the top with the goal of the decision, then the objectives from a broad perspective, through the intermediate levels to the lowest level, which usually is a set of the alternatives.
3. Construct a set of pairwise comparison matrices. Each element in an upper level is used to compare the elements in the level immediately below with respect to it.
4. Connect the comparisons to obtain the priorities of the alternatives with respect to each criterion and the weights of each criterion with respect to the goal.

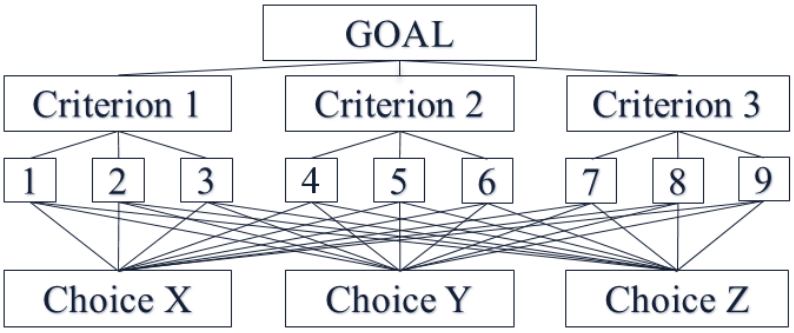



Figure 6. AHP structure.

Figure 6 illustrate the AHP method in a structured hierarchy perspective. Firstly, the problems are defined and the main goal is accountable for these problems. The middle level presents the objectives from a broad perspective, having a set of alternatives. All these alternatives and objectives determine the overall goal which will settle the problems. After the structure is completed, the attributes are compared in pairs among themselves. The aim of the pair-wise comparison is to compare the relative importance of the two attributes, their order and the likelihood of each of them in terms of the objectives. In other words, each attribute is compared to every other attribute by using a scale of 1-9, whilst obtaining a numerical weight. Overall, AHP is a very flexible method of decision making since there is no one right way to form the hierarchy. The decision maker can decide itself how to create a hierarchy that fulfils every need and viewpoint.

### 2.2.2 Sense and Respond Method

Modern organizations are moved from the traditional make and sell concept models towards a sense and respond way of thinking. The focus of the make and sell concept model was predicting customers' needs and then adapting production and inventory to meet the forecasts. The Sense and Respond method relies on real-time sensors of a customer's needs. (Bradley & Nolan 1998.) The Sense and Respond (S&R) method was firstly described by Haeckel (1992) in 1992, but developed further by Bradley and Nolan (1998), and Markides (2000) for targeting methods to analyzing dynamic business strategies. Moreover, S&R is a widely customizable industrial operational strategy to deal with the current turbulent business environment (Takala et al. 2013b: 47). The main idea of S&R philosophy is the implementation of the best action in a turbulent business environment by detecting changes (sensing) and reacting to them properly (responding). In other words, the method helps organizations to expect, foresee, adapt, and respond to continuously changing business environment situations by converting threats into opportunities and drawbacks into strengths. (Takala et al. 2013b: 47.) The method is the starting point to implementing sustainable competitive advantage (Ranta & Takala 2007).

The Sense and Respond method was utilized by Ranta and Takala (2007) in an operative management system by introducing the Critical Factor Index (CFI). "The CFI method is a measurement tool to indicate which attribute of a business process is critical and which is not, based on the experience and expectations of the respondents" (Ranta & Takala 2007). The CFI is a supporting tool for the strategic decision-making and helps managers make decision fast and react better. Furthermore, the S&R model within the CFI method has gone through three stages of development, which are called the BCFI model (Balanced Critical Factor Index model), the SCFI model (Scaled Critical Factor Index model), and the latest NSCFI model (New Scaled Critical Factor Index) (Liu, Wu, Zhao & Takala 2011: 1012). All stages can be used in a research and a purpose of one stage differs to another. Generally S&R method makes it possible to gather data from the organization regarding employees' expectations and experience and how they see themselves compared to competitors by using a specific questionnaire (Ranta & Takala 2007).

The questionnaire's structure was developed by Ranta and Takala and it consist of four phases which are demonstrated in Tables 1 and 2. A respondent evaluates both, expectation and experience in a scale of 1 (low) to 10 (high) and the direction of development (both, experience and expectations) by using a scale of "Worse", "Same", and "Better". In the fourth phase the respondent will compare its own organization's performance to competitors by using the same criteria as in the previous phase.

Table 1. Format of questionnaire (part 1).

| ATTRIBUTES | Scale: 1=low, 10=high | | Compared with competitors X | | |
|---|---|---|---|---|---|
| | Expectation | Experience | Worse | Same | Better |
| Performance 1 | | | | | |
| Performance 2 | | | | | |

Table 2. Format of questionnaire (part 2).

| ATTRIBUTES | Direction of development, experiences (past) X | | | Direction of development, expectations (future) X | | |
|---|---|---|---|---|---|---|
| | Worse | Same | Better | Worse | Same | Better |
| Performance 1 | | | | | | |
| Performance 2 | | | | | | |

In order to analyze the questionnaires data, the following equations (1) – (8) are used in the calculations of CFI, BCFI, SCFI and NSCFI models (9) – (12).

**Importance Index** – presents the level of importance of a criterion amongst others. This index reflects the actual expectations of the company regarding a criterion (Takala et al. 2013b: 49).

$$\text{Importance Index} = \frac{\text{Avg}\{\text{expectation}\}}{10}. \quad (1)$$

**Gap Index** – helps to understand the gap between experience and expectations of a specific criterion (Takala et al. 2013b: 49).

$$\text{Gap Index} = \left|\frac{\text{Avg}\{\text{experience}\} - \text{Avg}\{\text{expectation}\}}{10} - 1\right|. \quad (2)$$

**Development Index** – demonstrates the actual direction of the company's development, the positive or negative change of a criterion's performance (Takala et al. 2013b: 49).

$$\text{Development Index} = |(\text{better}\% - \text{worse}\%) * 0.9 - 1|. \quad (3)$$

**Performance Index** – reflects the value of a criterion's performance based on the real experiences of the informants (Takala et al. 2013b: 49).

$$\text{Performance Index} = \frac{\text{Avg}\{\text{experience}\}}{10}. \quad (4)$$

**Standard deviation of experience** – reflects the evidence if the informants have a similar answer or controversial meaning regarding to one attribute for what they have experienced (Takala et al. 2013b: 49).

$$\text{SD Experience Index} = \frac{\text{Std}\{\text{experience}\}}{10} + 1. \quad (5)$$

**Standard deviation of expectation** – reflects the evidence if the informants have similar answer or controversial meaning regarding to one attribute for what they expect (Takala et al. 2013b: 49).

$$\text{SD Expectation Index} = \frac{\text{Std}\{\text{expectation}\}}{10} + 1. \quad (6)$$

**Gap Index'** – is improved Gap Index for NSCFI.

$$Gap\ \text{Index}' = 2^{\frac{\text{Avg}\{\text{expectation}\} - \text{Avg}\{\text{experience}\}}{10}}. \quad (7)$$

**Development Index'** – is improved Development Index for NSCFI

$$\text{Development Index}' = 2^{(\text{worse\%} - \text{better\%})}. \quad (8)$$

After the raw data has been exposed to the previous equations, it will be analyzed by the equations of CFI, BCFI, SCFI, and NSCFI models which are listed as follows (9) – (12).

**Critical Factor Index (CFI)** –is a measurement tool to indicate which attribute of a process is critical and which is not, based on the experience and expectations of informants. The CFI was introduced by Ranta and Takala (2007).

$$\text{CFI} = \frac{\text{Std}\{\text{experience}\} * \text{Std}\{\text{expectation}\}}{\text{Importance Index} * \text{Gap Index} * \text{Development Index}}. \quad (9)$$

**Balanced Critical Factor Index (BCFI)** – is the most useful and used index in order to define the most critical factors which have a significant influence on the overall organization's performance (Takala, Shylina, Forss & Malmi 2013a). The BCFI method was developed in the University of Vaasa 2010 by taking the principle of the CFI theory into consideration (Takala et al. 2013a).

$$\text{BCFI} = \frac{\text{SD Expectation Index} * \text{SD Experience Index} * \text{Performance Index}}{\text{Importance Index} * \text{Gap Index} * \text{Development Index}}. \quad (10)$$

**Scaled Critical Factor Index (SCFI)** – the main purpose is to solve the problems when the informants sample is too narrow and limited. Liu et al. (2011) developed the SCFI model that accurately models the S&R theory.

$$\mathrm{SCFI} = \frac{\sqrt{\frac{1}{n}*\sum_{i=1}^{n}[\mathrm{experience(i)}-1]^2}*\sqrt{\frac{1}{n}*\sum_{i=1}^{n}[\mathrm{expectation(i)}-10]^2}*\mathrm{Performance\ index}}{\mathrm{Gap\ index}*\mathrm{Development\ index}*\mathrm{Importance\ index}}. \quad (11)$$

**New Scaled Critical Factor Index (NSCFI)** – is an improved model based on the earlier SCFI model, developed by Liu and Liang (2015: 1026–1027).

$$\mathrm{NSCFI} = \frac{\sqrt{\frac{1}{n}*\sum_{i=1}^{n}[\mathrm{experience(i)}]^2}*\sqrt{\frac{1}{n}*\sum_{i=1}^{n}[\mathrm{expectation(i)}-11]^2}*\mathrm{Performance\ index}}{\mathrm{Gap\ index}\prime*\mathrm{Development\ index}\prime*\mathrm{Importance\ index}}. \quad (12)$$

In order to limit the data range to a more reasonable level, the gap index and development index are modelled with an exponential function in the NSCFI. The gap index within small samples in the CFI/ BCFI/SCFI models can cause multiplying by 0.1 or 10, which might mislead the interpretations. Furthermore, the data boundary is non-inclusive (0, 11) in the NSCFI, whereas the data boundary is inclusive [1, 10] in the SCFI. This preserves the output data validity when the input data is reaching the extreme boundary.

### 2.2.3 Knowledge and Technology

Emphasis has shifted significantly from the traditional risk management, which can be defined as various modes of "protecting the system and its users from the failures in the system", towards uncertainty management, since uncertainty can provide both opportunities as well as dangers to the performance of the system (Takala & Uusitalo 2012). In order to study the impact of technology and knowledge on uncertainty in the investment decision making process and apply knowledge and technology to the Sense and Respond method, respondents are required to assess the share of basic, core, and spearhead technologies in percentages for each attribute while the summation of the three terms should be 100 per cent (Takala et al. 2013b: 48). Format of the Knowledge and

Technology (K/T) questionnaire, which is a part of the S&R questionnaire, is demonstrated in Table 3.

Table 3. Format of the T / K questionnaire's phase.

| ATTRIBUTES | Knowledge / technology requirement | | |
|---|---|---|---|
| | Basic % | Core % | Spearhead % |
| Performance 1 | | | |
| Performance 2 | | | |

First, the K/T-data is analyzed by comparing the BCFI values to the BCFI K/T values, where Table 4 provides formulas for calculating the values of the BCFI K/T for each attribute, since the color of the attribute is taken into consideration when the purpose is to highlight the dominating technology. The dominating technology is an attribute with a value more than 43% or the one with the highest value (Takala 2012). The relationship between BCFI and BCFI K/T observes resource allocation from the perspective of K/T.

Table 4. Technology Rankings: General formulas (Takala et al. 2013b: 48).

| | RED attributes | YELLOW attributes | GREEN attributes |
|---|---|---|---|
| *Basic* | (B)CFI / (B% / 100) | (B)CFI * (B% / 100) | (B)CFI / (B% / 100) |
| *Core* | (B)CFI * (C% / 100)$^2$ | (B)CFI / (C% / 100) | (B)CFI * (C% / 100)$^2$ |
| *Spearhead* | (B)CFI * (SH% / 100)$^3$ | (B)CFI / (SH% / 100)$^2$ | (B)CFI * (SH% / 100)$^3$ |

This research also exploits a sand cone model in order to compare K / T attributes to each other. The sand cone model illustrates the studied object by showing its hierarchies as well as the relative importance and relationship of the sub-objects. Internally crucial factors for the organization are placed in the bottom of the structure and they are a base for value creation. The rest of the factors are then placed on this base. The top of the

model shows the customer-oriented factors that result from internal factors. (Takala, Leskinen, Sivusuo, Hirvelä & Kekäle 2006: 338.) The sand cone model exploits the analytical hierarchy process in order to detect crucial factors by their value weights.

An original version of the sand cone model was presented by Ferdows and De Meyer (1990). The model was created to ameliorate organizations' manufacturing strategies by analyzing four different and important capabilities: quality, dependability, speed and cost-efficiency. The original version is presented in Figure 7, where quality is at the bottom of triangle as a corner stone. Dependability is the second layer and the following layer is speed. Finally comes cost-efficiency as an ultimate goal, which means it is the most visible and external factor, and doesn't have great influence on the stability of the structure. On the contrary, cost efficiency is the result of quality, dependability and speed factors. (Takala et al. 2006: 338–339.)

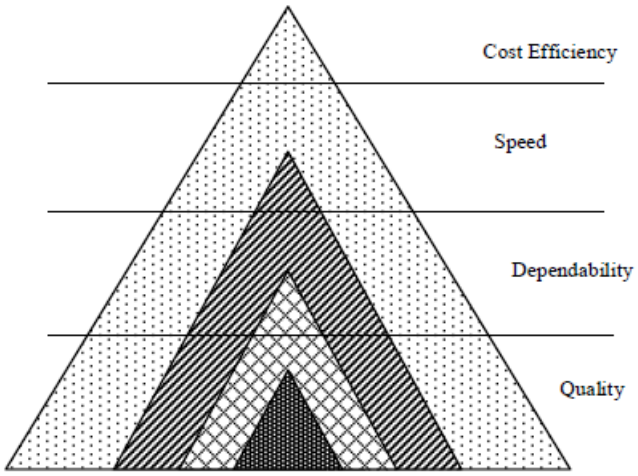



Figure 7. The original sand cone by Ferdows and De Meyer (Takala et al. 2006: 338).

The sand cone model emphasizes how development should always start from the bottom of the model in order to achieve the best overall performance. Eventually, development based on the sand cone model must have a positive effect towards the top of the model, for example in cost efficiency. Otherwise, the model is not working properly according to its principles. (Niemisto & Takala 2003: 102.)

The sand cone model can be used also as an uncertainty illustrator. Questionnaires data's uncertainty is determined with the help of the aforementioned knowledge and technology rankings (K/T) from which variability coefficients are calculated using the following equation. (Takala et al. 2006: 338–339.)

$$\text{Var } C_{C1,C2,C3,C4} = \sqrt{\sum_{i=B,G\ SH}^{C1,(C1,C2,C3,C4\ldots)} \left(\frac{std_i}{mean_1}\right)^2}. \quad (13)$$

Furthermore, the variability coefficients results are inserted to the sand cone model in a form of risk that can cause a collapse in the model's layers. These collapses may happen due to the different technology and knowledge requirements of the different departments which are competing for the same investment budget. In addition, a figure can be calculated from the variability coefficients determining the amount of K/T affected risk in each group. This figure is called T&K –uncertainty and it describes how much in general the department "falls" under its competitive range when the T&K risk estimate materializes. The equation for the T&K–uncertainty is illustrated below. (Takala et al. 2006: 338–339.)

$$\text{T\&K} - \text{uncertainty} = \sqrt{\sum_{i=C1,C2,C3,C4..} \text{Var } C_i^2}. \quad (14)$$

Hereafter, when K/T – uncertainties are calculated, the AHP is used to weigh the investment criteria. Calculated variability coefficients depicting the uncertainties are placed to the sand cone model to illustrate the weighted criteria and collapse risk caused by the uncertainty. Figure 8 demonstrates the sand cone model within three departments and four investment criteria. Selected criteria are organized to the model based on the criteria that is crucial for the department. Hereafter, the variability coefficients are added to the sand cone model in the form of collapses (the darker grey color). Criteria within over 100 percent variability question the whole evaluation based on that criterion. The right side of the model presents the T&K –uncertainty i.e. the total uncertainties as well as the graphical illustrations of the possible collapses of the department's sand cone. (Takala et al. 2016.)

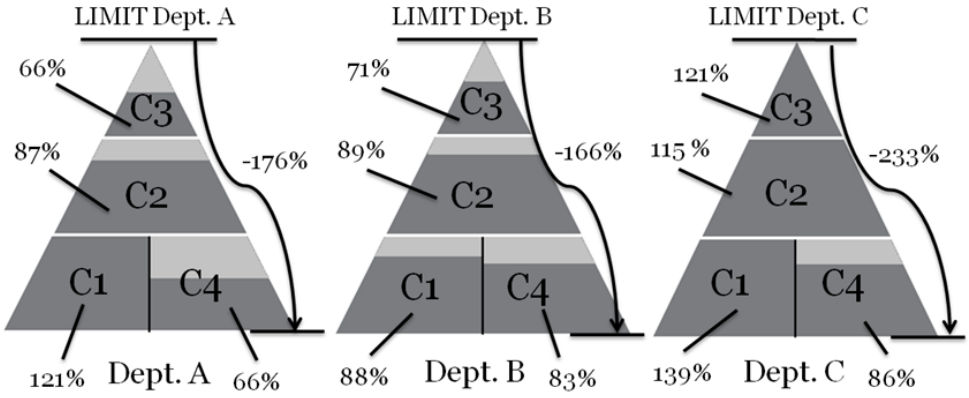



Figure 8. The Sand Cone Models with K/T collapse risks (Takala, Zucchetti, Daneshpour, Kunttu, Välisalo, Pirttimäki & Kiiski 2016: 29).

In order to create the sand cone model, there are two possible ways to proceed. Either to connect the basic, core and spearhead technology weights directly to the model or to calculate variability coefficients from the technology levels. The latter was evaluated to be better in measuring the uncertainty related to decision making and has more potential considering the calculations. (Zucchetti 2016: 40.)

### 2.2.4 RAL Concept

The RAL model is a holistic and a multi-focused manufacturing strategy model based on business goals, which are proposed as the theoretical foundation to build normative models. The RAL was originally created by Takala (2002) for measuring and understanding the success factors in logistics, but later extended to all operations strategies and operations management. The RAL model was embraced by Takala, Kamdee, Hirvelä and Kyllonen (2007) to support the Business strategy related to the manufacturing strategy. The RAL model contains factors' responsiveness, agility and leanness, which is illustrated in Figure 9. An Organization achieves its optimization of the RAL model components by prioritizing between cost, quality, time and flexibility. (Takala et al. 2007.)

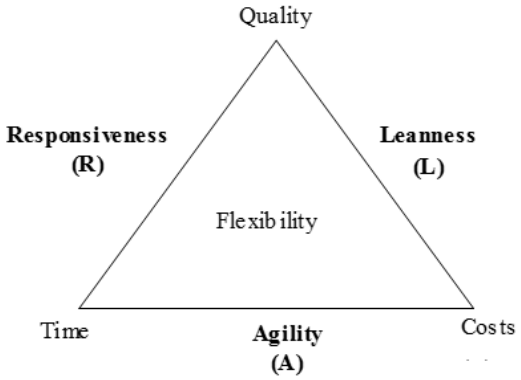



Figure 9. RAL model (Takala et al. 2007).

The RAL model is demonstrated in Figure 9, in a shape of a pyramid to review the manufacturing strategy. The components are described in more detail below (Takala et al. 2007).

**Responsiveness** – is the "speed by which the system satisfies unanticipated requirements" (Takala et al. 2012). According to Holweg (2005), an organization's responsiveness is the ability to purposefully react and fulfill its customer requests within the boundaries of promised time and cost. Furthermore, the responsiveness of an organization is achieved through its sensitivity to respond to environmental (market) demands and flexibility of its managers and leaders. (Gomez-Gras 2009.)

**Agility** – is the "speed by which the system adapts to the optimal cost structure" (Takala et al. 2012). According to Yauch (2011), agility is the ability of an organizational unit to succeed in turbulent and competitive environmental conditions. To be agile, organizations need to adopt and continuously improve the flexibility of their operations and processes. The agility of processes leads to on time delivery to diversified customer demands for products and quality at optimal costs.

**Leanness** – is to "minimize waste in all resources and activities" (Takala et al. 2012). According to Senaratne (2008) leanness starts with the minimization of waste while negating it from the value chain of the product or project delivery systems. Minimizing

the material waste or process waste enables the organizations to deliver at desired quality with a cost advantage over its competitors. Unnecessary inspections and quality checks are a waste of process time. During the construction phase, poor material handling or wrong supply of items account for wastage. Adaptation of leanness can be an answer to deliver the quality projects at a customer satisfying price.

**Flexibility** – is "the ability of any system to adopt to the changing environmental conditions, in terms of cost, time, quality and organizational disruption". According to Slack (2005), flexibility in combination with processes and organizational activities provide the ability to anticipate in uncertain environments, which eventually results in a competitive advantage. Constraints, such as costs and time, hinder the system response to fulfil customer demanded quality. Any system which transforms to a new state quickly and smoothly within the organizational disruption is called a flexible system. More flexibility in the manufacturing operations enable organizations to react to changing customer needs, respond to competitive pressure, and positive presence in the market. (Slack 2005.)

### 2.2.5 Manufacturing Business Strategy

Organizations continuously make decisions mostly on resource allocation in order to succeed in the market in long-term. Therefore, based on these decisions, organizations can determine their position in the market by defining their operational strategy. The manufacturing strategy has an important role in this situation. The concept of manufacturing strategy was defined by Skinner (1969) as a model which evaluates the competitive priorities of an organization in order to reach a competitive advantage in the current market. These competitive indexes of companies belong to different competitive groups such as analyzers, defenders, prospectors and reactors (Miles & Snow 1978).

According to Takala et al. (2007), the Manufacturing Strategy Index (MSI) is supported by the RAL (Responsiveness, Agility and Leanness) model by taking four main criteria into consideration, cost (C), quality (Q), time/delivery (T) and flexibility (F), which are

evaluated with the help of the AHP method mentioned above. The MSI is presented as function

$$\mathrm{MSI} = \mathrm{fMSI}\,(\mathrm{Q}, \mathrm{C}, \mathrm{T}, \mathrm{F}), \tag{15}$$

where Q stands for quality, C for cost, T for time and delivery, and F stands for flexibility.

Figure 10 demonstrates different positions of an organization considering their operation strategy. Prospector is located at the top of the triangle where the quality attribute is located in the RAL model. Analyzer is located on the right angle of the triangle where the cost weight value is the most important. Defender and Time are located on the left of the triangle.

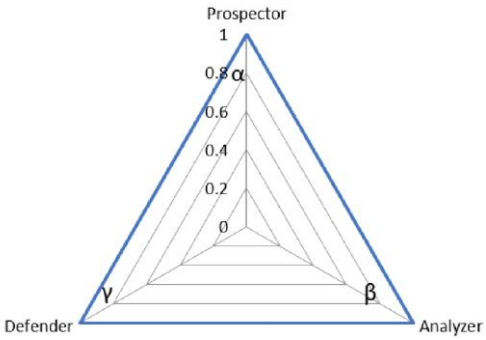



Figure 10. Manufacturing business strategy.

To calculate the MSI, there is a need for knowing all the basis equations which are introduced below. The equations to calculate normalized weights of core factors, competitive priorities, are as follows (Liu 2013: 2827).

$$\mathrm{Q}' = \frac{\mathrm{Q}}{\mathrm{Q}+\mathrm{C}+\mathrm{T}}, \tag{16}$$

$$\mathrm{C}' = \frac{\mathrm{C}}{\mathrm{Q}+\mathrm{C}+\mathrm{T}}, \tag{17}$$

$$T' = \frac{T}{Q+C+T}, \tag{18}$$

$$F' = \frac{F}{Q+C+T+F}, \tag{19}$$

where Q stands for quality, C for cost, T for time and delivery, and F stands for flexibility.

The next equations stand for the analytical models that provide the calculations of MSI of operational competitiveness in each group.

According to Liu (2013: 2827), the analytical model to calculate the MSI model for a Prospector is presented in equation (20) while Figure 11 demonstrates the operation strategy of a prospector's manufacturing business strategy in a form of a triangle.

$$MSI_P = 1 - \left(1 - Q'^{\frac{1}{3}}\right) * (1 - 0.9 * T') * (i - 0.9 * C') * F'^{\frac{1}{3}}, \tag{20}$$

where Q' is the normalized quality, T' is the normalized time, C' is the normalized cost, and F' is the normalized flexibility.

According to Liu (2013: 2827), the analytical model of calculating the MSI model for a Defender is presented in equation (21) while Figure 11 demonstrates the operation strategy of a defender's manufacturing business strategy in a form of a triangle.

$$MSI_D = 1 - \left(1 - C'^{\frac{1}{3}}\right) * (1 - 0.9 * T') * (i - 0.9 * Q') * F'^{\frac{1}{3}}. \tag{21}$$

According to Liu (2013: 2827), the analytical model to calculate the MSI model for an Analyzer is presented in equation (22) while Figure 11 demonstrates the operation strategy of an analyzer's manufacturing business strategy in a form of a triangle.

$$\mathrm{MSI_A} = 1 - (1 - \mathrm{F}') * \left( \mathrm{abs} \begin{Bmatrix} (0.95 * \mathrm{Q}' - 0.285) * \\ (0.95 * \mathrm{T}' - 0.285) * \\ (0.95 * \mathrm{C}' - 0.285) \end{Bmatrix} \right)^{\frac{1}{3}}. \quad (22)$$

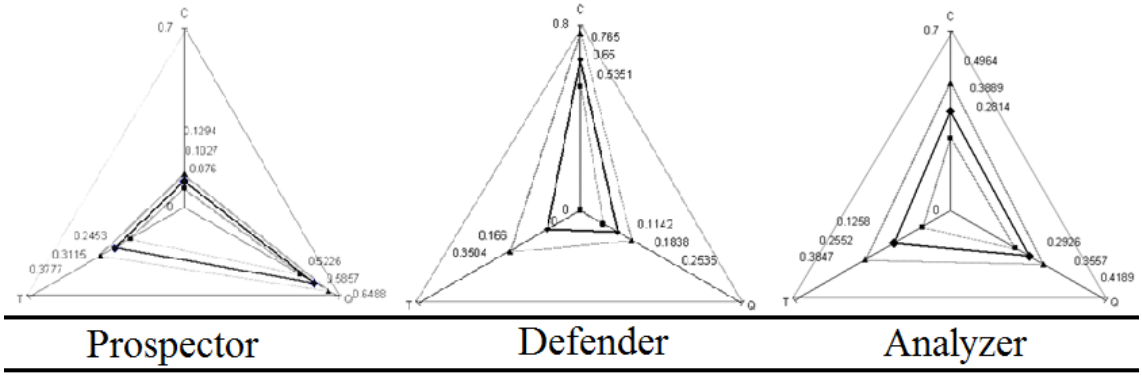



Figure 11. Operations strategies.

Figure 11 demonstrate the differences between each operations strategies in the RAL - model. For example, the prospector is focusing on more quality factor than to any other factors. Alternatively, the defender strategy is focusing on cost factor and the analyzer strategy focus is distributed to each factor.

### 2.2.6 Sustainable Competitive Advantage risk level

The sustainable competition advantages risk level method (SCA) is a risk measurement tool to estimate the functionality of the operations strategy. This tool helps understand if a company's internal resource allocation supports the company's strategy. For measuring the company's risk level of the operation strategy, the research uses three different indexes, which are Mean Absolute Percentage Error (MAPE), Root Means Squared Error (RMSE), and Maximum Deviation (MAD). (Takala et al. 2013b: 50; Takala et al. 2013c: 57–58.)

The SCA equations are designed to utilize the angle values, as they more accurately reflect the direction of strategy implementation. The SCA values are between 0 – 1 and

therefore, the closer the risk value is to number one, the better it is. Closer to 0 means that the current strategy is not stable and there is a possibility of collapse. The following equations obtain data from CFI, BCFI, SCFI, NSCFI, and AHP. (Takala et al. 2013b; Takala et al. 2013c 57–58.)

MAPE (Mean absolute percentage error) – is a measure of prediction accuracy of a forecasting method in statistics (Takala et al. 2013: 63).

$$\mathrm{MAPE} = \mathrm{SCA} = 1 - \sum_{\alpha,\beta,\gamma} \left| \frac{\mathrm{BS}-\mathrm{BR}}{\mathrm{BS}} \right|, \tag{23}$$

where B refers to the angel in radians and S refers to operations priorities strategy (MSI), and R refers to the S&R (BCFI) resource allocation, either in the past or future.

RMSE (root means squared error) – is a frequently used measure of the differences between values (sample and population values) predicted by a model or an estimator and the values actually observed (Takala et al. 2013: 63).

$$\mathrm{RMSE} = \mathrm{SCA} = 1 - \sqrt{\sum_{\alpha,\beta,\gamma} \left( \frac{\mathrm{BS}-\mathrm{BR}}{\mathrm{BS}} \right)^2}. \tag{24}$$

MAD (maximum deviation) – the average distance of each data value from the mean (Takala et al. 2013: 63).

$$\mathrm{MAD} = \mathrm{SCA} = 1 - \max_{\alpha\beta\gamma} \left| \frac{\mathrm{BS} - \mathrm{BR}}{\mathrm{BS}} \right|. \tag{25}$$

# 3 EMPIRICAL RESEARCH

The current chapter describes the empirical research- steps and findings in the case company's Southern Finland's Residential Project Development. The chapter has been dived to four main sub-chapters: "Overview of the research- and analysis process", "Data processing and analysis", "Findings", and "Summary". The main role of the chapter is to show how the methods are utilized as well as to present the findings of the research.

## 3.1 Overview of the research- and analysis process

The research includes multiple phases in order to gather data and to provide valuable information towards resource allocation. Firstly, the Residential Project Development will be presented and divided to smaller entities. Then respondents are delimited and finally, questionnaires' attributes are modified and new attributes are presented in order to get more suitable data for the research.

Figure 12 is an overview of the research's phases in general. The research starts from collecting knowledge from theories and scientific literature in order to gain sophisticated knowledge on the subjects (phase 1. "Data collection"). This phase also involves editing questionnaires to correspond to the Residential Project Development's needs. The questionnaires will be tested with the Acid-test before research can continue to collecting data from the respondents. The second phase, "Answers from Questionnaires" involves collecting raw data from the respondents by questionnaires. The third phase, "Analysis of Raw Data" analyze data by using the aforementioned equations. For example, a great discrepancy ratio will lead to the rejection of data. The fourth phase, "The Analytical Evaluation" involves MSI evaluation and other necessary evaluations, such as S&R, SCA and K/T. The fifth phase, "Correlation analysis" involves the previous phases' analytics and their correlation with each other (by Residential Project Development phases and together). The sixth phase, "Development analysis" propose additionally critical processes and resources. Moreover, the results from the sixth phase are introduced to at least one respondent from each phase and their opinions are collected. The method is

called the Weak Market Test (WMT) which is used in order to understand how the calculated results meet reality. The final phase, "Conclusions" involves assessments and suggestions improvements for the RPD process based on the data.

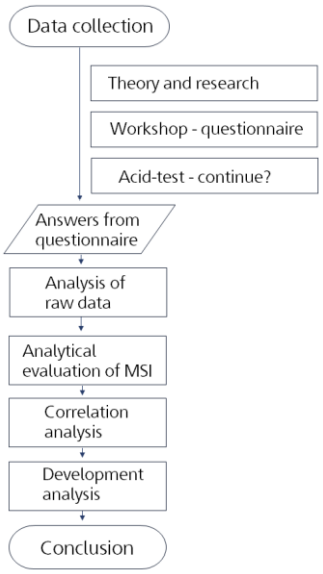



Figure 12. The research process.

The research involves a couple of boundaries which affect the final outcome. Firstly, the data is collected from a micro level excluding a macro level from the study and it focuses on Southern Finland on a regional basis. Additionally, the research focuses more on the BCFI and NSCFI models in order to gain the best possible analysis. This is because the BCFI is the most useful and used index in order to define the most critical factors which have a significant influence on the overall performance of an organization (Takala, Shylina, Forss & Malmi 2013a). The NSCFI is the improved model having the purpose of solving problems when the respondents sample is too narrow and limited.

### 3.1.1 Residential project development

The Residential Project Development's core element is to improve and implement improvements to the whole concept in order to gain a continuous improvement cycle. The

process is wide and for that reason it is divided into five phases which are presented in Figure 13. The content of these phases are explained below.


Figure 13. Residential Project Development divided into five phases.

In the **Land Acquisition** phase, land areas are analyzed and compared to the current plot strategy. When the analysis shows that the studied area fulfils investment proposal requirements for the qualitative, structural, and economic perspective, the project gets an opening shot. Running time is difficult to define. (The case company 2017.)

The **Project- and sketch design** phase contains the basic results of a project plan workshop where contents of the object (technical issues, cost, quality level, return level, and the target group) are defined. A whole process team and a foreman participate and commit themselves to the project plan, which is the backbone of the project. Costs and profitability are evaluated regularly. A project plan is drawn up based on the proposal for plans and they are modified until the result is good. Targeted duration is approximately four months. (The case company 2017.)

The **Preparation of construction** phase includes a proposal for the basic plans and main tasks, which have been calculated. Apartments layout plans, apartment inventory and the equipment level will be locked. Apartments are priced preliminary for a Pre-marketing phase and marketing materials are prepared. Targeted duration is approximately four months. (The case company 2017.)

In the **Pre-marketing** phase, a project's web-site will be published and advertising is started in different media. Targeted duration is approximately four months. (The case company 2017.)

The **Sale and implementation** phase includes selling the residences to customers and the start of the construction phase. Targeted duration is approximately eighteen months. (The case company 2017.)

Figure 14 demonstrate simplified timeline for the Residential Project Development's process. The duration of the first phase is almost impossible to estimate since it is specific for each project. The target duration of the other phases in general are marked in months, for example the Pre-marketing phase takes approximately four months before sale and construction can begin. The whole process takes a total of approximately 30 months without the Land acquisition phase.

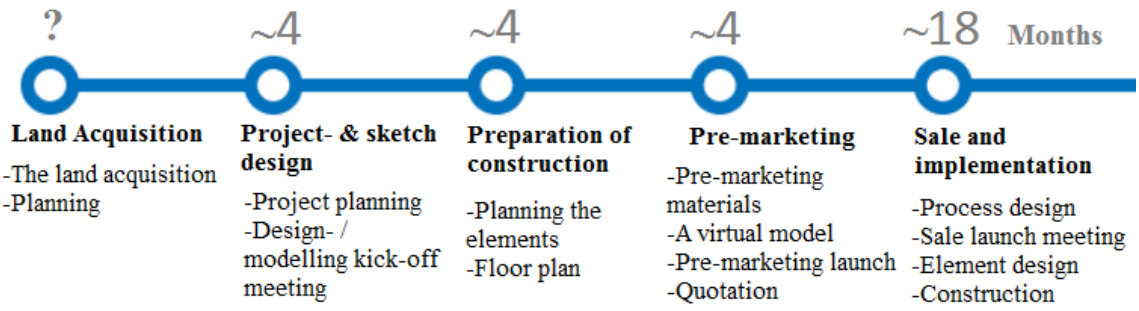



Figure 14. Residential Project Development timeline.

To understand the total cost of a residential project, the reader should know how the costs have been divided in an indicative project (Figure 15). It is important to notice that the construction, labor and raw material segment is the biggest expenditure, followed by taxes. The actual cost varies completely depending on a project to project.

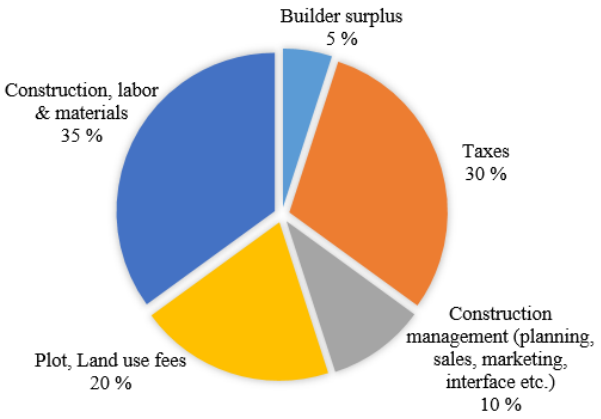



Figure 15. How a residential project costs are divided (the case company 2017).

### 3.1.2 Respondents

The respondents are divided into five groups, which are correspondent to the Residential Project Development phases. Each group contains at least three respondents and the total number of respondents will be 16. The groups will be investigated together and separately in order to gain overall knowledge. In this case, suggestions of improvements will be easier to target to specific groups. Respondents will give data from both sides, from the case company's perspective and also from their competitor's perspective. The following Table 5 shows the precise amount of respondents per phase. The number of respondents is affected by the number of employees involved in that particular phase, whereby the number of respondents differs between the phases.

Table 5. Amount of respondents by groups.

| Group number | Respondents group | Amount |
|---|---|---|
| 1 | Land acquisition | 3 |
| 2 | Project & sketch design | 3 |
| 3 | Preparation of construction | 3 |
| 4 | Pre-marketing | 3 |
| 5 | Sale and implementation | 4 |
| | Total | 16 |

In general, the most respondents' job titles are Director, Manager, or Developers' Agent. The respondents' high competence and expertise should be a representation of their knowledge on the operations of the studied divisions. In addition, certain kinds of boundaries are set for the respondents in order to forestall their personal opinions and the professional qualifications of the interviewees. These boundaries are:

1. Experience in the construction industry for at least three years.
2. Experience of competing companies.
3. Are working with the Residential Project Development process daily.
4. Are in accountable positions and are able to observe the process from various perspectives.

### 3.1.3 Questionnaire

The research exploits two different questionnaires in order to analyze the Residential Project Development comprehensively. These questionnaires are the AHP questionnaire and the Sense and Respond questionnaire, which are explained below. The S&R questionnaire includes two sections, the first evaluates the division's daily operations (OP), and the second evaluates activities in a more general level (BSC). According to Kaplan and Norton (2005) a BSC (Balanced Score Card) helps companies answer critical performance questions such as 'How customers see the company in general?', 'What we must distinguish in ourselves?', and 'How can the company continue to improve, develop and create additional value?'. The basic research attributes for these questionnaires comes from Takala et al. (2013b), which are verified and validated to work in an operation strategy environment. Data is collected either using interviews (face to face) or respondents have answered questionnaires by themselves via email which includes precise guidelines for filling the questionnaires.

The basic questionnaire attributes were presented to the case company's employees in order to collect their opinions about the attributes suitability to this research. Within the workshop, the questionnaires were tailored to be more suitable for the research project development process. They proposed a new additional project category to include the

basic attributes in OP, in which case there were 10 categories totally (Figure 16). The categories have a total of 43 attributes, which are evaluated by respondents. Each attribute and category has a unique id-number, which are used in multiple figures and tables instead of the attributes' names. Additionally, respondents noticed a great need to go through a further more detailed explanation of each attribute since each respondent needs to understand these attributes similarly. From Figure 16, the S&R questionnaire's Operations Priorities (OP) part evaluates knowledge and technology management, processes and work flows, projects, as well as organizational and information systems. The Balanced Score Card (BSC) section has the division's external- and internal structure, learning and growth, trust, and business performance.

| **Information systems** | | **O4** | **Processes & Work flows** | | **O2** |
|---|---|---|---|---|---|
| Information systems support the business processes | ← Time | T3 | Short and prompt lead-times in order-fulfilment process | ← Flexibility | F3 |
| Visibility of information in information systems | ← Time | T4 | Reduction of unprofitable time in processes | ← Cost | C3 |
| Availability of information in information systems | ← Time | T5 | On-time deliveries to customer | ← Quality | Q1 |
| Quality & reliability of information in information systen | ← Quality | Q4 | Control and optimization of all types of inventories | ← Quality | Q2 |
| Usability and functionality of information systems | ← Quality | Q5 | Adaptiveness of changes in demands and in order backlog | ← Flexibility | F4 |
| **Organizational systems** | | **O3** | **Knowledge & Technology Management** | | **O1** |
| Leadership and management systems of the company | ← Cost | C4 | Training and development of the company's personnel | ← Flexibility | F1 |
| Quality control of products, processes and operations | ← Quality | Q3 | Innovativeness and performance of research and development | ← Cost | C1 |
| Well defined responsibilities and tasks for each operation | ← Flexibility | F5 | Communication between different departments and hierarchy level | ← Time | T1 |
| Utilizing different types of organizing systems | ← Flexibility | F6 | Adaptation to knowledge and technology | ← Flexibility | F2 |
| Code of conduct and security of data and information | ← Cost | C5 | Knowledge and technology diffusion | ← Cost | C2 |
| | | | Design and planning of the processes and products | ← Time | T2 |
| **Project** | | **O10** | **Learning and growth** | | **O7** |
| Quality is equivalent to expected level | ← Quality | Q11 | Know-how | ← Quality | Q9 |
| Cost management | ← Cost | C12 | Knowledge | ← Quality | Q10 |
| Projects are possible to implement in time | ← Time | T9 | Competence | ← Cost | C8 |
| Projects are enough flexible to conform changes | ← Flexibility | F11 | Engagement | ← Flexibility | F7 |
| **Business Performance** | | **O9** | **Trust** | | **O8** |
| Financial | ← Cost | C9 | Performance-to-promise | ← Time | T7 |
| Sales | ← Cost | C10 | Professional relationship | ← Time | T8 |
| Customer | ← Cost | C11 | Openness | ← Flexibility | F8 |
| | | | Benevolent colaboration | ← Flexibility | F9 |
| | | | Empathy | ← Flexibility | F10 |
| **External Structure** | | **O5** | **Internal Structure** | | **O6** |
| Customer satisfaction | ← Quality | Q6 | Process improvement | ← Time | T6 |
| Customer loyalty | ← Quality | Q7 | Innovation | ← Cost | C6 |
| Brand | ← Quality | Q8 | Information technology | ← Cost | C7 |

Figure 16. Questionnaires' attributes.

The AHP is used in this research to analyze the questionnaires and for calculating the weights of the main criteria's and sub-criteria's. The main criteria's are based on the manufacturing strategy and manufacturing capabilities and they are cost, quality, delivery, and flexibility. The AHP questionnaire's structure is demonstrated in Appendix 4. The AHP questionnaire is a pair-wise comparison questionnaire which uses a scale of

1 to 9 that ranges from equally important to extremely important. For example, a respondent will compare two different factors, A and B, in the pair-wise comparison. Figure 17 demonstrate AHP questionnaire's structure and Appendix 1 demonstrate entire AHP questionnaire which each respondent has answered. The AHP questionnaire has a major role in final analysis.

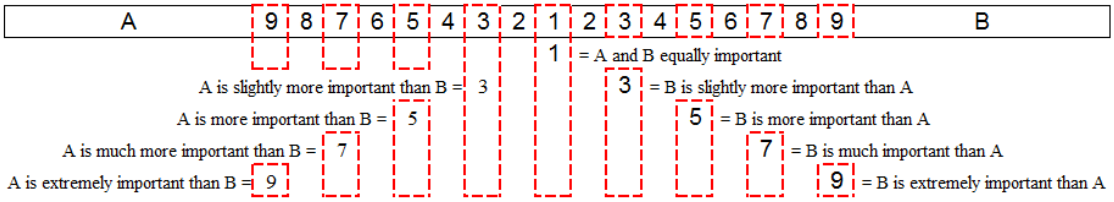



Figure 17. AHP pair-wise comparisons.

The second questionnaire, the Sense and Respond questionnaire, has to correspond to the MSI, RAL and S&R boundaries. The following questionnaire integrates the AHP topology into the S&R methodology, which is divided to the attributes from OP (Operations Priorities) and BSC (Balanced Score Card) questionnaires between the general points of RAL Model: cost, quality, time, and flexibility. The respondents were asked to evaluate each attribute in terms of expectations and real life experiences. Essentially, the questionnaires give more emphasis on which way the employees believe the attribute will develop within the next few years and how it has changed within the last few years. Furthermore, The S&R form's scale is from 1 to 10 which has been chosen to evaluate the different attributes. The relatively wide range makes it easier to point out inconsistencies between expectations and experiences. The list of attributes used in the S&R questionnaire can found in Appendix 2 and 4, and Appendix 3 presents the Sense & Respond response techniques which are shared among the respondents. In order to analyze the Knowledge and Technology section in the S&R questionnaire, the respondents named a couple of examples for each K/T level. Consequently, this made it easier for the respondents to fill in the questionnaires. Table 6 presents the respondents'

examples for the K/T levels where each attribute presents the current situation in the industry.

Table 6. K/T technology levels examples: Residential Project Development.

| | |
|---|---|
| **Basic Technology** | 1. Standardized operation<br>2. Personnel<br>a. Know-how<br>3. Customer focus |
| **Core Technology** | 1. Development<br>2. BIM (Building Information Models)<br>3. Sales Facilities |
| **Spearhead Technology** | 1. Self-healing Material<br>2. Advanced Building Material<br>3. IOT<br>4. 3D Scanning<br>5. Big Data & Analytic<br>6. Integrated BIM |

## 3.2 Data processing and analysis

The sub-chapter includes detailed steps for analysis of raw data. Some results are presented and the final comprehensive findings are in the next chapter including more details. Finally, the SCA risk levels are presented to show how well a division's resource allocation supports their business strategy.

Microsoft Excel 2013 software has been used for data processing which has been found to be suitable for this kind of research since similar studies have also taken advantage of this. In a perspective of Sense & Respond (S&R), the study will focus on the BCFI – and NSCFI models, which are the most useful and used indexes in order to define the most critical factors which have significant influence on the overall organization's performance. The NSCFI method is mostly used as the main method when analyzing each phase, since it is considered to be the most reliable in this situation due to the fact that the number of responses in each phase is limited and the sample is too narrow. The BCFI

method is utilized when the whole Residential Project Development is analyzed, since the number of responses is higher in each phase.

### 3.2.1 Acid-Test

Before the actual data can be collected, the questionnaires must be tested with the Acid-test. In the test, questions will be predisposed to the Acid-test, where a respondent's data is analyzed and the results are viewed with the respondent. In this way, we can be sure that questionnaires are suitable for the research if the acid-test successfully passes certain criteria. The following acid-test is successfully implemented and attributes in the questionnaires are behaving correctly, in which case acid-test is passed and can be moved on to the next step.

The respondent 9 in the case company participated in the Acid-test and results were tangible since the critical resources were close to the respondent's opinions. The respondent is from the Preparation of construction phase. Figure 18 shows the results from a NSCFI perspective. The critical factors in the future are: C3 – reduction of unprofitable time in processes, Q5 – usability and functionality of information systems, T3 – information systems support the business processes, since the attributes are below the horizontal lines. Information systems category combine most of the critical factors in the past and the future. Additionally, attribute Q8 – brand is slightly above the black horizontal line because it is over resourced and needs more attention in the future. On this basis it can be concluded that, information systems is a major critical resource in terms of cost, quality, and time.

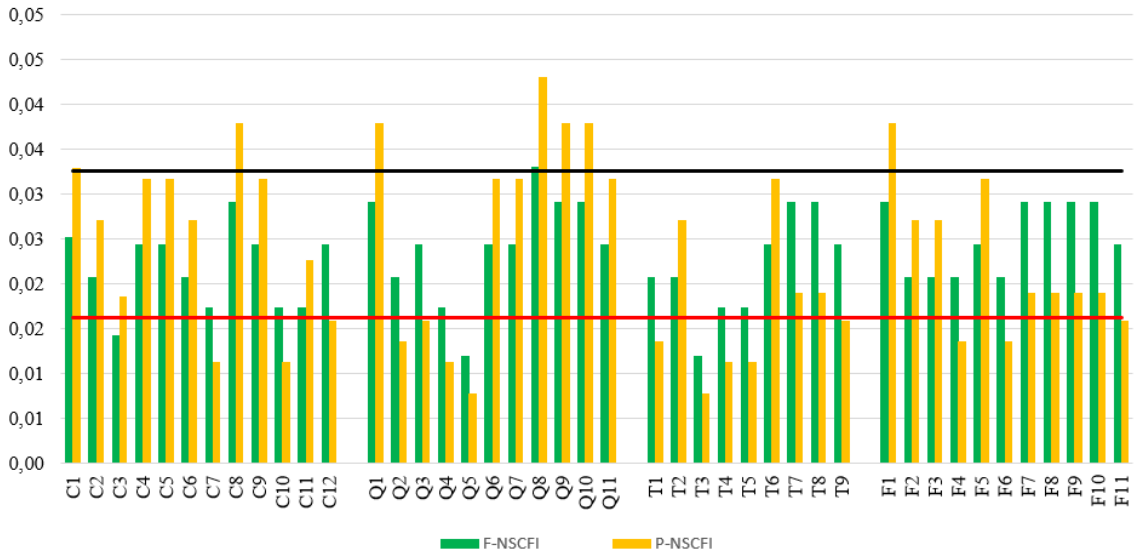



Figure 18. NSCFI (OP and BSC) – Acid-test.

Furthermore, Table 7 shows the SCA risk-levels' values (MAPE, RMSE, and MAD) which are all critical since most of them are under 0.9. Because of this, the Acid-test data suggests that resource allocation does not support the company's operational strategy. The high risk values derive from the MSI and S&R values, where the interviewees' personal opinion is influencing the results. The MSI values emphasize to Defender strategy type when the S&R values are emphasized to Analyzer, which cause high SCA risk-levels. Moreover, the Acid-test included only an employee's opinion whereby the risk-level is indicative.

Table 7. SCA risk-levels.

| Technique | Prospector | Analyzer | Defender | MAPE | RMSE | MAD |
|---|---|---|---|---|---|---|
| MSI (P) | 0,94 | 0,79 | 0,97 | | | |
| MSI (F) | 0,93 | 0,84 | 0,96 | | | |
| BCFI (P) | 0,93 | 0,89 | 0,93 | 0,86 | 0,91 | 0,93 |
| BCFI (F) | 0,91 | 0,97 | 0,91 | 0,80 | 0,88 | 0,91 |
| NSCFI (P) | 0,92 | 0,93 | 0,91 | 0,79 | 0,87 | 0,90 |
| NSCFI (F) | 0,91 | 0,97 | 0,90 | 0,80 | 0,88 | 0,91 |

### 3.2.2 AHP analysis

The AHP analysis is used for evaluating the attributes' priorities and these priorities are used in other evaluations such as MSI, SCA, and Knowledge and Technology. The AHP questionnaire's data is used in the analysis and the Analytical Hierarchy Process structure graph can be found from Appendix 4. After the data has been collected from the respondents and it has been analyzed, the inconsistency ratio (ICR) is calculated in order to evaluate the validity of each answer in the AHP. If the ICR is less than 0.30, the answer is considered to be valid and reliable and can be used in the decision making process and in this research (Takala et al. 2013a). All of the respondents' AHP answers are utilized in this research, because of low ICR values and the questionnaires are correctly filled.

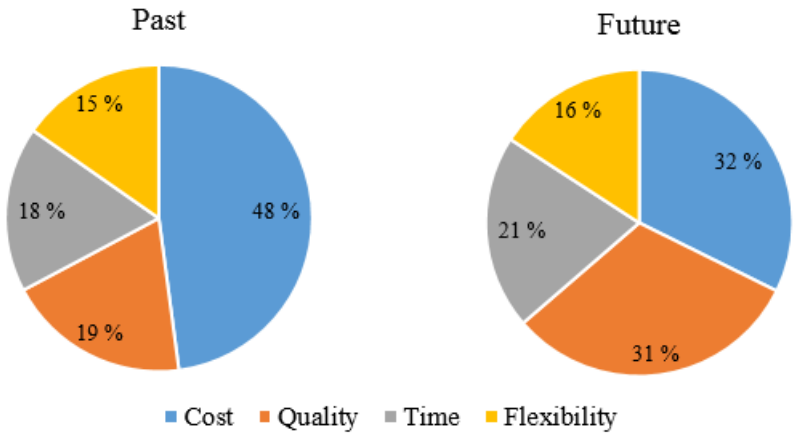



Figure 19. Respondents' priorities in the past and future.

Figure 19 pie charts present the respondents' weight priorities in the past and in the future in the Residential Project Development phases in general. Findings indicates that the cost factor weight value has been the biggest in the past. However, the cost weight will decrease in the future and will divide into other factors whilst still remaining the most important factor. This is undoubtedly influenced partly by consumers' and third party influencers' environmental awareness and long-term effects on living standards for future generations (Ding 2008: 463). Furthermore, the case company's current strategy

encourage employees to perform better in terms of quality (the case company 2017). This 'radical' change should also be reflected in resource allocation throughout all the operational strategy phases. In order to analyze future changes in factors' weights more accurately, the importance of the factors in each phase is discussed below.

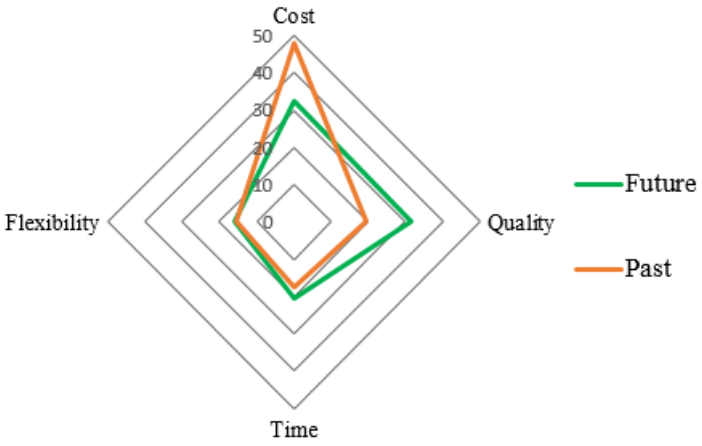



Figure 20. Priorities in future versus past in RPD.

Figure 20 clarifies the total priorities in the Residential Project Development. Based on the results, the main superior priority is cost and quality is the second in the past. In the future, quality will be worth the weight levels with cost. According to the case company, only focusing on operational excellence is not a part of the strategy and the company wants to do things cost-effectively with high quality from the start. Their strategy is to focus on reducing the waste of time and unnecessary work in order to effectively implement the best practices, procedures, systems, and develop people's skills (The Case Company 2017). However, the weight of time is considerably smaller than cost or quality, thus weight priorities may not fully support the strategy's "reduce the waste of time and unnecessary work".

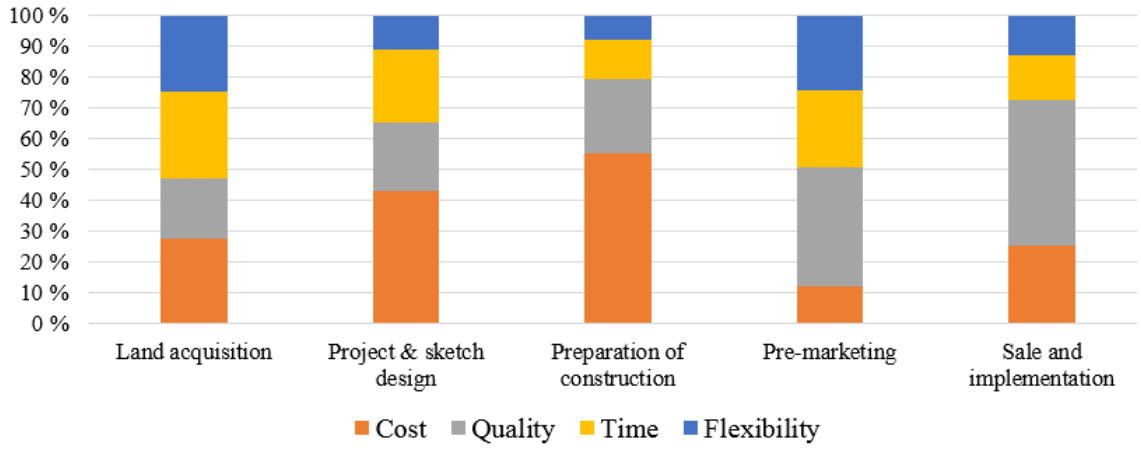



Figure 21. Priorities weight by phases in the future.

Figure 21 presents the priorities weight by the Residential Project Development's phases in the future. Primarily, it can be seen that the Preparation of construction phase and the Project and sketch design phase have the largest percentage in the cost factor (56 and 43 percentage). However, while Sale and implementation has prioritized the quality factor as the most important among others, the first three phases prioritized it as less important. In contrast, the time and flexibility factors are often prioritized as the least important in most of the phases. Furthermore, the factors are most evenly distributed in the Land acquisition phase. The concept of priorities weights is key to the field of SCA analysis as the MSI future values derive from the figure.

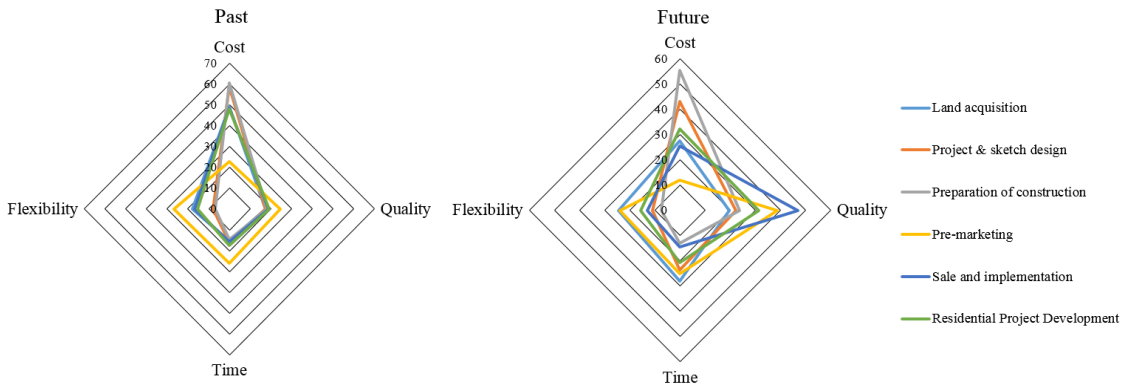



Figure 22. Priorities by phases in the past and future.

Figure 22 illustrates the factors' priorities by phases in the past and future. In the past, the cost factors are clearly the most important factors among the others, but the order of importance is clearly offset by others in the future. The Pre-marketing phase was the most interesting phase in the past because it differed from others so remarkably; the weight values are more evenly distributed for each factor. On other hand, the Sale and implementation phase will make the biggest change when the costs lose significant weight to the quality in the future. In the future, Land acquisition will be the most evenly distributed amongst each factor and the Preparation of construction phase will continue to focus on cost the most. It is clear that the company's result depends on the cost and thus costs are involved strongly in preparation which supports why the Preparation of construction phase will focus intensively on costs as well in the future.

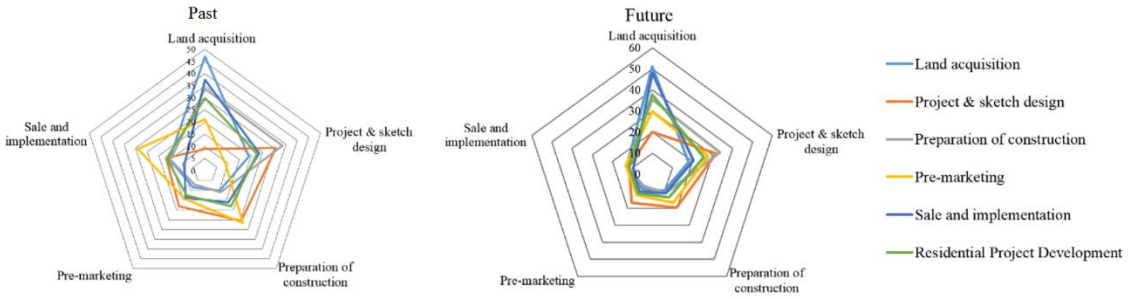



Figure 23. Phases' priorities by phases in the past and future.

According to the respondents in each phase, Figure 23 clarified phases' weight distribution between phases. Based on the results it can be stated that there are different views on the importance of the phases within the organization's process in the past. Evidence indicates that currently the phases do not agree with, what is the most crucial phase. On other hand, each phase is affected differently by one another and for example, Pre-marketing considers the Sale and implementation phase the most important phase among others in the past. However, most of the phases consider the Land acquisition phase as the most important in the future, and the phases are somewhat in agreement with the order of priorities of the phases, which certainly will affect the clarity of the process. Thus, it can be seen that the Pre-marketing is affected mostly by Land acquisition and

Project- and sketch design phases in the future, which is reasonable since their operations affect the pre-marketing's material the most. Furthermore, the Pre-marketing phase is considered to be the least valued phase, where even the phase itself agrees within this.

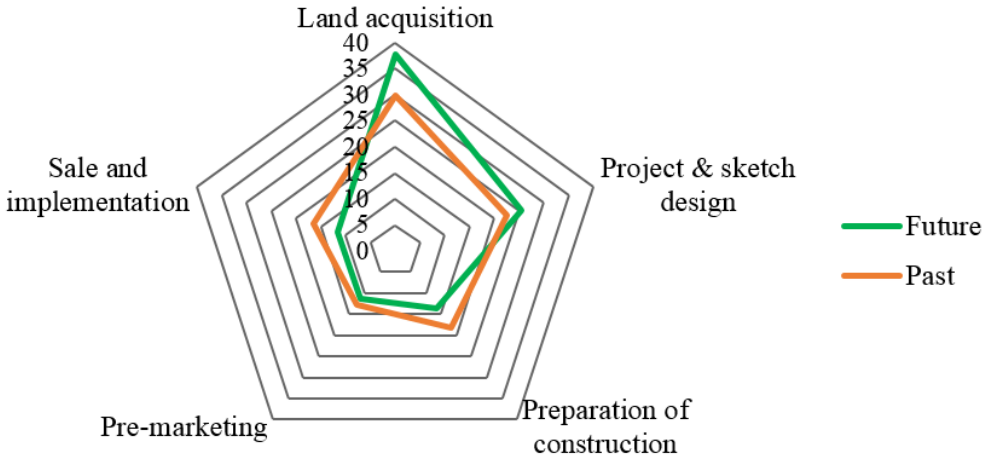



Figure 24. Priorities by phases, past versus future.

Overall, Figure 24 depicts the priorities by phases in the future versus in the past. The given data suggests that the Residential Project Development's two first phases will gain weight in the future, when the other phases will slightly lose weight according to the respondents. Furthermore, the priority weights are in a phase order where the first phase is the most important and the last phases are the least important. Additionally, Figure 25 concludes the original OP priorities in each phase in the past and in the future. The Land acquisition phase relies on the organizational systems and processes and work flows in its operation, whereas the information systems are not so important. The Project and sketch design phase's operation develops towards processes and work flows and the information systems weight will decrease in the future. The Preparation of construction phase relies heavily on the organizational systems, processes and the work flows comes second, leaving the other two priorities less important. The third phase's weight values will change the least when compared to the other phases. The Pre-marketing phase will change the most, and knowledge and technology management will be the most important in the future. Besides these changes, the weights will be more evenly distributed in the

future than in the past. In the Sale and implementation phase, the factors are fairly evenly distributed, although knowledge and technology management and information systems are the most important. Overall, weight priorities for the factors will slightly change in the future, and will almost be evenly distributed between each factor, when the RPD is viewed as an entity.

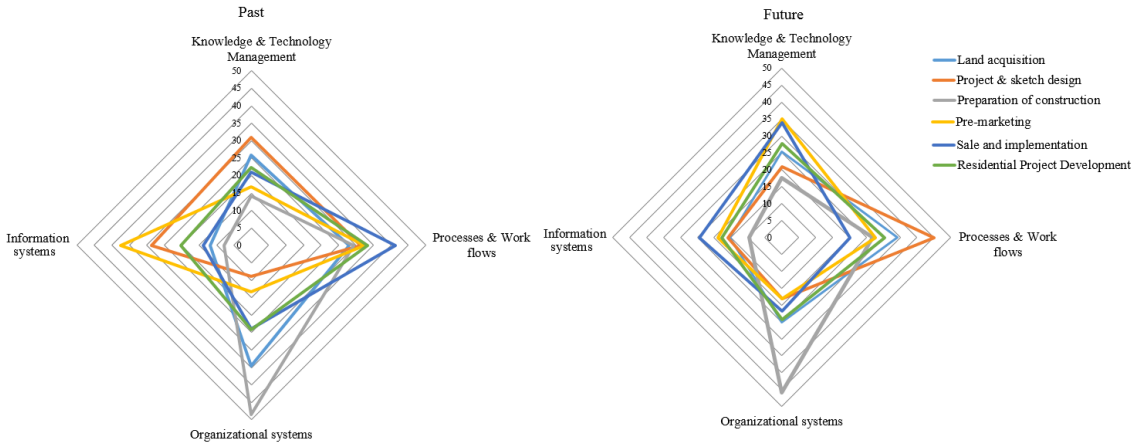



Figure 25. OP priorities by phases, past versus future.

### 3.2.3 Residential Project Development analysis

In this research, the analysis involves multiple stages in order to provide comprehensive results within relative supporting arguments. The S&R method is used to define critical and balanced areas of the Residential Project Development and data is collected from the case company's Residential Project Development division, which is further divided into five phases. The analysis contains two time periods, 3 years in the past (P) and 3 years in the future (F). Each phase is evaluated separately and as a division. The analysis contains distributed and normalized values in terms of quality, cost, time, and flexibility. Moreover, critical attributes and difficult issues which have emerged, are discussed among the respondents and their opinions are presented anonymously using the respondents' ID-numbers.

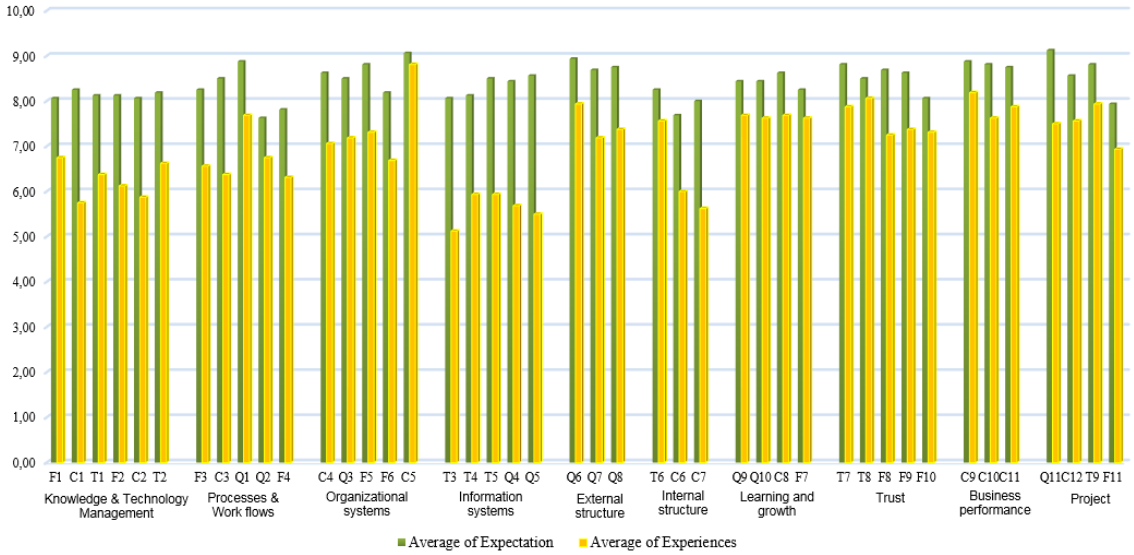



Figure 26. Average of expectation vs. experience in RPD.

The initial analysis focuses on the gap between past experience and expectations in the questionnaires, which Figure 26 illustrates. The greater the gap is, the more development the attribute needs. The most interesting attributes with the biggest gap between experience and expectations are information systems: T3 – information systems support the business processes, T4 – visibility of information in the information systems, T5 – availability of the information in information systems, Q4 – quality and reliability of information in the information systems, and Q5 – usability and functionality of the information systems. It means that the information systems are currently slowing down employees rather than giving opportunities. The respondents believe that these attributes will evolve within the next three years. Moreover, the general level of division (BSC categories) is currently on a better level than daily operations (OP categories) whereas more development efforts can be directly targeted to the daily operations. Though, expectations of the division are ranked relatively high, this signifies a normal environment of many organizations in which employees are expecting a better working environment in the future in all of the terms. Hence, it is advised that the management of the divisions should allocate more resources towards establishing well-defined information systems channel. Next, the different Residential Project Development's phases are analyzed separately in terms of S&R, and MSI.

**Land acquisition**

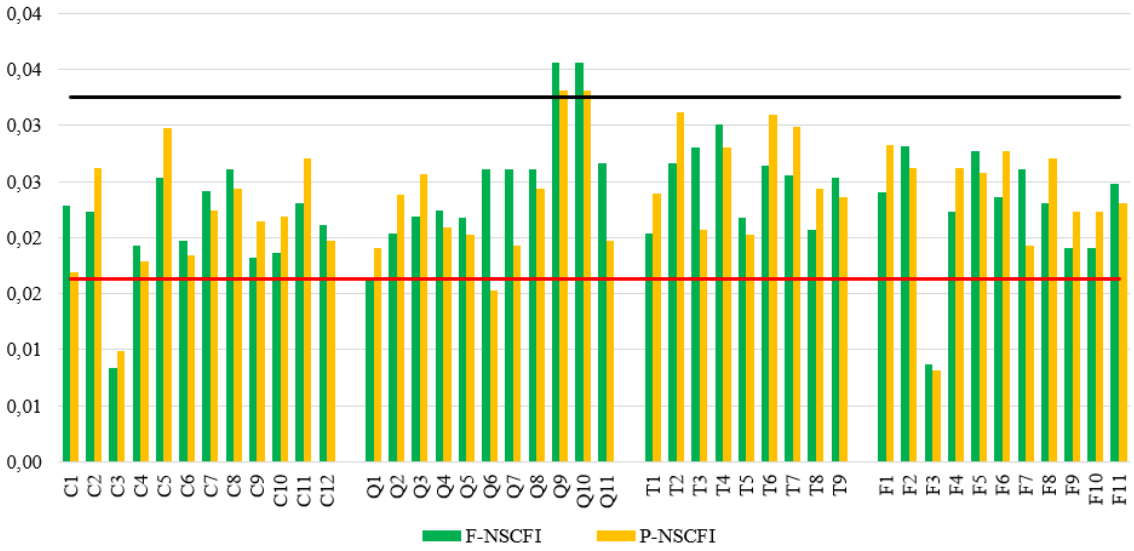
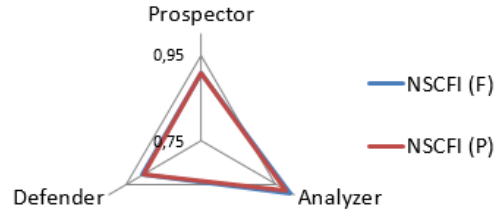



Figure 27. Comparison of NSCFI past and future in Land acquisition.

Figure 27 provides information about the Land acquisition phase resources by using the NSCFI method which purpose is to solve the problem when the respondents sample is too narrow and limited. The red line presents a lower resource limit and black line presents an upper resource limit. Attributes between these lines are in the balanced zone and are allocated correctly. Attributes over black line are over resourced and need more attention and attributes below red line mean that the attribute is critical. Taking the results from figure 27, which predict the situation in the future and the past, into consideration the critical attributes in the future are: C3 – reduction of unprofitable time in processes and F3 – short and prompt lead-times in order-fulfillment process. Attributes which need an attention are Q9 – know-how and Q10 – knowledge. Additionally, Q6 – customer satisfaction is rising from the critical zone to the balanced zone, which means that the attribute will be invested. Overall the situation in the Land acquisition phase is excellent based on the results since the criticalities are significantly less than in the forthcoming phases.




| Quality | Cost | Time | Flexibility | Quality | Cost | Time | Flexibility |
|---|---|---|---|---|---|---|---|
| 516,53 | 461,85 | 416,66 | 456,77 | 402,10 | 368,49 | 367,90 | 363,39 |
| Prospector | Analyzer | Defender | Reactor | Prospector | Analyzer | Defender | Reactor |
| 0,909 | 0,990 | 0,906 | 0,908 | 0,908 | 0,978 | 0,906 | 0,907 |
| Future | | | | Past | | | |

Figure 28. Land acquisition phase in the past and the future – NSCFI.

Figure 28 is divided to two parts; the triangle presents the distribution of operational strategies, and the table area presents the calculated values of the NSCFI in the future and the past. The second row on the table presents the calculated values of the NSCFI and the value on the black background provides the calculations of the MSI model of operational competitiveness for each group. The higher the value is the more significant role the particular strategy type has. According to the Land acquisition's respondents, the phase tends to be an analyzer-type strategy in the past and the analyzer strategy will become even more obvious in the future (Figure 28). When the strategy type is analyzer, the phase combines the strength of two other strategies together and balances between quality, cost, and time. In other words, the division's phase keenly follows the changes in the industry, and the respondent 1 confirms this.

Table 8. Domineering strategy type order – Land acquisition.

| | Strategy type | Strategy type order |
|---|---|---|
| MSI (P) | Defender | Defender > Prospector > Analyzer |
| MSI (F) | Analyzer | Analyzer > Defender > Prospector |
| NSCFI (P) | Analyzer | Analyzer > Prospector > Defender |
| NSCFI (F) | Analyzer | Analyzer > Prospector > Defender |

Table 8 presents the domineering strategy type order in the Land acquisition phase, where 'P' stands for past and 'F' for future. According to the phase's respondents, the domineering strategy type is Analyzer in the future. Although the MSI past order differs from the NSCFI order, both methods of analysis (MSI and NSCFI) show similar results in the future, which implicates that the phase's respondents AHP weights support the operational strategy.

**Project- and sketch design**

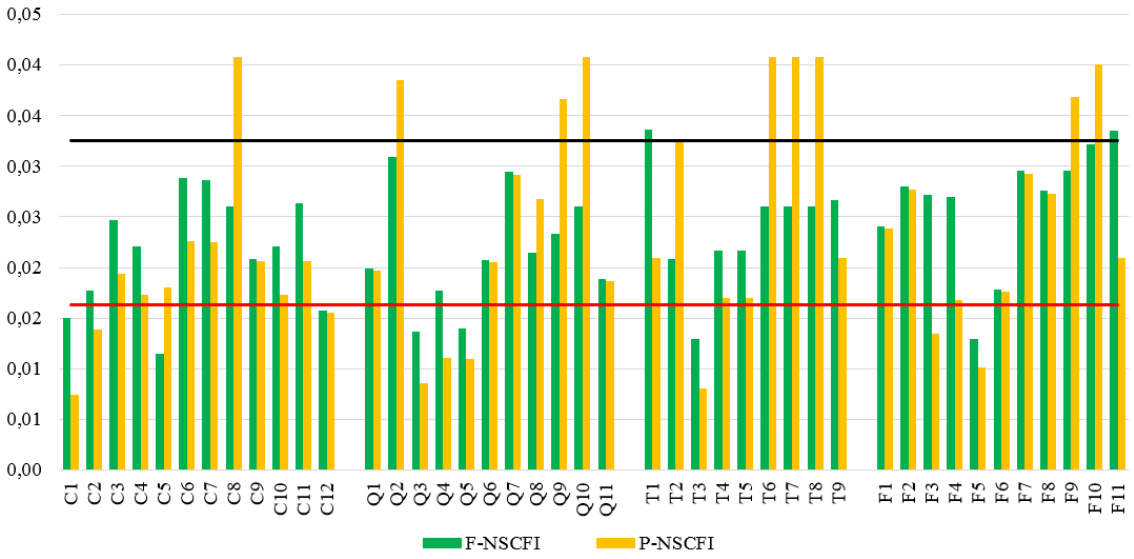
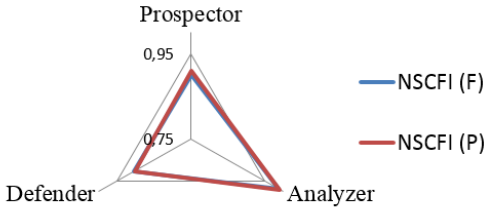



Figure 29. Comparison of NSCFI past and future in Project- & sketch design.

According to the Project- and sketch design phase's respondents, critical factors in the past are (Figure 29): C1 – innovativeness and performance of research and development, C2 – knowledge and technology diffusion, C12 – cost management in projects, Q3 – quality control of products, processes, and operations, Q4 – quality and reliability of information in information systems, Q5 – usability and functionality of information systems, T3 – information systems support the business processes, F3 – short and prompt lead-times in order-fulfilment process, and F5 – well defined responsibilities and tasks for each operation. In the future, the number of critical attributes will be reduced as

follows: C1 – innovativeness and performance of research and development, C5 – code of conduct and security of data and information, C12 – cost management in projects, Q3 – quality control of products, processes, and operations, Q5 – usability and functionality of information systems, T3 – information systems support the business processes, and F5 –well defined responsibilities and tasks for each operation. Attributes which are over resourced and need attention in the future are: T1 – communication between different departments and hierarchy levels, and F11 – projects are flexible enough to conform to changes. The overall situation for the Project- and sketch design phase is more critical than in the Land acquisition phase based on the results. It can be generally stated that the information systems do not support the business process although information is currently somehow visible and available from the information systems.




| Quality | Cost | Time | Flexibility | Quality | Cost | Time | Flexibility |
|---|---|---|---|---|---|---|---|
| 308,08 | 338,24 | 280,84 | 377,77 | 273,61 | 223,62 | 250,19 | 247,38 |
| Prospector | Analyzer | Defender | Reactor | Prospector | Analyzer | Defender | Reactor |
| 0,901 | 0,988 | 0,904 | 0,902 | 0,909 | 0,991 | 0,902 | 0,906 |
| Future | | | | Past | | | |

Figure 30. Project- & sketch design phase in the past and the future – NSCFI.

Essentially, the findings of operational strategy for the Project- and sketch design phase are almost similar to the Land acquisition phase. The strategy type for both phases in the past period of time is analyzer. Thus, when the previous phase's strategy type will be strengthened, the current phase's strategy type will slightly lose weight, whilst still remaining the strongest (Figure 30).

Table 9. Domineering strategy type order – Project- & sketch design.

| Strategy type | Strategy type order |
|---|---|

| | | |
|---|---|---|
| MSI (P) | Defender | Defender > Prospector > Analyzer |
| MSI (F) | Analyzer | Analyzer > Defender > Prospector |
| NSCFI (P) | Analyzer | Analyzer > Prospector > Defender |
| NSCFI (F) | Analyzer | Analyzer > Defender > Prospector |

According to the phase's respondents, the domineering strategy type in the future is Analyzer when using both methods (Table 9). Additionally, the strategy type order also remains the same in both methods. However, the MSI past order differs from the NSCFI order which indicates towards disagreements with the employees' thoughts and operations. For example, the phase strongly emphasizes costs in their opinions, but decisions in operations clearly take into account each of the fours variables: cost, quality, time, and flexibility.

**Preparation of construction**

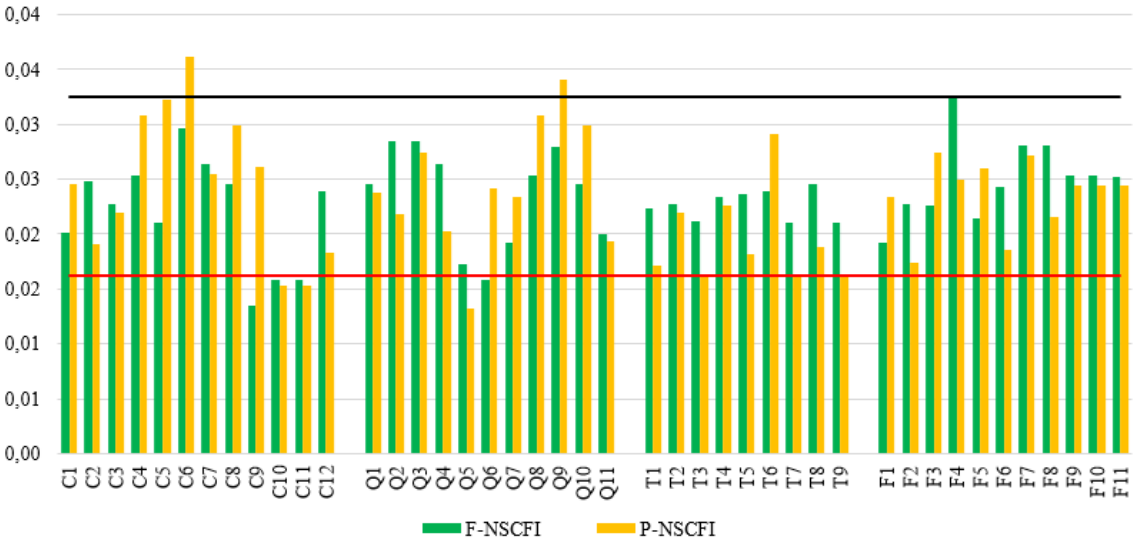
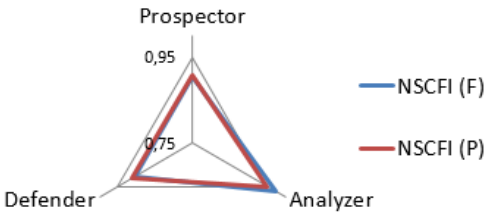



Figure 31. Comparison of NSCFI past and future in Preparation of construction.

According to the Preparation of construction phase's respondents, critical factors in the past and currently are (Figure 31): C10 – sales, C11 – customer, Q5 – usability and functionality of information systems, T3 – information systems support the business processes, T7 – performance-to-promise, and T9 – projects are possible to implement in time, in which case these attributes need attention in order to increase them to a balanced zone. On top of that, critical factors in the future are: C9 – financial, C10 – sales, C11 – customer, and Q6 – customer satisfaction. In turn, attributes which are relatively decreasing are C9 – financial and Q6 – customer satisfaction. Most of the attributes related to time are improving considerably in the future, which means that more resources are invested into them or they are better taken into account. Nonetheless, the weight values of time will not increase in the future, when looking at the results of the AHP (Figure 22). However, those getting worse attributes should also get more attention and ensure, that they will not be critical afterwards. Overall the situation for the Preparation of construction phase is on a satisfactory level based on the results and the current situation is worrying (multiple critical attributes), but clearly moving towards a better balance.




| Quality | Cost | Time | Flexibility | Quality | Cost | Time | Flexibility |
|---|---|---|---|---|---|---|---|
| 466,39 | 477,06 | 368,41 | 496,82 | 398,37 | 400,70 | 261,72 | 360,21 |
| Prospector | Analyzer | Defender | Reactor | Prospector | Analyzer | Defender | Reactor |
| 0,905 | 0,972 | 0,905 | 0,905 | 0,909 | 0,952 | 0,910 | 0,910 |
| Future | | | | Past | | | |

Figure 32. Preparation of construction phase in the past and future – NSCFI.

According to the Preparation of construction's respondents, the phase tends to be an analyzer-type strategy in the past which will become even more obvious in the future (Figure 32) as also noted in previous phases. Even though the AHP-results refer to costs

of great weight, the phase tends to balance more between quality, cost, and time in their operations.

Table 10. Domineering strategy type order – Preparation of construction.

| | Strategy type | Strategy type order |
|---|---|---|
| MSI (P) | Defender | Defender > Prospector > Analyzer |
| MSI (F) | Defender | Defender > Prospector > Analyzer |
| NSCFI (P) | Analyzer | Analyzer > Defender > Prospector |
| NSCFI (F) | Analyzer | Analyzer > Defender > Prospector |

According to the phase's respondents, the domineering strategy type is Analyzer in the future by the NSCFI, but the MSI claims it to be Defender. The MSI order differs from the NSCFI order which reflects risk-level and uncertainty. The high risk is caused by disagreements in the AHP and S&R results. The phase focuses considerably on the costs even though the actual operation is more distributed to other factors, like quality and time. This has probably been strongly influenced by the respondents' view of the cost of the project rather than the cost of the operational level.

**Pre-marketing**

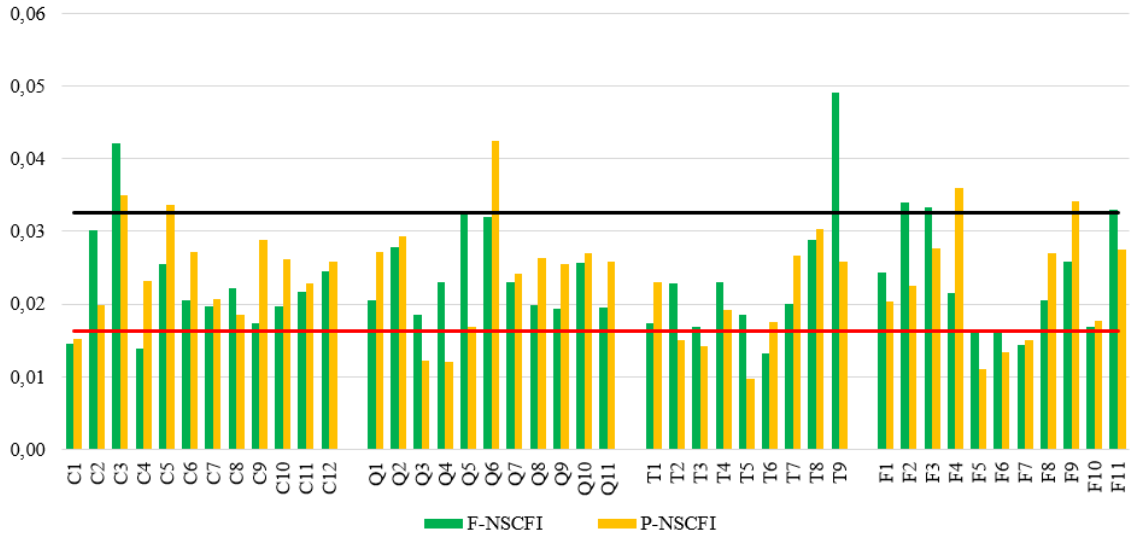
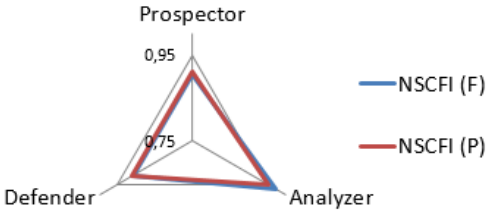



Figure 33. Comparison of NSCFI past and future in Pre–marketing.

According to the Pre-marketing phase's respondents, the present critical factors are (Figure 33): C1 – innovativeness and performance of research and development, Q3 – quality control of products, processes and operations, Q4 – quality & reliability of information in information systems, T2 – design and planning of the processes and products, T3 – information systems support the business processes, T5 – availability of information in information systems, F5 – well defined responsibilities and tasks for each operation, F6 – utilizing different types of organizing systems, and F7 – engagement. In the future, the number of critical attributes will be reduced and these will be: C1 – innovativeness and performance of research and development, C4 – leadership and management systems of the company, T6 – process improvement, F6 – utilizing different types of organizing systems such as projects, teams, and processes, and F7 – engagement. As can be seen from the figure 33, many of the attributes are critical currently but investing in these can bring them to the balanced zone. Attributes which are over resourced and need attention in the future are: C3 – reduction of unprofitable time in processes, T9 – projects are possible to implement in time, F2 – adaptation to knowledge

and technology, F3 – reduction of unprofitable time in processes, and F11 – projects are flexible enough to conform to changes. Following attributes are getting relatively worse: C9 – financial, C10 – sales, and F4 – adaptiveness of changes in demands and in order backlog. Overall the situation for the Pre-marketing phase is at a satisfactory-level based on the results, due to the amount of criticalities, even though most of the attributes are quite near to being pulled to the balanced zone.




| Quality | Cost | Time | Flexibility | Quality | Cost | Time | Flexibility |
|---|---|---|---|---|---|---|---|
| 326,65 | 338,99 | 262,06 | 319,84 | 253,78 | 260,43 | 171,01 | 216,71 |
| Prospector | Analyzer | Defender | Reactor | Prospector | Analyzer | Defender | Reactor |
| 0,907 | 0,972 | 0,908 | 0,907 | 0,911 | 0,953 | 0,911 | 0,911 |
| Future | | | | Past | | | |

Figure 34. Pre-marketing phase in the past and the future – NSCFI.

According to the Pre-marketing's respondents, the phase tends to be an analyzer-type strategy in the past, when other values have been stabilized within each other. The analyzer strategy will become even more obvious in the future (Figure 34). When the strategy type is analyzer, the phase combines the strength of two other strategies together and balance between quality, cost, and time. In other words, the division's phase keenly follows the changes in industry, and respondent 14 confirms this. Table 11 presents the domineering strategy type order in the Pre-marketing phase. According to the phase's respondents, the domineering strategy type is Analyzer in the past and the future. Both methods of analysis, MSI and NSCFI, show similar results, which implicates that resource allocation support the operational strategy as well as the research validity and reliability.

Table 11. Domineering strategy type order – Pre-marketing.

| | Strategy type | Strategy type order |
|---|---|---|
| MSI (P) | Analyzer | Analyzer > Prospector > Defender |
| MSI (F) | Analyzer | Analyzer > Prospector > Defender |
| NSCFI (P) | Analyzer | Analyzer > Defender > Prospector |
| NSCFI (F) | Analyzer | Analyzer > Defender > Prospector |

**Sale and implementation**

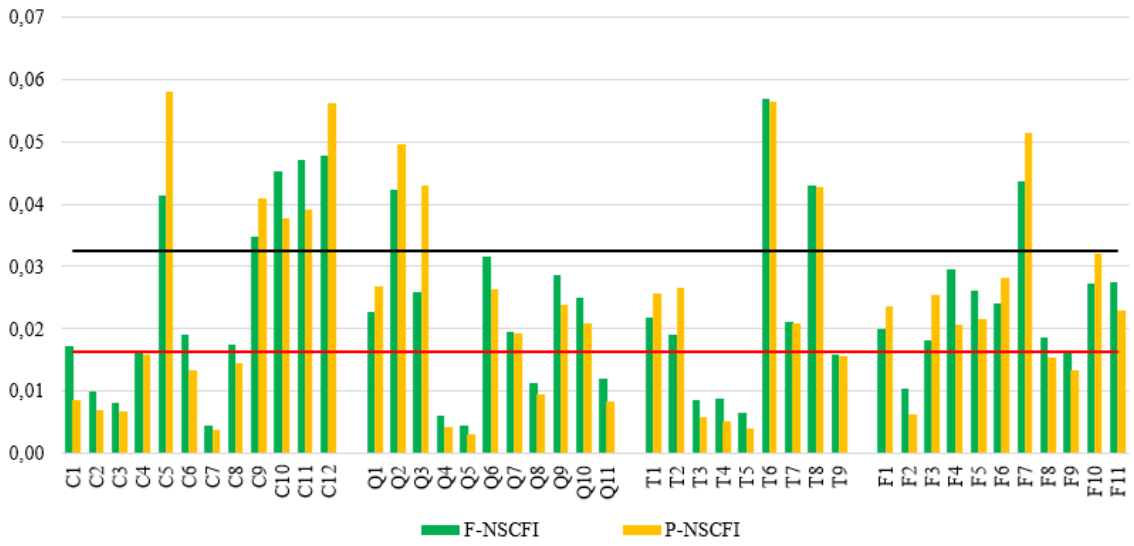
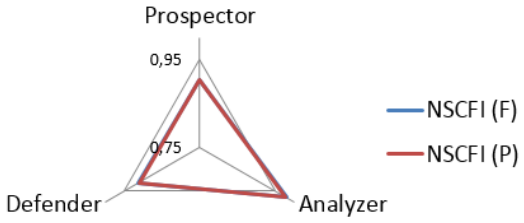



Figure 35. Comparison of NSCFI past and future in Sale and implementation.

Taking the results from Figure 35, which predicts the situation in future and past, into consideration the critical attributes in the past for Sale and implementation phase are: C1 – innovativeness and performance of research and development, C2 – knowledge and technology diffusion, C3 – reduction of unprofitable time in processes, C4 – leadership and management systems of the company, C6 – innovation, C7 – information technology, C8 – competence, Q4 – quality & reliability of information in information systems, Q5 – usability and functionality of information systems, Q8 – brand, Q11 – quality is

equivalent to expected level, T3 – information systems support the business processes, T4 – visibility of information in information systems, T5 – availability of information in information systems, T9 – projects are possible to implement in time, F2 – adaption to knowledge and technology, F8 – openness, and F9 – benevolent collaboration. In the future, the situation will slightly change towards better and the critical attributes will be: C2 – knowledge and technology diffusion, C3 – reduction of unprofitable time in processes, C4 – leadership and management systems of the company, C7 – information technology, Q4 – quality and reliability of information in information systems, Q5 – usability and functionality of information systems, Q8 – brand, Q11 – quality is equivalent to expected level, T3 – information systems support the business processes, T4 – visibility of information in information systems, T5 – availability of information in information systems, T9 – projects are possible to implement in time, F2 – adaption to knowledge and technology, and F9 – benevolent collaboration. Attributes which need more attention in future are C5 – code of conduct and security of data and information, C9 – financial, C10 – sales, C11 – customer, C12 – cost management, Q2 – control and optimization of all types of inventories, Q6 – customer satisfaction, T6 – process improvement, T8 – professional relationship, and F7 – engagement. Overall the situation for Sale and implementation phase is critical, thus many attributes move from the critical zone towards the balanced zone.




| Quality | Cost | Time | Flexibility | Quality | Cost | Time | Flexibility |
|---|---|---|---|---|---|---|---|
| 331,84 | 446,62 | 291,96 | 378,06 | 288,77 | 366,31 | 249,54 | 313,24 |
| Prospector | Analyzer | Defender | Reactor | Prospector | Analyzer | Defender | Reactor |
| 0,903 | 0,978 | 0,912 | 0,907 | 0,904 | 0,974 | 0,911 | 0,908 |
| Future | | | | Past | | | |

Figure 36. Sale and implementation phase in the past and the future – NSCFI.

According to the Sale and implementation's respondents, the phase tends to be an analyzer-type strategy in the past, where other values are far behind, and the analyzer strategy will become even more obvious in the future (Figure 26). When the strategy type is analyzer, the phase combines the strength of two other strategies together and balance between quality, cost, and time. In other words, the division's phase keenly follows the changes in industry, and respondent 19 confirms this.

Table 12. Domineering strategy type order – Sale and implementation.

| | Strategy type | Strategy type order |
|---|---|---|
| MSI (P) | Defender | Defender > Prospector > Analyzer |
| MSI (F) | Analyzer | Analyzer > Prospector > Defender |
| NSCFI (P) | Analyzer | Analyzer > Defender > Prospector |
| NSCFI (F) | Analyzer | Analyzer > Defender > Prospector |

Table 12 presents the domineering strategy type order in the Sale and implementation phase, where 'P' stands for past and 'F' for future. According to the phase's respondents, the domineering strategy type is Analyzer in the future by NSCFI and MSI. The MSI order differs from the NSCFI order which will reflect on risk-levels.

**Residential project development**

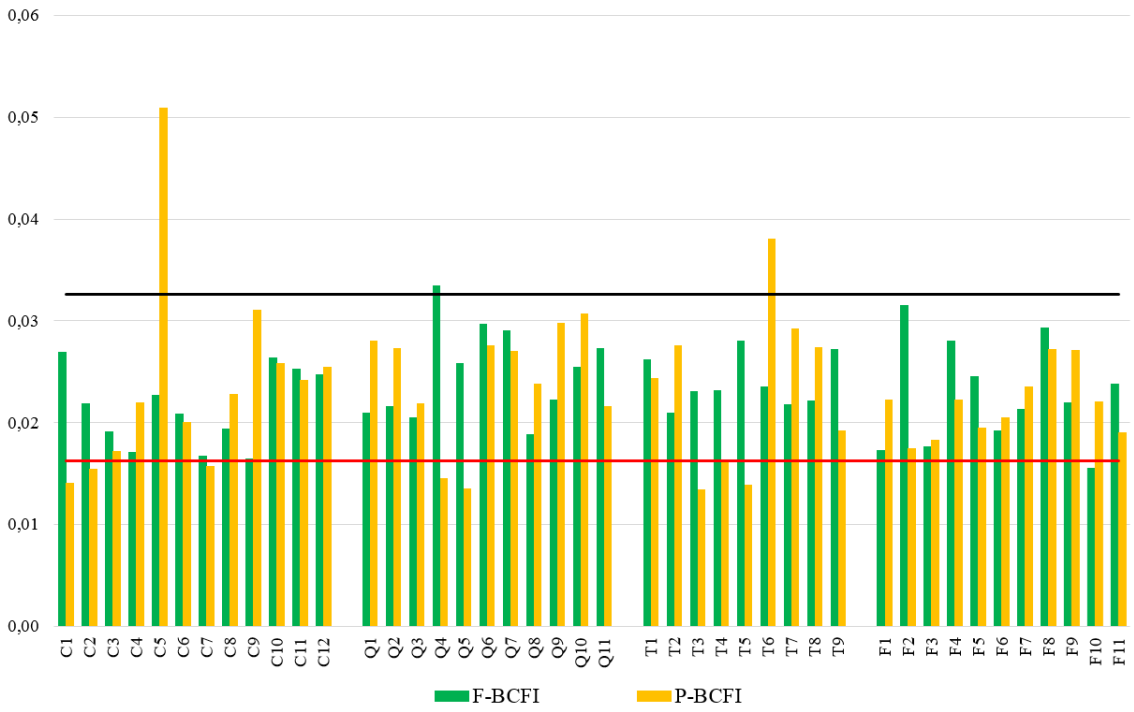
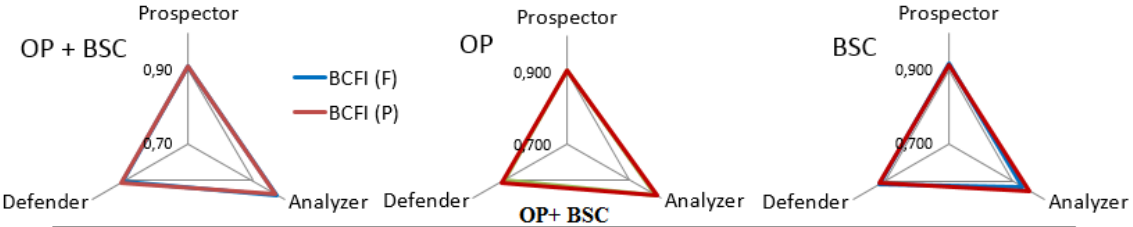



Figure 37. Comparison of BCFI past and future in Residential Project Development.

In order to be able to better understand the whole Residential Project Development process, the division is analyzed as its entity. The analysis contains all 16 respondents and utilizes the BCFI method, since there are considerably more answers. Taking the results from Figure 37, which predicts the situation in the future and the past, into consideration the critical attributes in the present for the Residential Project Development-process are: C1 – innovativeness and performance of research and development, C2 – knowledge and technology diffusion, C7 – customer loyalty, Q4 – quality & reliability of information in information systems, Q5 – usability and functionality of information systems, T3 – information systems support the business processes, and T5 – availability of information in information systems. The number of critical attributes is smaller than the average number on its actual phases. In addition, in the future the amount of critical attributes will be reduced to only one attribute, which is

F10 – empathy. Moreover, the attributes which need attention in the present contain only C5 – code of conduct and security of data and information, and T6 – process improvement and in the future, Q4 – quality and reliability of information in information systems. According to results, the situation for the RPD is considerably improving towards a better operation, although it needs a lot of effort in many phases and attributes. Figure 37 shows that the general situation in the future will be improved. However, there will be some difficult attributes in the future: C1, Q4, Q5, T3, T4, and T5, since each of these increase considerably versus the past. It means that the company should pay more attention on such attributes and put more resources into improving and changing them as the respondents assume.




**OP+ BSC**

| Quality | Cost | Time | Flexibility | Quality | Cost | Time | Flexibility |
|---|---|---|---|---|---|---|---|
| 22,43 | 20,99 | 17,62 | 20,42 | 13,43 | 13,59 | 10,58 | 11,21 |
| Prospector | Analyzer | Defender | Reactor | Prospector | Analyzer | Defender | Reactor |
| 0,909 | 0,977 | 0,906 | 0,908 | 0,910 | 0,971 | 0,911 | 0,911 |
| Future | | | | Past | | | |

**OP**

| Quality | Cost | Time | Flexibility | Quality | Cost | Time | Flexibility |
|---|---|---|---|---|---|---|---|
| 12,21 | 10,80 | 12,12 | 13,23 | 6,42 | 7,33 | 5,80 | 6,16 |
| Prospector | Analyzer | Defender | Reactor | Prospector | Analyzer | Defender | Reactor |
| 0,904 | 0,983 | 0,900 | 0,902 | 0,906 | 0,986 | 0,911 | 0,908 |
| Future | | | | Past | | | |

**BSC**

| Quality | Cost | Time | Flexibility | Quality | Cost | Time | Flexibility |
|---|---|---|---|---|---|---|---|
| 10,22 | 10,19 | 5,51 | 7,19 | 7,01 | 7,06 | 4,78 | 5,05 |
| Prospector | Analyzer | Defender | Reactor | Prospector | Analyzer | Defender | Reactor |
| 0,916 | 0,932 | 0,916 | 0,916 | 0,914 | 0,953 | 0,915 | 0,915 |
| Future | | | | Past | | | |

Figure 38. Operations strategy of RPD in the past and the future - BCFI.

Figure 38 presents similar results to the respondents' perception regarding the company strategy. The figure collapses the OP and BSC values by using BCFI in the past and in the future. From the respondents' point of view, an analyzer-type strategy has been the

main strategy and will slightly decrease in the future in perspectives of OP and BSC, thus remaining as the main. This also shows that the company will continue to operate routinely and efficiently through the use of formalized structures and processes. In their more turbulent areas, the top managers watch their competitors closely for new ideas, and then they rapidly adopt those that appear to be the most promising. An Analyzer organization attempts to minimize operational risk while maximizing the opportunity for profit, combining the strength of two other strategies. Analyzer organizations have a mixture of products and markets, where some are stable and others changing. The growth normally occurs through market penetration and also through product and market development. Their coordination is both simple and complex, since their planning is both intensive and comprehensive. Furthermore, the organization is moderately efficient and their dominant alliances are marketing, applied research, and production. (Mike & Snow 2003: 550–552.) From the results of the BSC perspective, the division sees the strategy not as clearly as in OP, because of almost balancing between Analyzer, Defender, and Prospector in the future.

Table 13. Domineering strategy type order – Residential Project Development.

| | Strategy type | Strategy type order |
|---|---|---|
| MSI (P) | Defender | Defender > Prospector > Analyzer |
| MSI (F) | Analyzer | Analyzer > Defender > Prospector |
| BCFI (P) | Analyzer | Analyzer > Defender > Prospector |
| BCFI (F) | Analyzer | Analyzer > Prospector > Defender |

Table 13 presents the domineering strategy type order in the Residential Project Development, where ‘P’ stands for past and ‘F’ for future. It can be seen from Table 13 that the domineering strategy type order is Analyzer. Although the MSI past order differs from BCFI order, the strategy is Analyzer in the future. Since the MSI (P)’s order differs from the BSCFI (P)’s order, the respondents’ thoughts about cost, quality, time, and flexibility differs from division’s operations.

As a conclusion, the general view of the Residential Project Development is in clear vision since different phases see the operational strategy in same way as the whole division. In the past period of time, the division is strongly Analyzer and two other types' values are almost equally the same which will be strengthened in the future as well. Each phase experiences different criticalities in their operations even though they are working closely with each other. However, the phases differ considerably from one another and should therefore be developed separately, taking into account the needs of that particular phase. The sustainable development of a bigger picture should take the whole process into account, not forgetting about the differences in each phase.

### 3.2.4 Knowledge and technology analysis

In this research, Knowledge and Technology is analyzed by using data from the AHP and S&R questionnaires and examined in each Residential Project Development's phase. At first, K/T is analyzed on a general level and then by using the Sand Cone model.

Figure 39 concludes the technology ranking points and indicates that the basic technology is dominating in the Residential Project Development division. From the technology rankings point of view, the division is found to be somewhat competitive. However, the spearhead ranking shows that the RPD does not aim overweightly to invest in the technologies focused on the future. The construction industry's best practices, procedures, and systems can be seen to be similar regardless of the competing companies, since Finland's regulations and laws strongly affect the operations. Each attribute is relying on over 50 percent on basic-technologies except C1. An average of the Core-technologies is 23 percent and the spearhead-technology average is 17 percent. Even though the operation is strongly relying on basic-technologies, a competitive advantage can also be found in each attribute. On the other hand, it would be desirable to strengthen and create even more new competitive advantages for the future.

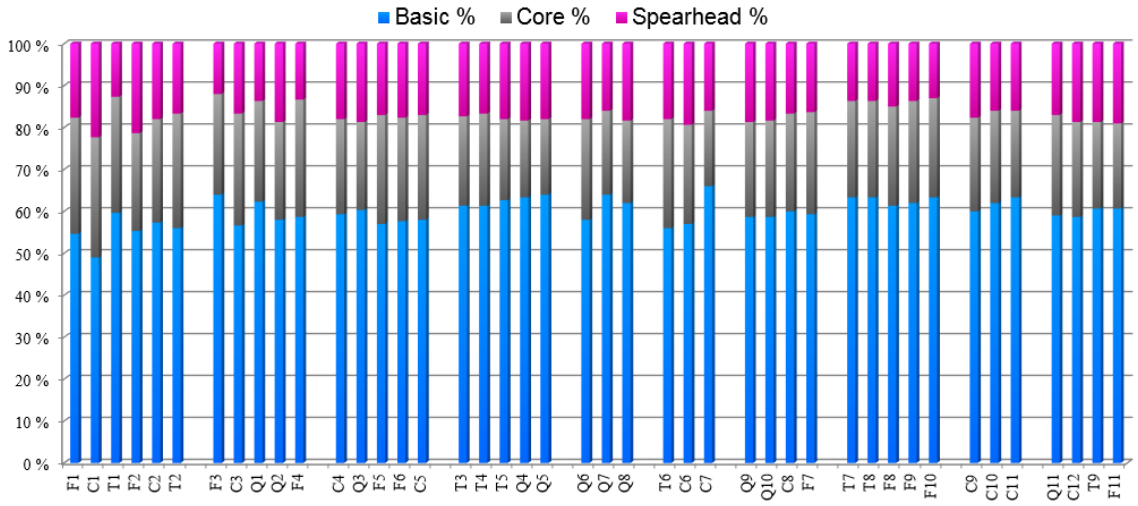



Figure 39. Technology and Knowledge level, Residential Project Development.

Figure 40 observes the relationship between BCFI, BCFI K/T (F), and BCFI K/T (P) from the perspective of K/T. From the technology rankings point of view, some of the attributes which are below the red line are going to be critical by lack of resource allocation, but the attributes over black line are going to be over resourced. Table 14 clarifies critical attributes and attributes which need attention according to BCFI K/T in the past and in the future. The criticalities from this perspective are very close to criticalities in the RPD by using the BCFI method (Figure 37). In the future, critical attributes do not occur but multiple quality attributes will be over resourced. This may be influenced by the company's current strategy, which is heavily focused on quality. Although, the overall current situation is observed to be critical, the K/T effect has provided a positive impact in general when most of the attributes are quite near to being pulled into the balanced zone.

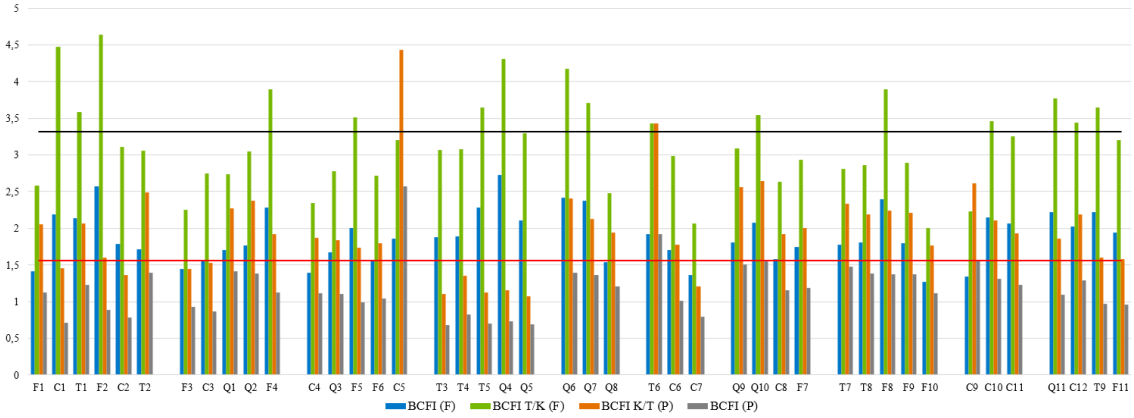



Figure 40. BCFI vs. BCFI K/T (F) and BCFI K/T (P).

Table 14. Residential Project Development, critical attributes BCFI K/T.

| Past | Future |
|---|---|
| **Critical resources** | |
| C1 – innovativeness and performance of research and development<br>C2 – knowledge and technology diffusion<br>C3 – reduction of unprofitable time in processes<br>C7 – information technology<br>Q4 – quality & reliability of information in information systems<br>Q5 – usability and functionality of information systems<br>T3 – information systems support the business processes<br>T4 – visibility of information in information systems<br>T5 – availability of information in information systems<br>F3 – short and prompt lead-times in order-fulfilment process | |
| **Need attention** | |
| C5 – code of conduct and security of data and information<br>T6 – process improvement | C1 – innovativeness and performance of research and development<br>C10 – sales<br>C12 – cost management<br>Q4 – quality & reliability of information in information systems<br>Q6 – customer satisfaction<br>Q7 – customer loyalty<br>Q10 – knowledge<br>Q11 – quality is equivalent to expected level<br>T1 – communication between different departments and hierarchy levels<br>T5 – availability of information in information systems<br>T6 – process improvement<br>T9 – projects are possible to implement in time<br>F2 – adaptation to knowledge and technology<br>F4 – adaptiveness of changes in demands and in order backlog<br>F5 – well defined responsibilities and tasks for each operation<br>F8 – openness |

The research exploits the coefficient of variation (CV) which is used to evaluate the usability of the AHP assessment results and is calculated by dividing the standard deviation of the attribute assessment results with the corresponding average value (Mäkipelto 2010: 29). The CV illustrates the homogeneity of the results which means that the higher the CV, the higher the deviation is related to the priority in question (Leskinen & Takala 2005: 42). Therefore, the CV can be considered as an indicator of quality to the decisions made by the AHP and "a measure for the operative reliability of the evaluations" (Takala et al. 2006: 339). Figure 41 exploits the CV in each RPD phase by using the OP's attributes and Figures 42, 43, and 44 exploits the variability coefficients (VarC) which are obtained from the CV in each RPD phase.

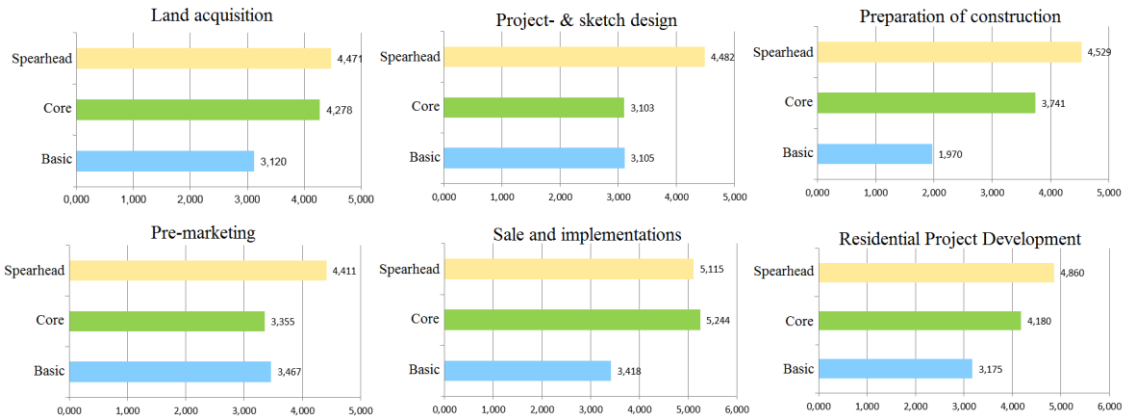



Figure 41. CV of TK - OP in each phase.

Figure 41 represent the coefficient of variation of the TK by using the original OP attributes only. Often the greatest variation occurs in the spearhead while the smallest variation occurs often in basic. Moreover, the Sale and implementation phase has the greatest variation while Preparation of construction has the smallest average variation. Due to the large variations, employees are not fully aware of their competitive edge and where they come. In order to reduce variation, operations need to be clarified and employees need to be informed more often to keep them up to date.

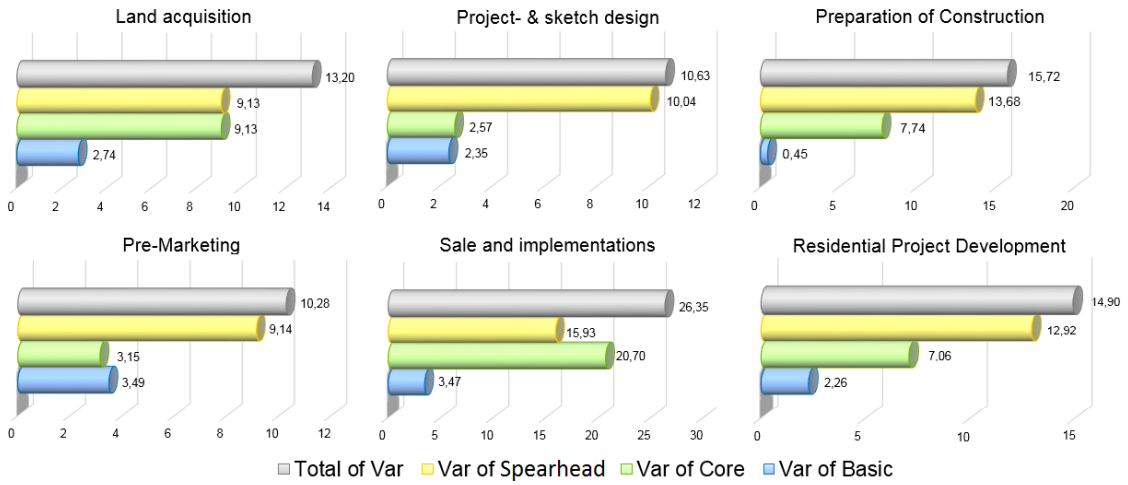



Figure 42. TK Risk - OP in each phase.

Figure 42 represents the TK Risk by using OP attributes only. The risks are presented in each phase and the RPD by separating basic, core, and spearhead attributes. As can been seen from the figure where the smallest risk occurs in basic technologies and the biggest risk occurs in spearhead technologies. The Pre-marketing phase has the smallest total of Var TK risk while the Sale and implementation phase has the biggest risk. Additionally, the Project- and sketch design has the smallest average TK Risk in OP attributes while Sale and implementation has the highest. Thus, it can be stated that the greatest risk is found from the Sale and implementation phase, when Figures 41 and 42 has been interpreted. Furthermore, when the strategy type of each phase is Analyzer, the employees are strongly following changes in the industry and not focusing on creating innovations by themselves, it is clear that the future T/K is more risky. The division or the case company does not lead the industry from the perspective of future innovations, which leads to doubt how they can keep up with the pace of change. Next, each phase is analyzed more thoroughly by using the variability coefficients and the Sand Cone model.

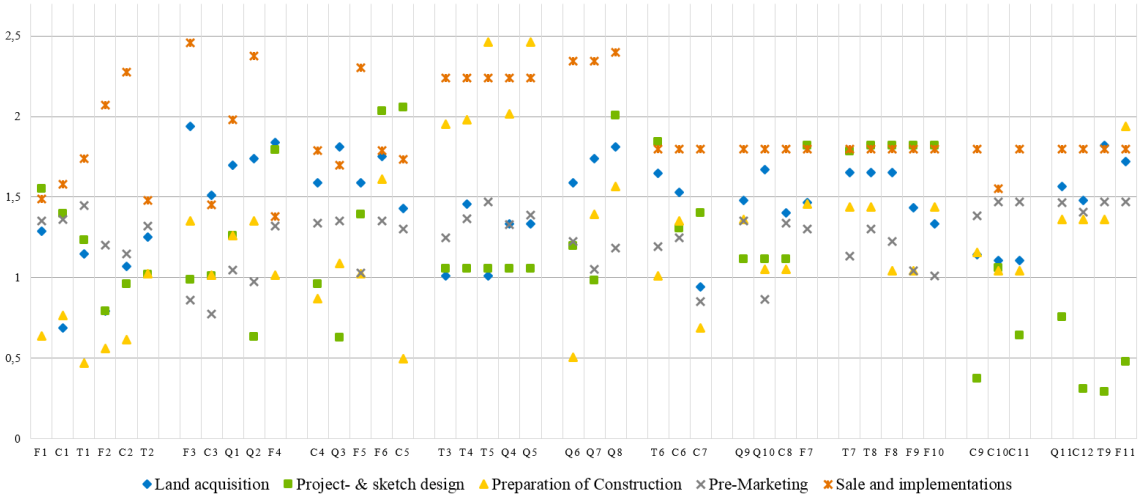



Figure 43. The variability coefficients in Residential Project Development.

Figure 43 presents the variability coefficients of the Residential Project Development. As can be observed from the figure, all the coefficients are higher than 0.5 under each criterion. Additionally, all the criterions are distributed between 0.5 – 3.0. All five phases were assigned rather high variabilities under each criterion as can be seen from the figure. In this case, the Sale and implementation phase has the highest variability in every criterion. Furthermore, no criteria received variabilities lower than one in any of the five phases. This makes the uncertainty rather high for every phase. In general, the BSC attributes' uncertainty is on a more tolerable level than the OP attributes' uncertainty since the BSC VarC values are smaller. Altogether it can be said that there is a lot of uncertainty in investment decision-making in Residential Project Development.

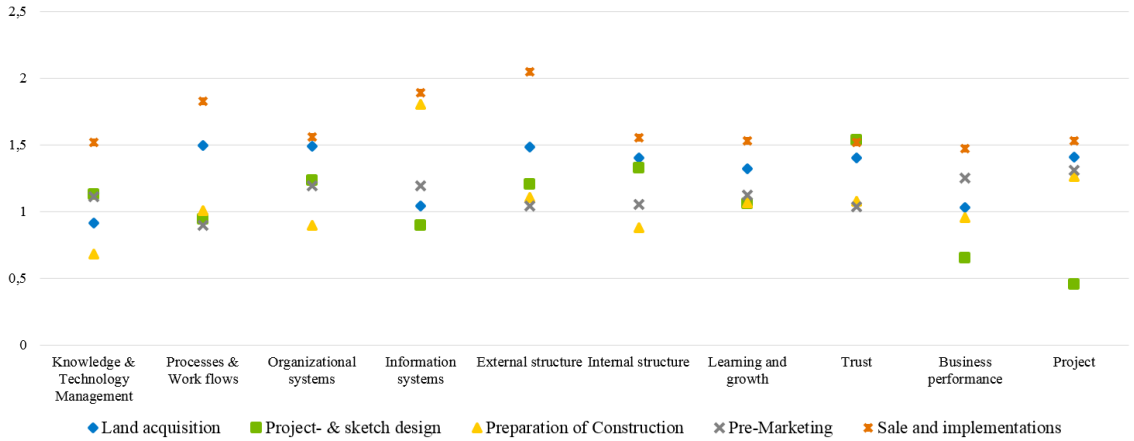



Figure 44. The variability coefficients of RPD by categories.

Figure 44 handles the attributes of each category as a coherent entity and shows the variability coefficients of the Residential Project Development in categories from the perspectives of OP and BSC. The best situation seems to be in the Preparation of construction, since all the coefficients are near or less than 1, except in information systems, which is critical to the phase. In turn, Sale and implementation has the highest variability coefficients in each category which reflects to decision uncertainty. On the other hand, the Sale and implementation phase can be considered as the broadest phase, including various decisions than in any other phase, which reflects to high uncertainty. According to the model, there is indeed some uncertainty in the investment decisions of the case company.

After naming the technologies, the K/T rankings were gathered with a questionnaire and analyzed by using implementation indexes. The variability coefficients of the Residential Project Development's phases are inserted into the Sand Cone model to illustrate the form of collapses (darker grey in Figure 45). Those criteria with over 100 percent variability question the whole investment decision evaluation based on that criterion (Takala et al. 2016). Although there are small differences among the uncertainties of different criteria between each phase, the big picture can be seen from the T&K-uncertainty figures next to the sand cones. As can be seen from each Sand Cone model, the T&K-uncertainty is over 100 percent in each phase which puts the whole decision evaluation under question

as well as the comparison of different phases. The Sand Cone model contains both the OP's and BSC's categories and attributes and each phase's Sand Cone model is built by using the phase's priorities from the AHP questionnaires. The OP's and BSC's categories handle the attributes of each category as a coherent entity, which seems to reduce a small percentage of uncertainty value.

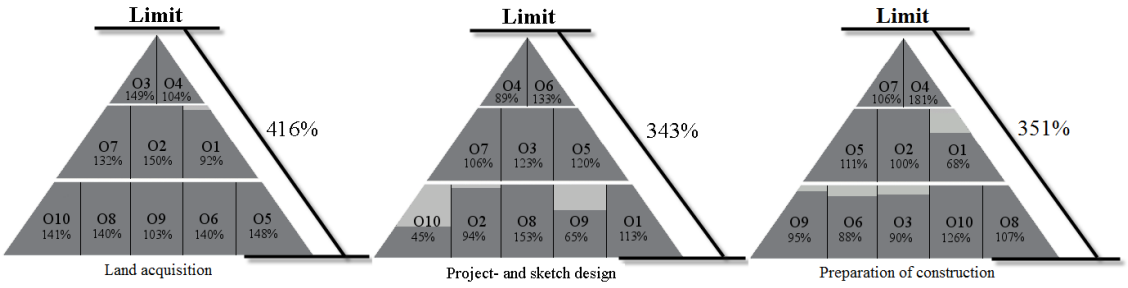



Figure 45. The T&K -uncertainty and the sand cone collapses.

The total amount of technology and knowledge-affected risk in each phase is presented in Figure 45 alongside the sand cones. "This figure is called the T&K uncertainty and it describes how much, in general, the department 'falls' under its competitive range when the T&K risk estimate materializes" (Takala et al. 2016). As can be noticed, the first three phases' T&K-uncertainty is over 100-percent which puts the decision evaluation into question, as well as the comparison of different phases (Takala et al. 2016). However, the Project- and sketch design phase received tolerably low uncertainty values in O10 – project and O9 – business performance, where both values are below 70-percent.

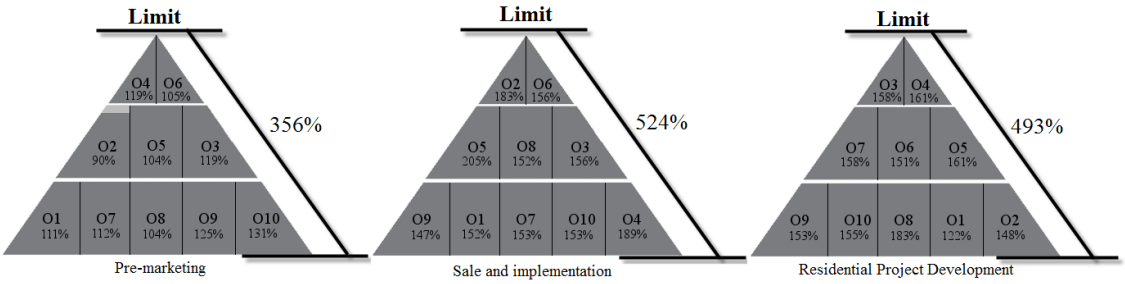



Figure 46. The T&K -uncertainty and the sand cone collapses.

Figure 46 indicates the T&K-uncertainty and the sand cone collapses in the last two phases and in the Residential Project Development-division as a whole. The T&K-uncertainty is over 100-percent in each phase, which again puts the decision evolution into question. The value of uncertainty is affected by the high amount of used attributes, when all of the OP's and BSC's attributes are taken into account.

The same kind of analysis regarding the source of uncertainty can also be conducted with the Sand Cone model based on the technology levels (Figure 47). In this model, the phases' Sand Cones are replaced with sand cones depicting uncertainty in basic, core and spearhead technology by only using OP attributes. The source of uncertainty in the BSC generally has greater values than the OP in all phases because it is not separately processed. As can be noted, the spearhead technology is the greatest source of uncertainty in this analysis too. Moreover, the Sand Cone model of technology levels facilitates a deeper analysis of uncertainty between the individual criteria. For example, it can be observed how the uncertainty in O5 – external structure, which is among the highest in each phases' Sand Cones (in Figures 45 and 46), is almost solely caused by the variability of the spearhead-and core technologies.

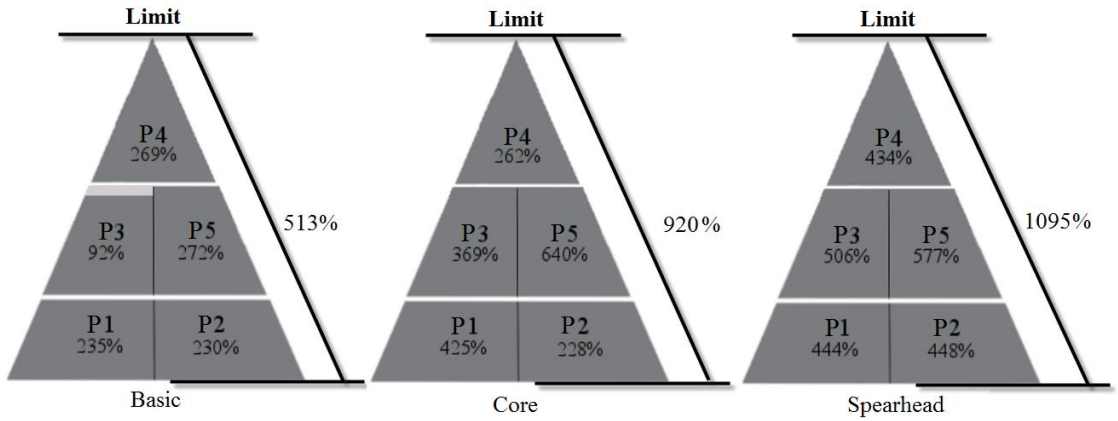



Figure 47. The sand cone model: technology levels - OP.

The next step is to study which aspect of the basic, core, and spearhead classification cause the most variability in the answers from the OP perspective. The "P" -ID comes from the phase number. The image is very clear in this regard, as can be seen from Figure 48, the spearhead technology and knowledge are the main sources of the uncertainty in each phase. Even the core technology returns rather high variabilities in every phase. Therefore, a conclusion can be drawn that the company relies on basic technologies (Figure 39) and bases its technology and knowledge management mainly on basic technology since uncertainty is high in the other two. This can be seen as a means of securing the distribution of energy to customers. Moreover, the percentage amount of spearhead technology is small compared to the basic technology, which decreases the total uncertainty in strategic decision-making since most decisions are based on majority technologies i.e. basic technology.

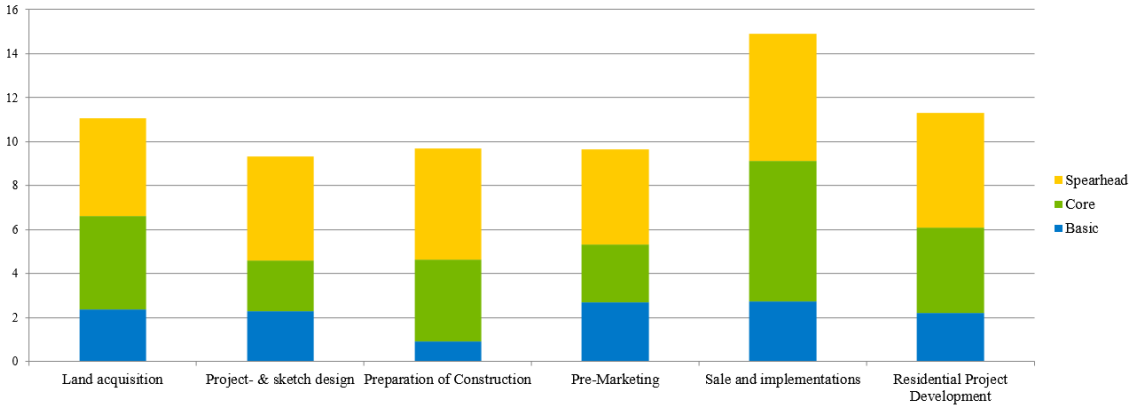



Figure 48. The source of uncertainty in RPD – OP.

As a conclusion, each phase has a rather high K/T uncertainty in investment decision making, since the coefficient of variation and variability coefficients values are great. The biggest TK Risk comes from the spearhead technologies because the strategy type of each phase is Analyzer and the employees are strongly following changes in the industry and not focusing on creating innovations by themselves. This makes it clear that the future T/K is more risky. The division or the case company does not lead the industry from the perspective of future innovations, which leads to doubt how they can keep up with the pace of change. In the perspective of K/T –uncertainty, although multiple core's and spearhead's values of coefficient of variation are over one (>1), almost all the basic CV values are less than one (<1) which is a strong indication of reliability for basic as Mäkipelto and Takala suggested (2009: 292).

### 3.2.5 SCA analysis

After evaluating and defining the critical areas of the case company's Southern Finland Residential Project Development division, the next step of analysis is to define the risk levels in all phases using the SCA method. There are two periods taken into consideration, past 3 years and future 3 years, and the SCA risk levels are measured by the MAPE, RMSE and MAD based on the BCFI and NSCFI. The potential outcomes out of the SCA analysis have a valuable practical nature. The operations SCA evaluation is defined as a risk probability that the division has to change its operations strategy during the period of

time. The SCA analysis provides information about which strategy type may bring better business performance during the analyzed time, forecasting the future strategy (supported by the future critical attributes). The method has wide potential and a sufficient practical value for strategic decision-making process' and strategic analyses. Moreover, SCA validation brings better stability, sensitivity, flexibility and sustainability for the organization, as well as enlarges its performance and competitiveness. Besides the SCA method ensures that the different resources of the company are operating according to the company's strategy (Takala et al. 2013c). The risk levels of the Residential Project Development are calculated by phases separately and together. The values of SCA are between 0 and 1. Therefore, values that are close or greater than 0.97 are considered to be high, values that vary from 0.90 to 0.97 are defined as medium and values that are less than 0.90 are low values (Takala, Shylina & Tilabi 2014).

Table 15. Residential Project Development's SCA results.

| | Technique | β | γ | α | MAPE | RMSE | MAD |
|---|---|---|---|---|---|---|---|
| Land acquisition | BCFI (P) | 1,07 | 1,07 | 1,01 | 0,88 | 0,92 | 0,94 |
| | BCFI (F) | 1,06 | 1,06 | 1,03 | 0,97 | 0,98 | 0,99 |
| | NSCFI (P) | 1,07 | 1,07 | 1,00 | 0,87 | 0,92 | 0,94 |
| | NSCFI (F) | 1,07 | 1,07 | 1,00 | 0,97 | 0,98 | 0,98 |
| Project- & Sketch design | BCFI (P) | 1,07 | 1,07 | 1,00 | 0,81 | 0,88 | 0,91 |
| | BCFI (F) | 1,07 | 1,06 | 1,00 | 0,93 | 0,96 | 0,96 |
| | NSCFI (P) | 1,07 | 1,08 | 0,99 | 0,79 | 0,87 | 0,90 |
| | NSCFI (F) | 1,08 | 1,07 | 0,99 | 0,91 | 0,94 | 0,95 |
| Preparation of Construction | BCFI (P) | 1,05 | 1,05 | 1,03 | 0,85 | 0,91 | 0,93 |
| | BCFI (F) | 1,07 | 1,07 | 1,00 | 0,84 | 0,90 | 0,92 |
| | NSCFI (P) | 1,06 | 1,06 | 1,02 | 0,83 | 0,89 | 0,92 |
| | NSCFI (F) | 1,07 | 1,07 | 1,01 | 0,85 | 0,91 | 0,93 |
| Pre-marketing | BCFI (P) | 1,06 | 1,06 | 1,02 | 0,95 | 0,97 | 0,97 |
| | BCFI (F) | 1,07 | 1,07 | 1,00 | 0,94 | 0,96 | 0,97 |
| | NSCFI (P) | 1,06 | 1,06 | 1,02 | 0,96 | 0,97 | 0,98 |
| | NSCFI (F) | 1,07 | 1,07 | 1,01 | 0,94 | 0,96 | 0,97 |
| Sale & implementation | BCFI (P) | 1,07 | 1,07 | 1,00 | 0,88 | 0,93 | 0,94 |
| | BCFI (F) | 1,06 | 1,06 | 1,02 | 0,97 | 0,98 | 0,98 |
| | NSCFI (P) | 1,07 | 1,06 | 1,01 | 0,88 | 0,93 | 0,94 |
| | NSCFI (F) | 1,07 | 1,06 | 1,00 | 0,93 | 0,96 | 0,97 |
| Residential Project Development | BCFI (P) | 1,07 | 1,07 | 1,01 | 0,90 | 0,94 | 0,95 |
| | BCFI (F) | 1,07 | 1,07 | 1,00 | 0,94 | 0,96 | 0,97 |
| | NSCFI (P) | 1,07 | 1,07 | 1,00 | 0,89 | 0,93 | 0,94 |
| | NSCFI (F) | 1,07 | 1,07 | 1,00 | 0,94 | 0,96 | 0,97 |

According to Table 15, almost all the risk levels in the future are over 0.90 which means that the company operation strategy is going to be sustainable. Meaning that, all the available resources are allocated in a proper way. Thus, the Project- and sketch design phase has the biggest risk-level since values are near or below 0.9 and it has the highest risk level compared to other phases. One of the reasons for this outcome could be based on the BCFI results where the company does not invest enough resources in supporting the work of this phase. The Preparation of construction phase has about the same risk level in the past and future, which can be explained by how the case company's changes have not influenced the phase considerably.

Based on previous results, the Land acquisition phase used to focus highly on cost, even though its decisions needed more flexibility and time. This caused a high risk-level for the phase in the past. In the future, the direction will be better since other factors (quality, time, and flexibility) gain more weight which positively influences the risk-level. The same analysis can also be conducted to the Project- and sketch design phase, Sale and implementation phase and RPD as an entity. The Preparation of construction and Pre-marketing phases' risk level will increase in the future, since either one of the phase's weight values do not change enough with the change of industry and the cost, quality, time, and flexibility weights do not correspond to the changes needed in development.

Table 16. SCA risk-level - OP and BSC compared.

| | SCA OP | | | SCA BSC | | |
|---|---|---|---|---|---|---|
| Technique | MAPE | RMSE | MAD | MAPE | RMSE | MAD |
| BCFI (P) | 0,88 | 0,92 | 0,94 | 0,92 | 0,95 | 0,96 |
| BCFI (F) | 0,93 | 0,96 | 0,96 | 0,99 | 1,00 | 1,00 |
| NSCFI (P) | 0,87 | 0,92 | 0,94 | 0,92 | 0,95 | 0,96 |
| NSCFI (F) | 0,93 | 0,96 | 0,97 | 0,98 | 0,99 | 0,99 |

According to the respondents, there are differences between the OP and BSC risk-levels. As can be seen from Table 16, the BSC's SCA risk levels are slightly smaller than in OP. Thus, it can be stated that the division's daily operations are riskier than the division's

more general level. This is also noted in Figure 26, where the BSC is at a better level than the daily operations (OP), whereby there is a correlation between these two. Altogether, the risk-level is at a tolerable level and could be reduced by centralizing resources more on quality, time, and flexibility.

## 3.3 Findings

The findings are based on the questionnaires that were filled by 16 respondents. The results of every respondent are anonymous and individual responses cannot be separated understandably from the entity. Respondents form groups which are corresponding to the Residential Project Development phases and the results are presented in groups separately and together. Additionally, one respondent from each phase is interviewed face to face in order to get the respondents' opinions on the results (Weak Market Test, WMT). Each phase will be discussed once more separately, bringing the respondent's opinion first, followed by a comparison of the results with these opinions. Unfortunately, due to the scale of the research, the research cannot handle a proposal of each improvement with more details. The findings of the empirical study of operational competitiveness performance of the case company in Finland are presented below. After the performance sub-chapter, a general level of K/T and SCA risk level is gone through.

### 3.3.1 Performance

Results from the AHP analysis show that the phases' focus considerably on the costs even though the actual operation is distributed more to other factors, such as quality and time. However, the weight of the costs is and should be the greatest (Figure 19). Additionally, the cost weight will decrease in the future and divide to other factors, whilst still remaining the most important factor (Figure 20). This is certainly influenced partly by consumers' and third party influencers' environmental awareness and long-term effects on living standards for future generations, and the case company's strong focus on quality. Furthermore, priority weights are in phase order, the first phase is the most important and the last phases are least important (Figure 24). Next, the results are examined more closely

by phases separately and together. Tables from 17 to 22 summarize results from previous chapter.

Table 17. Land acquisition, critical attributes.

| Past | Future |
|---|---|
| **Critical resources** | |
| C3 – reduction of unprofitable time in processes<br>Q6 – customer satisfaction<br>F3 – short and prompt lead-times in order-fulfilment process | C3 – reduction of unprofitable time in processes<br>F3 – short and prompt lead-times in order-fulfilment process |
| **Need attention** | |
| Q9 – know-how<br>Q10 – knowledge | Q9 – know-how<br>Q10 – knowledge |

Respondent 1 from the **Land acquisition** phase agreed with the results and emphasized that this phase includes an extremely small group of people where the preservation of tacit knowledge is critical. For example, a year ago an employee went to work for a competitor firm, making his expertise, experience and tacit knowledge for the beneficial to the competitor. Because of this problem, the phase should systematically collect tacit knowledge among other types of knowledges from employees in order to increase know-how and knowledge, which are seen as attention attributes. Employees also improve their skills alongside everyday routines themselves, and they should also be active and find training courses that will improve their future competences. Furthermore, the respondent disclosed that, employees' knowledge and know-how come through from experience and everyday work. Additionally, the phase has successfully started using a new information system and perceives that they have the required information systems in the future, which is reflected to the research as a balanced, non-critical information systems resource. What comes to critical resources, Finland's and Southern-Finland cities' laws and regulations are affecting to unprofitable- and short & lead-times. As an another example, a project timeline can move more than six months ahead, because of a city's operating model, which is difficult to influence by company's employees. The phase's employees' work is

partly lobbying towards city's employees, but all the unprofitable time cannot be removed by lobbying or pushing them. In addition, it is clear that certain policies can't be changed, such as the length of time for appeal, which affect negatively towards the reduction of unprofitable time in processes. (Respondent 1.)

In order to interfere with attributes that need more attention, the phase should considerably focus on preservation of knowledge and know-how. This can be done by sharing tacit knowledge more efficiently with methods such as systematically improving information systems and sharing information among new employees. Although, training and development of the company's personnel is seen as competitive advantage according to the respondents, know-how and knowledge are at the same level compared to competitors. Hence, know-how and knowledge should be looked at closer and consider how these could be better harnessed for competitive advantage, since there is a lot of opportunity. The both critical resources are included to the "Processes and Work-flows" –category, which is the most important factor to the phase (Figure 25), wherein these should be improved. Critical resources can be difficult to influence, since they strongly are influenced by third parties such as appeals from neighborhood's residents and city employees and their operations. However, a systematic approach and lobbying towards third parties is one way to do this. In addition, maximizing the reduction of unprofitable time in processes and, if necessary, reallocating employees input to other tasks will increase profitability. Q6 – customer satisfaction requires a closer approach by the employees, since it has been declared as critical.

Table 18. Project- and sketch design, critical resources.

| Past | Future |
|---|---|
| Critical resources | |
| C1 – innovativeness and performance of research and development<br>C2 – knowledge and technology diffusion<br>C12 – cost management in projects<br>Q3 – quality control of products, processes, and operations<br>Q4 – quality and reliability of information in information systems<br>Q5 – usability and functionality of information systems<br>T3 – information systems support the business processes<br>F3 – short and prompt lead-times in order-fulfilment process<br>F5 – well defined responsibilities and tasks for each operation | C1 – innovativeness and performance of research and development<br>C5 – code of conduct and security of data and information<br>C12 – cost management in projects<br>Q3 – quality control of products, processes, and operations<br>Q5 – usability and functionality of information systems<br>T3 – information systems support the business processes<br>F5 – well defined responsibilities and tasks for each operation |
| Need attention | |
| C8 – competence<br>Q2 – control and optimization of all types of inventories<br>Q9 – know-how<br>Q10 – knowledge<br>T6 – process improvement<br>T7 – performance-to-promise<br>T8 – professional relationship<br>F9 – benevolent collaboration<br>F10 – empathy | T1 – communication between different departments and hierarchy levels<br>F11 – projects are flexible enough to conform to changes |

Respondent 5 from the **Project- and sketch design** phase was able to highlight the vast majority of the results in the phase. The phase circumvents the greatest risks and prefers a well-known and safe routine and action. The respondent thinks that the phase is focused enough on innovation, although little is invested in innovations. As emphasized by the phase's analyzer strategy, competitors are closely monitored and only necessary innovations are selected. Additionally, employees' personalities either affect the research and development negatively or positively. Moreover, when it comes to information systems much is to be improved. Employees are relying too much on Excel and often information is transferred manually to other locations. Currently the information systems

do not create much of possibilities or relief to work but makes the operations more dilatory. Furthermore, a lack of resources or tools in cost management significantly complicates cost estimation and makes attribute C12 critical. Currently the phase's employees make a lot of choices based on inadequate cost estimations which adversely affects a successful project. (Respondent 5.)

Currently the phase is facing difficulties with information systems and the phase should considerably focus on improving it in every aspect. They should renew document management and information systems in order to increase quality, reliability, usability, and functionality of the systems. Secondly, it would be important to have a simpler and better tool for more accurate cost estimates. Additionally, cost estimations for each project should be conducted more often in order to make decisions more easily. Furthermore, employees' responsibilities and tasks should be made clearer among other phases' employees. Additionally, innovativeness and performance of research and development should be considered critically if the phase wants to avoid additional risk. On the other hand, research and development could be secured by reallocating resources in it while supporting knowledge and technology diffusion.

Table 19. Preparation of construction, critical attributes.

| Past | Future |
|---|---|
| Critical resources | |
| C10 – sales<br>C11 – customers<br>Q5 – usability and functionality of information systems<br>T3 – information systems support the business processes<br>T7 – performance-to-promise<br>T9 – projects are possible to implement in time | C9 – financial<br>C10 – sales<br>C11 – customers<br>Q6 – customer satisfaction |
| Need attention | |
| C6 – innovation<br>Q9 – know-how | |

Respondent 9 from the **Preparation of construction** phase agreed with most of the results. For example, when the cost importance shifts towards quality according to the AHP method, the phase stays strongly focused on costs in the future, whereby the phase does not react enough to the changes in factors. This abstinence will critically affect the C9, C10, C11, and Q6 attributes, according to the respondent. Furthermore, the respondent was worried by customers' feedback which weight decreased before reaching the phase where sometimes the feedback is not taken seriously enough. Additionally, the respondent emphasized that sometimes other departments do not understand another's problems and there may be accusation which has partly led to a lack of confidence. The phase is also inwardly warm and does not work in the moment. In this case, they do not seek enough inspiration from external sources and react slowly to changes and insufficiently follow what the competing companies do. Moreover, the phase relies heavily on standardized solutions, which may affect the inflexibility of the organization. Employees are doing their job as always before, and perhaps not enough attention is paid to new solutions such as the implementation of work methods. The case company is an international company and new ways of working can be easily sought out elsewhere. Additionally, the information systems do not support the operation enough, whereby employees are forced to; for example, do tasks manually or by using an excel-document as noted in the previous phase. Information is found from various information systems which are not integrated together and the information is transferred often by hand to other systems, usually to excel-documents which may even be used too often. (Respondent 9.)

The respondent who participated in the Acid-test is from the Preparation of construction phase. The phase's results have coherence between the acid-test, which increases the validity and reliability of the research. Currently the phase is facing great difficulties within the information systems as well as the Project- and sketch design phase is. The phase should considerably focus on the information systems in order to improve business processes. Improvements in the information systems provide necessary tools for flexibility and accuracy in the whole process when reliable information is always available at the right time. Additionally the phase should observe the changes around the market and estimate customer preferences carefully. Moreover, the phase should explore potential improvements to the practices that have been rooted to each employee over the

years. On the other hand, most of the criticalities are affecting activities on a more general level (BSC), whereby the phase should be looked at a more general level.

Table 20. Pre-marketing, critical attributes.

| Past | Future |
|---|---|
| **Critical resources** | |
| C1 – innovativeness and performance of research and development<br>Q3 – quality control of products, processes and operations<br>Q4 – quality & reliability of information in information systems<br>T2 – design and planning of the processes and products<br>T3 – information systems support the business processes<br>T5 – availability of information in information systems<br>F5 – well defined responsibilities and tasks for each operation<br>F6 – utilizing different types of organizing systems<br>F7 – engagement | C1 – innovativeness and performance of research and development<br>C4 – leadership and management systems of the company<br>T6 – process improvement<br>F6 – utilizing different types of organizing systems<br>F7 – engagement |
| **Need attention** | |
| C3 – reduction of unprofitable time in processes<br>Q6 – customer satisfaction<br>F4 – adaptiveness of changes in demands and in order backlog<br>F9 – benevolent collaboration | C3 – reduction of unprofitable time in processes<br>T9 – projects are possible to implement in time<br>F2 – adaption to knowledge and technology<br>F3 – short and prompt lead-times in order-fulfilment process<br>F11 – projects are flexible enough to conform to changes |

Respondent 14 from the **Pre-marketing** phase was positively surprised how well the results respond to the current situation and accentuates the results. The phase occasionally follows the activities of competing companies and does not run independently to create new innovation on a new basis. The phase's employees operate as they are used to, relying on standardized solutions that are not always up-to-date. For example, a standardized solution for room decor is not flexible enough to adapt to customer preferences when

preferences change over time. The phase can't offer flexible solutions for customers who either accept the standardized proposal or go elsewhere. Furthermore, a new way of presenting a final outcome to customers is missing and for example, competing companies make better use of technologies and materials, such as videos from a project, to get new customers. Altogether, marketing itself has remained in an outdated world and its operations are based on old operating models where employees do not seek for new customers efficiently but wait for customers to get in touch with them. The phase may also live in its own bubble without any knowledge of changes around it. As far as the information systems are concerned, current systems do not support the operation well enough. The information systems are stacked on top of each other and the information is divided into multiple locations lacking proper integration. Additionally, currently the information systems are not fully implemented from the point of Pre-marketing and the use is often challenging. (Respondent 14.)

The phase should considerably focus on creating a systematic way of staying up to date, and creating and sharing new innovativeness. One possibility is to create a concrete development center or a task group that is responsible for, among other things, the emerging criticalities from the research. Additionally, innovations and new ways of action should be divided better between phases and employees, and more attention should be paid to their adoption. Moreover, it has been expressed that the top management is not fully aware of where the phase is going or what it should aim for, so it is important to clarify the direction and communicate it to the employees.

Table 21. Sale and implementation, critical attributes.

| Past | Future |
|---|---|
| **Critical resources** | |
| C1 – innovativeness and performance of research and development<br>C2 – knowledge and technology diffusion<br>C3 – reduction of unprofitable time in processes<br>C4 – leadership and management systems of the company<br>C6 – innovation<br>C7 – information technology<br>C8 – competence<br>Q4 – quality & reliability of information in information systems<br>Q5 – usability and functionality of information systems<br>Q8 – brand<br>Q11 – quality is equivalent to expected level<br>T3 – information systems support the business processes<br>T4 – visibility of information in information systems<br>T5 – availability of information in information systems<br>T9 – projects are possible to implement in time<br>F2 – adaption to knowledge and technology<br>F8 – openness<br>F9 – benevolent collaboration | C2 – knowledge and technology diffusion<br>C3 – reduction of unprofitable time in processes<br>C4 – leadership and management systems of the company<br>C7 – information technology<br>Q4 – quality and reliability of information in information systems<br>Q5 – usability and functionality of information systems<br>Q8 – brand<br>Q11 – quality is equivalent to expected level<br>T3 – information systems support the business processes<br>T4 – visibility of information in information systems<br>T5 – availability of information in information systems<br>T9 – projects are possible to implement in time<br>F2 – adaption to knowledge and technology<br>F9 – benevolent collaboration |
| **Need attention** | |
| C5 – code of conduct and security of data and information<br>C9 – financial<br>C10 – sales<br>C11 – customer<br>C12 – cost management<br>Q2 – control and optimization of all types of inventories<br>Q3 – quality control of products, processes and operations<br>T6 – process improvement<br>T8 – professional relationship<br>F7 – engagement. | C5 – code of conduct and security of data and information<br>C9 – financial<br>C10 – sales<br>C11 – customer<br>C12 – cost management<br>Q2 – control and optimization of all types of inventories<br>C3 – quality control of products, processes and operations<br>Q6 – customer satisfaction<br>T6 – process improvement<br>T8 – professional relationship<br>F7 – engagement. |

Respondent 19 from the **Sale and implementation** phase agreed with the results and was surprised by the significance and usability of the results. The respondent also confirmed that a lot of criticalities can be found from the phase since the phase contains considerably more changing factors and employees than any previous phase. Currently much work is done manually and unprofitable time can be always reduced by improving the information systems, which are truly critical. Several information systems are inadequate and employees' thoughts, constraints and rooting in outdated methods make development and operations tacky. Data is often transferred and shared manually. Additionally, Excel is strongly relied on, even though the case company is multinational organization, which should rely on other, more modern information systems. In other words, information and data bounces back and forth, and is located in several different locations lacking integration. Furthermore, the direction of the strategy is difficult to perceive in everyday operations, even though the bigger picture is clear. Additionally, the respondent is worried by lower level strategies, which are partially crossed and leaders' uncertainty about the right direction, which bring several criticalities to the phase such as C1, C4, Q8, and F2. Management systems must be in line and going the same direction within all operations. Personnel changes at a higher level have contributed to the recent rise in digitalization and the importance of knowledge in the operations. However, there is a concern about resource shortage in the way of the potential for digitalization as a pioneers. Moreover, the case company's brand is generic, even though it should be desirable and identifiable. Currently the case company is clearly focusing on to a specific customer and employee segments such as engineers, which also reflects on, how potential customers and employees see the company. Finally, the respondent emphasizes that they should be more closely involved in development and seek the leadership in the market. (Respondent 19.)

Based on the results, the phase has clearly invested a lot of resources towards certain attributes such as C5, C9, C10, C11, C12, Q2, Q3, T8, and F9 since all of these are over resourced. However, most of them require considerable investments in the future as well in order to perform sustainably in the markets. As most of the phases' experience, the information systems should be improved from every perspective (Q4, Q5, T3, T4, and T5). Additionally, since the strategy type is Analyzer and they keenly follow the changes

in industry, attributes C1 C2, and F2 are truly critical since these do not support the strategy type at all. Furthermore, lower level strategies should be clarified among employees and ensure that those are not in conflict with each other, thus leadership and management systems are critical. Additionally, building the case company's brand and image, in order to increase its desirability and identifiability among potential customers and employees, has been identified to be critical in the past and in the future and the respondent agrees with this. The brand should not just focus on a specific segment but to get the attention of a larger target audience, since awareness among consumers creates a competitive advantage.

Table 22. Residential Project Development, critical attributes.

| Past | Future |
|---|---|
| Critical resources | |
| C1 – innovativeness and performance of research and development<br>C2 – knowledge and technology diffusion<br>C7 – customer loyalty<br>Q4 – quality & reliability of information in information systems<br>Q5 – usability and functionality of information systems<br>T3 – information systems support the business processes<br>T5 – availability of information in information systems | F10 – empathy |
| Need attention | |
| C5 – code of conduct and security of data and information<br>T6 – process improvement | Q4 – quality & reliability of information in information systems |

Based on overall situation in the Residential Project Development and previous chapter's results, the present situation is tolerable, albeit with various potential improvements. Employees believe that resources are reallocated towards critical resources such as information systems and the situation will improve considerably over the next three years. Although the overall situation is good, different phases are tackling with different

problems which should be taken into account separately and interpreted by the best experts in the case company in order to find improvements in practice by a reasonable level of investment.

According to the results, the Analyzer strategy type is considered to be the main strategy type in the past and in the future, leaving other strategy types far behind. Additionally, each phase's results support this strategy type. It is also noticeable that the company's current strategy is reflected in its visions and goals, and has been internalized at all levels of the Residential Project Development division. Their strategy is focusing on to reduce the waste of time and unnecessary work in order to effectively implement the best practices, procedures, systems and people skills, not forgetting about quality in processes. However, criticalities in the phases such as C1, C2, and F2 are in conflict with the strategy type, since even though the division keenly follows the changes in industry, the implementation of innovations and development ideas for the case company are inadequate.

The case company's success factors compared to competitors, based on the respondents' answers from S&R questionnaires' column "Compared to competitors", OP success factors are: F1 – training and development of the company's personnel, C5 – code of conduct, and security, and BSC factors are C9 – financial, T7 – performance-to-promise, and F10 – empathy. From the point of view of the results, the following attributes were not critical at any point and have create a successful competitive advantage: F1 – training and development of the company's personnel, T1 – communication between different departments and hierarchy levels, T2 – design and planning of the processes and products, Q1 – on-time deliveries to customers, Q2 –control and optimization of all types of inventories, F4 – adaptiveness of changes in demands and in order backlog, Q7 – customer loyalty, Q9 – know-how, Q10 – knowledge, T8 – professional relationship, and F11 – projects are flexible enough to conform to changes.

Generally, it can be summed up that the Residential Project Development requires a significant increase of the level of information systems, and innovativeness and performance of research and development. This can be achieved partially through a

systematic way of co-operation between responsible employees for information systems, decision makers, and the division's employees. Moreover, the amount of employees and the reallocation of resources should be reviewed again since clear critiques are emerging in the operations.

### 3.3.2 Results of K / T and SCA

The Residential Project Development seems to rely a lot on basic technology in securing its operations (Figure 39). This is quite reasonable result since the construction industry can't be compared with space technology, where spearhead technologies can be assumed to have a major role. Nonetheless, core- and spearhead technologies have been found evenly from each attribute that strengthens the steady development of each of these.

From the perspective of K/T, the variability coefficients can be concluded that there is uncertainty in investment decision making in the case company. Thus, the collapse risks in the Sand Cone layers and the T&K -uncertainty figures question the investment evaluation and the comparison of each phase. The uncertainty is caused by the spearhead technologies as observed from Figures 47 and 48, since operations rely heavily on monitoring their competitors closely for new ideas, and then rapidly adopting those which appear to be the most promising. However, adoption of knowledge and technology has been found to be critical in some phases. Furthermore, innovativeness and performance of research and development has been found critical in multiple phases, in which case the division should think carefully about their needs to contribute to development and research. Thus, the operations circumvent the greatest risks and prefer well-known and safe routines and action. Moreover, the operations need to be clarified and employees should be more aware of their competitive advantages which have been affected by unclear information and inconsistency in operations.

In the perspective of SCA, the validation tests MAPE, RMSE, and MAD for Critical Factor Indexes (BSCFI and NSCFI) in all the phases reached quite high values in the future except for the Preparation of construction phase in the past, meaning a small window of error (Table 15). According to Table 16, BSC's SCA risk level is slightly

smaller than in OP, it can be stated that the division's daily operations are riskier than the division's more general level. This is also noted in Figure 26, when BSC is on better level than daily operations (OP), whereby there is a correlation between these two. Altogether, the risk-level is at a tolerable level and could be reduced by centralizing resources more on quality, time, and flexibility, in which case the operation corresponds better to the weight limits. Altogether, almost all the risk levels are less than 0.10 in the future which means that the case company's operation strategy is sustainable.

## 3.4 Summary

Based on the results it was found that the case company's Southern Finland Residential Project Development division is mainly well balanced in its resource allocation and those resources which seem to be out of place are definitely heading in the right direction. Despite the fact that the direction of resource usage is mostly towards a good overall balance, the results clearly indicate that a thorough resource allocation should be taken into consideration. The results should be interpreted by the best experts in the case company in order to find improvements in practice by a low level of investment.

In general, the information systems are critical in the RPD and the phases' experiences criticality in a variety of ways. The benefits of implementing better information systems increase other attributes as well, if correctly exploited. In the perspective of SCA, the risk level is at a good level in several phases, excluding the Preparation of construction which has the highest risk level in the future. K/T perspective impairs the SCA values considerably since employees do not realize where their competitive advantage arises. Moreover, operations are relying on basic technologies (over 50-percentage) but also having core and spearhead technologies (Figure 39). Basic technologies clearly have the lowest K/T Risk and it is on a good level, while core and spearhead have mostly much higher risk, taking into account only the OP attributes (Figures 47 and 48). Hereby the high uncertainties are composed from core and spearhead uncertainties.

Based on the results, the RPD's strategy type is Analyzer and it will become even more obvious in the future. Even though the RPD combines the strength of two other strategies and balance between quality, cost, and time, there is a concern that they do not systematically follow the changes in industry enough. Additionally, the criticalities in phases such as C1, C2, and F2 are in conflict with the strategy type, since even though the division keenly follows the changes in the industry, the implementation of innovations and development ideas for the case company is inadequate. Moreover, the overall situation in the case company's Southern Finland's Residential Project Development is satisfying even though there are multiple changes to make in order to increase the sustainable competitive advantage.

# 4 DISCUSSION

The Master's Thesis is a scientific paper which consists not only of a research work but also a personal contribution made by the writer into the development of the chosen topic. Compared to the previous studies which combine sustainable competitive advantage and knowledge and technological perspectives, this research is very comprehensive study since it has multiple distinctive features. First of all, it measures resource allocation from the S&R and K/T point of view and the division's strategy type in each phase. Secondly, the research points out the K/T– uncertainty in investment decision making in each phase and finally points out the risk-level of each phase by using SCA. Furthermore, in order to exploit the Weak Market Test, some respondents' opinions are included to support the results and to strengthen its discoveries in each phase.

In today's highly competitive and fast paced world it is important for a company to have a balanced strategy which is unified and precisely executed to gain a sustainable competitive advantage in order to outperform its rivals. The freedom of action in a company is limited to satisfying the needs of those entities outside the firm (customers and investors, primarily) that give the resources it requires in order to survive. If employees and systems don't meet the needs of customers and investors and if they don't provide the products, services, and profit they require, the organization will be starved of the resources it needs to survive and will ultimately cease to exist.

In order to survive within nationwide competition, the critical attributes should be determined and solved in each of the division's phases individually and as larger entities on a division level. Since there are many variables involved and the period of time when the questionnaire was sent out has been unstable, the overall situation in the future is expected to be improved, even though new critical attributes will appear.

## 4.1 Findings and contributions

The findings and contributions are gone through by answering the research questions. The sub-questions' answers are presented first in order to support the main question's answer. The first sub-question, "What are the critical resources and how should they be reallocated to achieve better performance" is depending on each phase, since they operate very differently.

The **Land acquisition phase** differs significantly from the other phases with less critical attributes (Table 17). The phase's criticalities are related to reduction of unprofitable time in processes, and short and prompt lead-times in processes, which are greatly influenced by external factors such as laws, regulations, and city's employees' operational procedures. The phase should focus on these two criticalities by taking into account the possible delays in projects more carefully and sharing the workload between employees.

The **Project- and sketch design phase** has a lot more criticalities than the previous phase (Table 18) and the phase circumvents the greatest risks and prefers well-known and safe routines and action. The phase should considerably focus on getting more out of information systems and a way of creating more reliable cost estimations for projects by conducting estimations more often and relying on dynamic information systems. One possibility is to benchmark the best practices from other countries where the case company operates.

The **Preparation of construction phase** encounters the same problems with the information systems as the previous phase (Table 19). Additionally the phase should observe the changes around the markets and estimate customer preferences carefully. The phase also has the highest SCA risk level in the past and in the future, in which case the risk should be reduced by clarifying lower level strategies and by developing operations in order to eliminate criticalities.

The **Pre-marketing phase** has criticalities in information systems and the phase should focus on creating a systematic way of staying up to date and creating and sharing new

innovations from research and development (Table 20). The phase should get out of its closed bubble by taking advantage of the newest technologies and renew its operations towards customer-orientation.

The **Sale and implementation phase** is the most critical since the amount of critical attributes in the past and in the future are the highest (Table 21). The phase is struggling with its information systems and this brings far more troubles in operations than opportunities. Additionally, according to respondent 19, lower level strategies are partially crossed and managers' uncertainty about the right direction makes the operations disorganized. Finally, the phase experiences the case company's brand as generic, even though it should be desirable and more identifiable in Finland. Due to the number of criticalities in the phase, the management should support the development of every criticality of the phase towards a better outcome.

On a general level, each phase was linked by a bigger critical factor, information systems, which can be the reason to take an in-depth look into the information systems and significantly invest on these. Personnel changes at a higher level have contributed to the recent rise in digitalization and the importance of knowledge in the operations, whereby development will take a better direction from many points of view (Table 22). Moreover, the amount of employees and the reallocation of resources should be reviewed again since clear critiques are emerging in operations. One possibility is to benchmark the best practices from other countries where the case company operates in order to decrease the critical attributes. Despite the fact that the direction of resource usage is mostly towards a good overall balance, the results clearly indicate that a thorough resource allocation should be taken into consideration and make sure that the direction really is going to be better by utilizing this research.

What are the case organization's success factors compared to competitors? The division circumvents the greatest risks and prefers well-known and safe routines and action, which can be seen as an advantage since their focus is on what is best known. Based on the respondents' answers from S&R questionnaires, OP success factors are: F1 – training and development of the company's personnel, C5 – code of conduct, and security, and BSC

factors are C9 – financial, T7 – performance-to-promise, and F10 – empathy. From the point of view of the results, the following attributes were not critical at any point and thus have a successful competitive advantage: F1 – training and development of the company's personnel, T1 – communication between different departments and hierarchy levels, T2 –design and planning of the processes and products, Q1 – on-time deliveries to customers, Q2 –control and optimization of all types of inventories, F4 – adaptiveness to changes in demands and in order backlog, Q7 – customer loyalty, Q9 – know-how, Q10 – knowledge, T8 – professional relationship, and F11 – projects are flexible enough to conform to changes.

What is the level of uncertainty in investment decision making? The level of uncertainty is high since the coefficient of variation values and the variability coefficients values are exceptionally significant in each phase. Additionally, the collapse risks in the Sand Cone layers and the T&K -uncertainty figures question the investment decision-making evaluation and the comparison of each phase. The uncertainty is caused by the core and spearhead technologies as observed from Figures 47 and 48, since the operation relies heavily on monitoring their competitors closely for new ideas, and then rapidly adopting those which appears to be the most promising. Furthermore, the attributes such as C1, C2, and F2 have been found to be critical at some phases and for that reason are truly critical since these do not support the Analyzer strategy type at all, since for example adaption to new knowledge and technology is inadequate. Even though, the operations circumvent the greatest risks and prefer a well-known and safe routine, and action, each phase contains significant uncertainty in investment decision making, which negatively influence gaining a sustainable competitive advantage. Moreover, operations need to be clarified and employees should be better aware of their competitive advantages which have been affected by unclear information and inconsistencies in operations.

How can the case company's Southern Finland Residential Project Development be improved in the perspective of operational strategy? Based on the results, it was found that the case company's Southern Finland Residential Project Development division is mainly well balanced in its resource reallocation and those resources which have seemed to be out of place are definitely heading in the right direction. Despite the fact, that the

direction of resource usage is mostly towards a good overall balance, the results clearly indicate that a thorough resource allocation should be taken into consideration. According to the research results, each phase should be considered separately since each phase is facing different problems. Obviously, information systems need improvement on a bigger scale, but competitive improvement happens in each phase individually. The results should be interpreted by the best experts in the case company in order to find improvements in practice by a reasonable level of investment. Moreover, the research can be used as a tool for strategic decision-making.

## 4.2 Theoretical and practical implications

The research itself is comprehensive since multiple perspectives have been investigated and methodologies used such as: The Analytical Hierarchy Process, Critical Factor Indexes, Sense and Respond, the RAL–concept, Manufacturing Strategy Index, Knowledge and Technology, and Sustainable Competitive Advantage. Theoretically, the results provide a progress report about the present and the direction where the division and its phases are going to be in the future. This information provides insight information for decision makers to correctly reallocate resources towards a more sustainable competitive advantage and to support the decisions that sometimes appear to be difficult.

The results of the research were presented to the case company's directors and they were pleased with the concrete results. The research in itself certainly sparked interest amongst directors and the respondents, in which case the research was not made in vain. Practical implications focus on future decisions when this study will hopefully be used to support decisions. All in all, it seems that this research method can be utilized in this kind of context since the results are exploitable in strategic decision-making.

## 4.3 Validity and reliability

Independent answers from the respondents in both the AHP and S&R questionnaires improved the objectivity. Although, the amount of respondents in each phase was small, the respondents' high competence expertise should be representative of the knowledge of operations in the studied division. Furthermore, the amount of attributes in the questionnaires, which cover both OP and BSC areas, increased reliability since the results are based on a broader perspective. The Acid-test was passed when the respondents agreed with the results and additionally, the respondents gave their opinions related to improvement possibilities and agreed on almost every point in the results. Furthermore, utilization of Weak Market Test increased both, validity and reliability of the results.

In terms of the AHP questionnaire, the inconsistency ratio (ICR) is calculated in order to evaluate the validity of each answer in the AHP and each respondent's AHP answers are utilized in this research, because of low ICR values. In the perspective of K/T – uncertainty, although multiple core's and spearhead's values of the coefficient of variation are over one (>1), almost all the basic CV values are less than one (<1) which is a strong indication of reliability. Additionally, each model's strategy type order was either the same or close to each other, which indicates reliability. Furthermore, the results were gone through with the respondents and their opinions regarding results support the validity and reliability of this research.

## 4.4 Research limitations

The field of current research is relatively wide, as it touches theories from decision making and strategic planning to strategy selection and performance improvement areas. Hence there are obvious research limitations which affect the end results and their usability. The overall competitiveness potential is limited to an operation strategy level, which does not necessarily reflect the real business potential. Thus, a good competitiveness ranking does not necessarily lead to higher business performance.

The research is focusing only on the Southern Finland region, which is a rigorous limitation. All of the respondents (16), which is also a limitation, are working inside of this region, and asked to evaluate the situation in their perspective. Secondly, each human with a different past experience and educational background sees the questions differently, which affects the end results and generates limitations for the research. Therefore, the results of the research should not be generalized, since its relevant characteristics are completely specific to the Case Division.

Additionally, there are no previous studies on the case division, in which case the selected methodologies might not be fully suitable for this kind of context. Moreover, the analytical models for manufacturing strategies are not sufficiently calibrated on a global context. Finally, the research purpose is also seen as a boundary, when the purpose is to determine the current situation and potential possibilities for the performance improvement.

## 4.5 Future research

This research itself should not be the last in this case and several future research ideas can be proposed as follows.

As it was mentioned before, there are only 16 respondents from the case company. For future research it is more reliable and desirable to have more participants from each Residential Project Development phase. Furthermore, the research's region framing can be extended to cover the whole Finland, which could be done by the author in the future. Since the Residential Project Development is divided into five phases, none of the outcomes of this research show how the operation is perceived from an external point of view. Hereby, a sixth group could be included in order to collect data from employees, whose work is significantly impacted by the RPD. Additionally, a macro-level research can also be implemented in order to gain a wider scope research, since competitors would be studied more specifically.

Additionally, the used methodologies and their influences to the particular industry should also be studied more carefully since, for example, the K/T-uncertainty was notable. Moreover, it is recommendable to study the effect of the industry to the obtained results. How the used methodologies impinge on reliability and such as the SCA risk-level.

# 5 CONCLUSIONS

The main purpose of this research was to improve sustainable competitive advantages through resource allocation in Residential Project Development in the case company. Analysis of the operational competitiveness focuses on detecting the right operational strategy and resource allocation by exploiting seven different kind of methodologies: The Analytical Hierarchy Process (AHP), Critical Factor Indexes (CFI), Sense and Respond (S&R), the RAL-concept, Manufacturing Strategy Index (MSI), Knowledge and Technology (K/T), and Sustainable Competitive Advantage model (SCA) were used in order to gain an overall picture.

The research was arranged in the case company among respondents in Southern Finland and the number of respondents, overall and per each phase, was sufficient enough for making strong statements. All the goals set were achieved and the study was carried out as planned. Different kinds of development ideas for each phase were presented in order to gain Sustainable Competitive Advantages. Additionally, the weaknesses of each phase and division were raised to make them more effective. The research started by collecting necessary information about the case company, about the research field, and methodologies. The proverb “well-designed is already half made” also is true in this study. When the background work was completed, more detailed sketches were made and the questionnaires were modified. So far, everything went as it was intended to. However, receiving data from the respondents took some time, but eventually went smoothly. Analyzing and rendering the results went unexpectedly easily, as the phases’ criticalities and problems were particularly clear.

Overall, the research was very difficult to accomplish due to the scale of the division and the variety of the phases. Therefore, due to the scale of the study, it is impossible to intervene with all the perspectives and details. Nevertheless, a further deeper investigation of the criticalities is necessary.

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# APPENDICES

# APPENDIX 1. AHP questionnaire.

**Master Thesis, Residential Project development**
**Klaus-Erik Heimonen, University of Vaasa**

Name _____

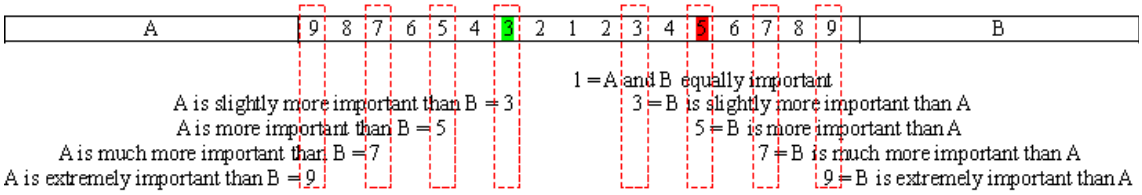
Southern-Finland Residential Project Development.

Collected information is confidential. The results of the responses are collected for my research's statistical data, such that individual responses are not separately identifiable.

Define your company's Residential Project Development's operation strategy's the weight values of quality, costs, time, and flexibility. Note that the sum of the row should be a total of 100 %.

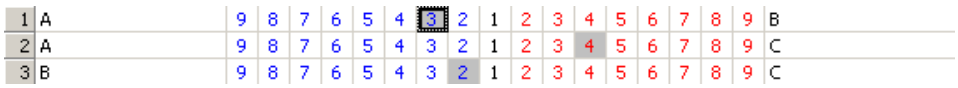
| | Quality % | Cost % | Time % | Flexibility % |
|---|---|---|---|---|
| Last 3~5 years | | | | |
| Coming 3~5 years | | | | |

The questionnaire is based on AHP (Analytical Hierarchy Process) where respondent make pairwise comparison among all the factors. Firstly you need to compare these two given factors and select one factor which you considered as more important than the other. Secondly you need to give a weight within scale of 1-9 to indicate in what extent you consider this selected factor is more important than the other one. If the factors are equally important, then select number 1.




In order to ensure the validity of answers, two incorrect examples with high inconsistence ratio (ICR) are illustrated below. By understanding the causes of ICR, informants are recommended to recheck the consistency after filling the answers.

Example 1:




This means A>B & B>C & C>A which is logically inconsistence, so it causes high ICR.

Example 2:


This means A is much bigger than B, and A is a little bigger than C, from these two conditions it can be concluded that C should be bigger than B, but last condition put B is bigger than C, which is contradictory and causes high ICR.

FILLING THE FORM

Please evaluate the following criteria in every pairwise comparisons what are more important in your opinion. Please circle **(O) the evaluation values for past situation** (Last 3-5 years) and mark **(X) the evaluation values for future situation** (coming 3-5 years). **Nb!** Explanation of the criteria's are at the end of this

1 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 2
3 9 8 7 6 5 4 3 2 O 2 3 X 5 6 7 8 9 4

**Main groups**

| | | |
|---|---|---|
| Land acquisition | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Project- & sketch design |
| Land acquisition | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Preparation of construction |
| Land acquisition | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Pre-marketing |
| Land acquisition | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Sale and implementation |
| Project- & sketch design | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Preparation of construction |
| Project- & sketch design | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Pre-marketing |
| Project- & sketch design | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Sale and implementation |
| Preparation of construction | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Pre-marketing |
| Preparation of construction | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Sale and implementation |
| Pre-marketing | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Sale and implementation |

**Main criteria**

| | | |
|---|---|---|
| Cost | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Quality |
| Cost | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Time |
| Cost | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Flexibility |
| Quality | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Time |
| Quality | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Flexibility |
| Time | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Flexibility |

Categories

**Main criteria**

| | | |
|---|---|---|
| Knowledge & Technology Management | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Processes & Work flows |
| Knowledge & Technology Management | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Organizational systems |
| Knowledge & Technology Management | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Information systems |
| Knowledge & Technology Management | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | External structure |
| Knowledge & Technology Management | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Internal structure |
| Knowledge & Technology Management | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Learning and growth |
| Knowledge & Technology Management | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Trust |
| Knowledge & Technology Management | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Business performance |
| Knowledge & Technology Management | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Project |
| Processes & Work flows | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Organizational systems |
| Processes & Work flows | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Information systems |
| Processes & Work flows | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | External structure |
| Processes & Work flows | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Internal structure |
| Processes & Work flows | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Learning and growth |
| Processes & Work flows | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Trust |
| Processes & Work flows | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Business performance |
| Processes & Work flows | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Project |
| Organizational systems | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Information systems |
| Organizational systems | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | External structure |
| Organizational systems | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Internal structure |
| Organizational systems | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Learning and growth |
| Organizational systems | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Trust |
| Organizational systems | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Business performance |
| Organizational systems | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Project |
| Information systems | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | External structure |
| Information systems | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Internal structure |
| Information systems | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Learning and growth |
| Information systems | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Trust |
| Information systems | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Business performance |
| Information systems | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Project |
| External structure | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Internal structure |
| External structure | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Learning and growth |
| External structure | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Trust |
| External structure | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Business performance |
| External structure | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Project |
| Internal structure | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Learning and growth |
| Internal structure | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Trust |
| Internal structure | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Business performance |
| Internal structure | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Project |
| Learning and growth | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Trust |
| Learning and growth | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Business performance |
| Learning and growth | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Project |
| Trust | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Business performance |
| Trust | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Project |
| Business performance | 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 | Project |

THANK YOU FOR YOUR ANSWERS!

# APPENDIX 2. Sense & Respond questionnaire.

| Please answer to all attributes to form a useable answer. | Expectations | Experiences | Direction of Development, expectations (future) | | | Direction of Development, experiences (past) | | | Compared with competitors | | | Knowledge/technology requirement | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ATTRIBUTES | (1-10) | (1-10) | Worse | Same | Better | Worse | Same | Better | Worse | Same | Better | Basic % | Core % | Spearhead % |
| **Knowledge & Technology Management** | | | | | | | | | | | | | | |
| Training and development of the company's personnel | | | | | | | | | | | | | | |
| Innovativeness and performance of research and development | | | | | | | | | | | | | | |
| Communication between different departments and hierarchy levels | | | | | | | | | | | | | | |
| Adaptation to knowledge and technology | | | | | | | | | | | | | | |
| Knowledge and technology diffusion | | | | | | | | | | | | | | |
| Design and planning of the processes and products | | | | | | | | | | | | | | |
| **Processes & Work flows** | | | | | | | | | | | | | | |
| Short and prompt lead-times in order-fulfilment process | | | | | | | | | | | | | | |
| Reduction of unprofitable time in processes | | | | | | | | | | | | | | |
| On-time deliveries to customer | | | | | | | | | | | | | | |
| Control and optimization of all types of inventories | | | | | | | | | | | | | | |
| Adaptiveness of changes in demands and in order backlog | | | | | | | | | | | | | | |
| **Organizational systems** | | | | | | | | | | | | | | |
| Leadership and management systems of the company | | | | | | | | | | | | | | |
| Quality control of products, processes and operations | | | | | | | | | | | | | | |
| Well defined responsibilities and tasks for each operation | | | | | | | | | | | | | | |
| Utilizing different types of organizing systems (projects, teams, processes...) | | | | | | | | | | | | | | |
| Code of conduct and security of data and information | | | | | | | | | | | | | | |
| **Information systems** | | | | | | | | | | | | | | |
| Information systems support the business processes | | | | | | | | | | | | | | |
| Visibility of information in information systems | | | | | | | | | | | | | | |
| Availability of information in information systems | | | | | | | | | | | | | | |
| Quality & reliability of information in information systems | | | | | | | | | | | | | | |
| Usability and functionality of information systems | | | | | | | | | | | | | | |
| **External structure** | | | | | | | | | | | | | | |
| Customer satisfaction | | | | | | | | | | | | | | |
| Customer loyalty | | | | | | | | | | | | | | |
| Brand | | | | | | | | | | | | | | |
| **Internal structure** | | | | | | | | | | | | | | |
| Process improvement | | | | | | | | | | | | | | |
| Innovation | | | | | | | | | | | | | | |
| Information technology | | | | | | | | | | | | | | |
| **Learning and growth** | | | | | | | | | | | | | | |
| Know-how | | | | | | | | | | | | | | |
| Knowledge | | | | | | | | | | | | | | |
| Competence | | | | | | | | | | | | | | |
| Engagement | | | | | | | | | | | | | | |
| **Trust** | | | | | | | | | | | | | | |
| Performance-to-promise | | | | | | | | | | | | | | |
| Professional relationship | | | | | | | | | | | | | | |
| Openness | | | | | | | | | | | | | | |
| Benevolent colaboration | | | | | | | | | | | | | | |
| Empathy | | | | | | | | | | | | | | |
| **Business performance** | | | | | | | | | | | | | | |
| Financial | | | | | | | | | | | | | | |
| Sales | | | | | | | | | | | | | | |
| Customer | | | | | | | | | | | | | | |
| **Project** | | | | | | | | | | | | | | |
| Quality is equivalent to expected level | | | | | | | | | | | | | | |
| Cost management | | | | | | | | | | | | | | |
| Projects are possible to implement in time | | | | | | | | | | | | | | |
| Projects are enough flexible to conform changes | | | | | | | | | | | | | | |

SENSE AND RESPOND QUESTIONNAIRE

This questionnaire measures organization's opinions about business performance of the company. All boxes must be filled in order to form a useable answer.

**Explanations:**

Expectations = What is the level of expectations for an attribute in a scale of 1-10
Experiences = What is the level of experiences for an attribute in a scale of 1-10
Direction of development (future) = Direction of development compared to the situation expected 3~5 years after this questionnaire
Direction of development (past) = Direction of development compared to the situation 3~5 years before this questionnaire
Compared with competitors = Level of experiences compared to the competitors
Knowledge/technology requirement = evaluate how the required technology is divided between basic-, core- and spearhead technologies. The row total should be 100 %.

| | |
|---|---|
| **Basic Technology** | 1. Standardized operation<br>2. Personnel<br>a. Know-how<br>3. Customer focus |
| **Core Technology** | 1. OneSkanska<br>2. Development<br>3. BIM (Building Information Models)<br>4. Sales Facilities |
| **Spearhead Technology** | 1. Self-healing Material<br>2. Advanced Building Material<br>3. IOT<br>4. 3D Scanner<br>5. Big Data & Analytic<br>6. Integrated BIM |

**Knowledge and Technology explanations**

Basic Technology = the most critical technologies for the business and those are the foundation of the business.
Core Technology = brings competitive advantage to competitors and enables the organization to grow
Spearhead Techonology = is focuses mainly on future and it is the most potential and brings successful business opportunities in future.

# APPENDIX 3. Sense & Respond response technique:

The questionnaire is filled in one line at a time by estimating one feature completed before moving on to the next. Black rows need not be evaluated, they are headlines. The survey will need to be fully completed so that your answers can be used in the study

In two first columns, you need to evaluate on a scale 1-10, the expectation values for the level of the attributes and also evaluate on a scale of 1 to 10, the current experiences of the attributes. Next, expectations for future development are assessed, i.e. whether the performance level will improve, remain unchanged or weaken over the next 3 years. Similarly, it is assessed whether the performance of the property has improved, remained unchanged or deteriorated over the previous 3 years. Second, the last assessment is to compare with competitors, i.e. whether they are on the same level as competitors or whether they are better or worse. The final subject of the assessment is the Knowledge / Technology level. Respond to the form by considering the weighting of different technology levels from your own Residential Project Development's phase.

**Explanation for terms:**

Expectations are estimated on a scale from 1 to 10, with 1 low and 10 high expectations. Expectations are estimated based on how well the attribute is expected to function in the next 3 years.

Experiences are evaluated on a scale of 1 to 10, with 1 low and 10 high success rates. So, how well do you feel that the attribute is function in the past 3 years?

The trend in the expectation (future) is assessed by ticking whether the situation is expected to improve, deteriorate or remain unchanged over the next 3 years.

The trend in the experience (past) is assessed by ticking whether the situation improved, deteriorated or remained unchanged over the previous 3-5 years.

Competitor Comparison. The situation compared to competitors is estimated by ticking whether the company is judged to be better, worse, or as good as competitors.

Knowledge / technology level. Respond to the form by pondering the emphasis of the different technology levels (basic, core and spearhead technology) from the perspective of your own Residential Project Development. Note that the sum of each row in the table should be 100 percent.

- Basic Technology: Technologies that are commonly used and can be purchased or outsourced.
- Core Technology: The Company's current competitive technologies.
- Spearhead Technology: Technologies that emphasize more for the future.

The comment area is optional, for example you can put things up, what are good or why some point is bad experience

| Please answer to all attributes to form a useable answer. | Expectations | Experiences | Direction of Development, expectations (future) | | | Direction of Development, experiences (past) | | | Compared with competitors | | | Knowledge/technology requirement | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ATTRIBUTES | (1-10) | (1-10) | Worse | Same | Better | Worse | Same | Better | Worse | Same | Better | Basic % | Core % | Spearhead % |
| **Knowledge & Technology Management** | | | | | | | | | | | | | | |
| Training and development of the company's personnel | 8 | 7 | | x | | | x | | | x | | 30,00 % | 60,00 % | 10,00 % |
| Innovativeness and performance of research and development | 8 | 5 | | | x | | x | | | | x | 10,00 % | 80,00 % | 10,00 % |
| Communication between different departments and hierarchy levels | 9 | 6 | | | x | | x | | | | | 50,00 % | 50,00 % | 0,00 % |
| Adaptation to knowledge and technology | 10 | 8 | | | x | | x | | | x | | 35,00 % | 35,00 % | 30,00 % |
| Knowledge and technology diffusion | 9 | 7 | | | x | | x | | | x | | 50,00 % | 50,00 % | 0,00 % |
| Design and planning of the processes and products | 10 | 8 | | x | | | | x | | x | | 30,00 % | 30,00 % | 40,00 % |

APPENDIX 4. AHP structure for the research.