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SENSE AND RESPOND

Case study middle-size Information Technology Company

Master's Thesis in

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Contents

LIST OF FIGURES

LIST OF TABLES

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ABSTRACT:

The empirical objective of this research is to evaluate manufacturing strategy of a company in information technology segment by using two independent methods: "sense and respond" and "manufacturing strategy index" and validate them against each other by comparing the results. In Addition, this research also measures sustainable competitive advantage of the company and gives a prediction on future development. The data collection is gathered from a middle size software company with approximately 250 employees.

The result indicates that the Company's strategy belongs to Prospector type which focuses on product quality and customer satisfaction. The study also verifies that the Company is dynamically allocating its resources in order to adapt to the changes in the business environment so that it can follow the targeted operations strategy. However, due to the rapid development in geography and in quantity, the firm is taking relatively high operating risk and the development potential is narrower than expected.

The result of method validation proves that there is a relation between sense and respond method and manufacturing strategy index method regarding operations strategy. The two methods indicate similar outcome concerning the Company's operational strategy and its competitiveness in the market.

KEYWORDS: Sense and Respond, operations strategy, MSI, BCFI, CFI, SCFI, AHP

1. INTRODUCTION

1.1 Contribution of the research

The penetration increase of corporates into the world market has raised the consciousness of the fact that their positions are determined by the distinctive competences and strategy implementation. As a result, every company is attempting to identify an appropriate strategy that proposes a comprehensive framework for explicitly defining how it prioritizes and exploits organization's strength in order to grasp external opportunities and eliminate potential threats. In addition, each company shall respond promptly to existed or early signals concerning areas of opportunity in order to maintain or improve its competitiveness and enlarge its market share. According to Krugman (1994: 28 - 44), "Competitiveness is the ability and performance of an organization to offer products and/or services that can meet market needs and requirements, the ability to react faster compared to your competitors to the market changes and needs". In other words, although the stated goal of every company in the market is the product quality and customers' satisfaction, their ultimate target is to become better and faster than other competitors. This can be achieved by developing an effective and responsive operations strategy. According to Si, Takala & Liu (2011: 1000 - 1115), "future competitiveness of manufacturing operations under dynamic and complex business situations relies on forward-thinking strategies". Therefore, choosing an appropriate operations strategy and evaluating if various levels of the organization are operating in accordance with it is the crucial action required by every business. This research discusses one term used to evaluate operations strategy named sustainable competitive advantage (SCA) and corresponding methodologies.

1.2 Objective and scope of this study

The empirical objective of this research is to evaluate manufacturing strategy of a company in information technology segment by using two independent methods “sense and respond” and “manufacturing strategy index” and validate them against each other by comparing the results. Moreover, this research study also measures SCA of the studied company and gives a prediction on future development. The data collection is gathered from a middle size software company with approximately 250 employees.

This research study mainly focuses on operations strategy and SCA. The term SCA was first brought up by Porter (1985: 31) and was defined as a way to maintain a company’s competitiveness. Barney (1991: 99) improved the definition of SCA as “A firm is said to have a sustained competitive advantage when it is implementing a value creating strategy and when these other firms are unable to duplicate the benefits of this strategy”. Later in the same year Barney finalized SCA as a “resource base strategy”. The main idea of this theory is to clarify a state of SCA, where a firm must achieve and maintain an adequate level of resources. Furthermore, Marone (1989: 91 - 110) argued that knowledge and technology should affect the result of SCA because it plays an important role in the decision making process and strategy planning. Additionally, Rautiainen & Takala (2003: 10 - 12) described SCA as “risk level (probability in percentage) for that the operations strategy should essentially be improved to sustain the operations performance competitiveness during the period considered”. The performance of SCA is reinforced by the combination of resource allocations and mutual global operations strategy. This method includes the validation based on several methodologies: Manufacturing Strategy Index (MSI) and Sense and Respond (S&R) methodology (Takala et al, 2007: 326 - 344).

1.3 Structure of the study

The general structure of the study is depicted in below figure:

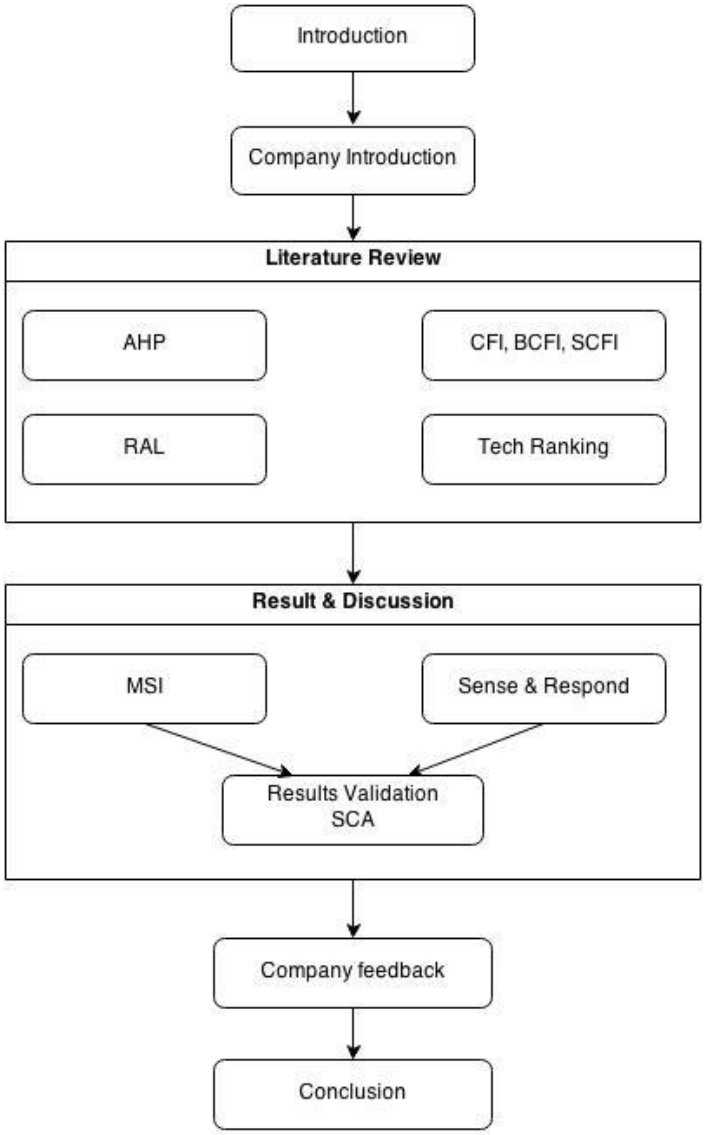

Figure 1. Structure of the study.

2. COMPANY BACKGROUND

The studied company is an independent privately-owned information technology (IT) company which was founded in 1999 in Vaasa, Finland. Apart from the main office in Vaasa, this IT Company has additional units in Tampere, Oulu, Seinäjoki, Jyväskylä and Hyvinkää. Moreover, it also has units in Turku, Pori and Helsinki. In 2012 it opened a new branch in Sri Lanka in order to expand its business outside Finland, reduce the operating cost and at the same time increase the profit margin. At the end of 2013, this Vaasa based company employs over 250 experts in software development, electronic design and industrial process development on its own products as well as clients' products and services. Statistics state that this ISO 9001:2008 certified, AAA rated company is performing constant profitable growth (Company info 2013).

The software company's target since the very beginning was to meet the software needs of industries. In approximately ten years period, it has become one of the biggest industrial-focused software companies in Finland. It is categorized as one of the fastest growing high-tech companies in Finland and in Europe. Most of its customers rank in the TOP 200 list of Finnish industrial manufacturing companies, which are operating globally in the energy and mechanical engineering field. For global customers, the Company creates either a part of projects (outsourcing) or complete solutions according to agreement. The products and services as the Company is providing are divided into three areas: Embedded systems, Industrial systems and Business solutions. The software production is based on a certified ISO 9001:2008 quality management system (Company info 2013).

Thanks to the increasing amount of industrial companies in Finland, the demands of the software solutions are getting more and more wide and vital for each company's operation. The Company is a leading Technology Partner focusing on boosting its clients' performance across all functions by applying information technology at its best. Having the advantage of software and electronics expertise, it researches, proposes and creates

solutions that enhance industrial innovations. This foundation of the IT Company has satisfied the market needs. In contemplation of entering into the international market, local Finnish companies realize the critical importance of software development in globalization strategy. Therefore, it concentrates more and more on its core competence and outsources software development to partners and subcontractors (Company info 2013).

2.1 Product and services

The Company is a leading Technology Partner focusing on software development, electronics design and industry best practices. They are integrated seamlessly into organizations through globally distributed projects and innovative solutions. The Company's target is to enhance client's performance across all functions by applying information technology at its best. Through collaborative innovation, the software company expects to convert technology to meaningful applications for clients' businesses. Following this cooperation, customers can focus attention on their core businesses while getting support from a Technology Partner which provides expert guidance in terms of software and electronics.

The AAA rated company's products and services are supported through customizable solutions and best practice consulting. They are divided into following areas (Company info 2013):

- Embedded Systems
- Industrial Systems
- Business Solutions

More detailed explanation is shown in the figure below.

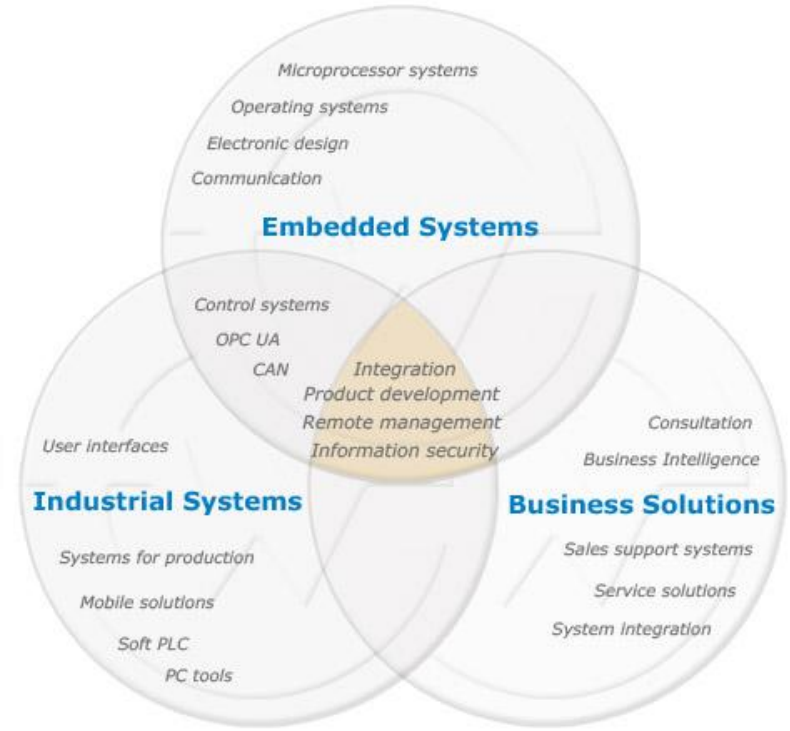

Figure 2. Solutions delivered by the Company's business segments (Company info 2013).

The figure demonstrates which systems and/or products are included in each segment. Some programs or products in the intersection are used for two or more service solutions. They are big projects which cover areas from business solution to industrial design and embedded system implementation. The Company's main business is to provide industrial solutions and best practice consulting for businesses. Moreover, the software company manages to have its own products: Product Configurator and Remote Management Device. Product Configurator is a sale tool which helps to boost the sale process, make it easier, faster and more effective. The product configurator has been widely adopted by industrial companies and helped them boosting up their businesses. Remote Management Device is a remote management system providing a complete set of tools for remotely controlling of vehicles, mobile working machines, production plants, infrastructure and real estates. It includes diagnostics, location tracking, remote control and reporting.

2.1.1 Embedded systems

Embedded Systems was the first spearhead area the Company oriented when it was formed. As part of the Company's core competence, many customer projects in this area have been ongoing throughout the lifetime of the company. The Company offers variety types of solution in embedded systems ranging from electronic design and programming up to a finished product. Electronic design (PCB), Microprocessor systems, Operating systems, Communication technologies (Company info 2013) are among its core competences in this area.

2.1.2 Industrial systems

The main focuses of industrial systems segment are industrial systems and platforms. The software company provides software based systems to control machine and equipment. Moreover, there are also systems for production and inventory management. The leading technology partner can offer the latest software technology available to provide intuitive and effective user interface with minimize cost (Company info 2013).

The following are the examples of the industrial system solutions provided by the Company:

- Graphical 2D and 3D trend displays
- Java EE platforms for the industry
- Cross-platform Qt systems
- Mobile applications and solutions
- OPC DA / OPC AE / OPC UA servers and client software
- Monitoring systems and solutions
- Real time monitoring solutions (Windows, Linux, HMI)
- Customized industrial software tools and systems

- Industrial Web technologies
- Commercialization projects
- Designing and testing user interfaces and usability
- Barcode and RFID solutions
- Windows/Linux-based systems

2.1.3 Business solutions

The main focuses of business solutions segment is to design and implement demanding business solutions for industrial companies. The Vaasa based company provides customers with innovative solutions by combining its own software development with commercial and Open Source software tools. Alternatively, it offers solutions to enhance existing information technology systems and develop new innovative solution which can then be plugged in existing IT systems. The Company's target is to support customers to meet their business goals.

The software company's business solutions confide essentially on the built-up experience through years of developing business solutions for partners. It can offer customers a cost-effective way of working together with across-the-board know-how, innovative and experienced software experts. Among them, agile project management is considered the most essential feature since it has been regarded as the key reason for customer satisfaction (Company info 2013). This agile model gives magnificent safeguards to ensure quality is at its highest. Moreover, it improves customer collaboration and ownership and thus, enhances customer satisfaction.

2.2 Company in numbers

The software company has constantly grown in terms of profit and number of employees. During 2013 the fast growing company has expanded over 25 percent compared to previous year. Since being established, the Company has managed to maintain a constant growth with two numbers every year. In thirteen years the fast growing company has become one of the biggest industrial-focused software companies in Finland.

As a result of fast developing, turnover of the Company has increased significantly, especially in the last 6 years. In the year 2012 turnover reached amount of 13 million euros, while in the year 2006 it was hardly 3 million euros. The turnover target for 2013 was over 16 million euros. The growth is due to increased amount of orders from the Technology Partner's old customers and new attracted customers (Company info 2013).

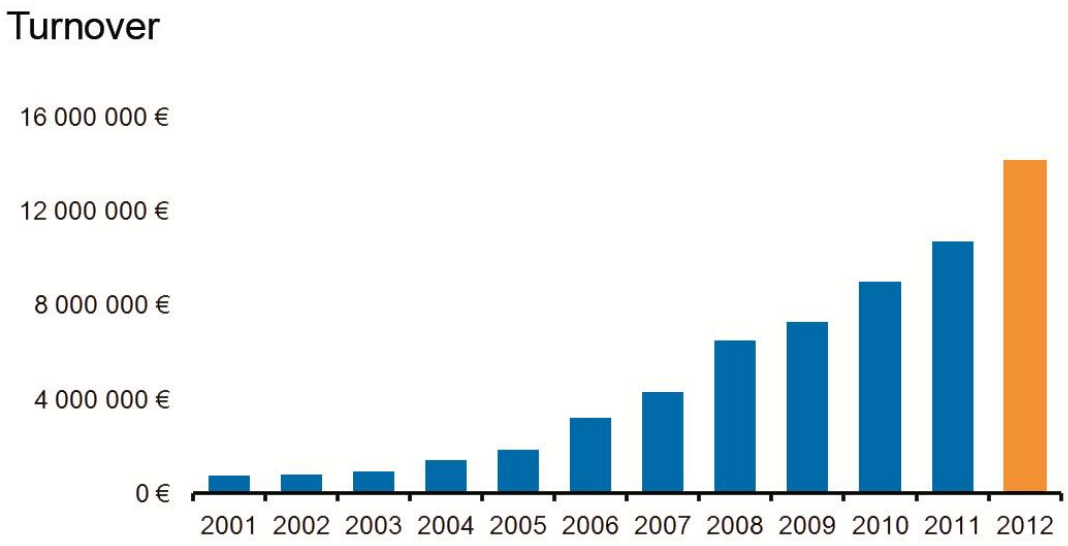

Figure 3. Company turnover 2001–2012.

With the 368 percent profitable growth rate over the past five years, the Company is ranked the 20th fastest growing high-tech company according to Deloitte Technology Fast 50 Finland 2011 program and the 430th place in Deloitte Technology Fast 500 EMEA program (Deloitte 2011). “The Technology Fast 500 EMEA pre-eminent technology awards program is a ranking of Europe, the Middle East and Africa's fastest-growing technology companies based on percentage revenue growth over five years” (Deloitte 2011).

In 2010 the Company was chosen 'Company of the Year' in Vaasa by Vaasan Yrittäjät ry. The criterion for the award was that the Company has a positive influence on the development of the area.

The Company is one of the big employers in Vaasa. Since it mainly offers hour based project for its customers, it is widely known that the growth of the Company is directly connected with the number of employees. Number of personnel has increased from some persons in the very beginning to around 250 people in the middle of 2013. It has recruited almost 50 new employees in 2013. In the past 5 years the number of employees increased approximately 2.5 times (Company info 2013).

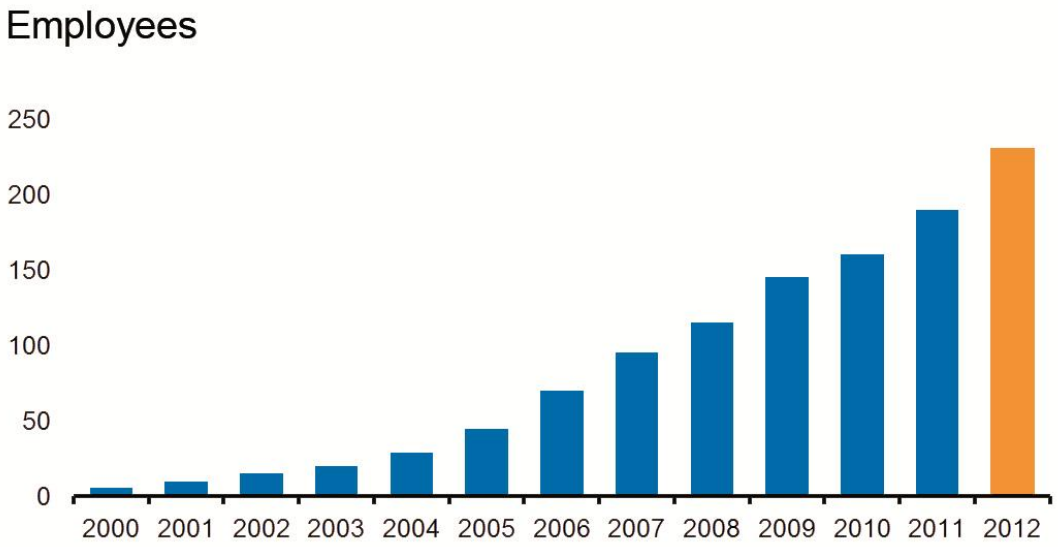

Figure 4. Company personnel 2000 - 2012.

2.3 SWOT analysis

Strengths

- Not tied to any specific technology
- Wide range of one-stop services
- Most of our customers rank in the TOP 200 list of Finnish industrial manufacturing companies
- Specifically designed products to solve the problems faced by industrial companies
- Employs state-of-the-art technologies
- Close partnerships
- Learning environment
- Software experts

- Effective network
- Responsible cooperation
- Best know-how at reasonable price
- An independent operator
- One of the biggest industrial-focused software companies in Finland

Weaknesses

- Individually tailored products– need lots of customization
- Developed products are not the main source of income

Opportunities

- Industrial companies have an increasing need for software
- Active participation in seminars, trade fairs (Automaatio, Subcontracting), conferences (OPC Day), exhibitions (ICT Expo)
- Enters new markets and expands in the existing market

Threats

- Technology is changing fast
- Industry-specific software is expensive
- Changing customer needs and requirements
- Increasing market volatility in connected industries directly affect growth of the Company

2.4 PEST analysis

Political

This includes regulation, tax policy, employment laws and political stability.

Economic

From the economic factors, most important could be current and projected economic growth, inflation, labor cost, impact of globalization.

Social

Since the Company provides services and software solutions, it is impossible to imagine the development of the Company without educated workforce. Therefore, it is important for the Company to pay attention to working attitudes, job market freedom, and lifestyle selections.

Technological

Advances in technology can change industry and competitive conditions dramatically, making it possible to produce new and/or better products at lower cost and opening up whole new industry frontiers. Moreover, technological developments can cause, for example, changes in capital requirements, learning or experience curve effects, etc. Competing companies may get access to superior know-how, upgrade their manufacturing capabilities and long-term effort to compete head-on against established companies. Apparently, that any changes in technology are most likely to influence the performance of the Company, since software solutions and provided services are the main source of its income.

3. LITERATURE REVIEW

The ultimate goal of each firm is to maintain its competencies in the marketplace with the purpose of obtaining perpetuity growth. In order to achieve its objective, it is essential for the firm to have an efficient operational strategy, which in turn has a significant impact on its strategic position in the market. According to Skinner (1986: 75), the key success determinant of a company under fierce competition in the marketplace lies in consecutive and timely launch of new products that meet the market demands, quality product reinforcing, and the flexibility in exploring and utilizing new materials at customer's desire. Thus, it is necessary for an enterprise to develop innovations to reap profit and keep growing over time. Therefore, a well-organized strategy might provide firms a better opportunity to allocate their resources effectively based on their competencies and weakness in the industry.

A prominent framework of the strategy types was firstly introduced by Miles & Snow (1978: 547), in which they analyze a broad spectrum of strategy types. The researchers have elaborated a model explaining that based on the fixed rate amongst RAL Model elements, including Quality, Cost, Time/Delivery, and Flexibility, the strategy type can be created. Miles & Snow have classified four different categories in their model, namely prospectors, defenders, analyzers and reactors. The first one is the strategy that a company pursues if it wants to seek an opportunity to be the market leader in the industry through innovation. The next one, defender strategy is for firms to keep a base number of customers by using low cost in order to create a stable market. The latter one, analyzer strategy is a mixed combination between prospector and defender strategy, in which quality, cost and time harmonize with each other. The last strategy is for prompt circumstances which needs responding immediately so basically it serves little purpose.

A manufacturing strategy is derived from three main phases of a business strategy, including competitive priorities, manufacturing objectives and action plans (Kim and Arnold (1996: 6)). In the first period, companies should propose the manufacturing strategy function in which RAL model elements are mixed together with the purpose of facilitating the business strategy effectively. In the next phase, based on the competitive priorities created in the previous phase, firms determine operating objectives which have significant influence on business performance measures. In the last period, action plans resulted from manufacturing objectives in the second phase are established. These plans are improvement programs to observe their impacts on specific manufacturing objectives. The process of manufacturing strategy can be seen in below figure.

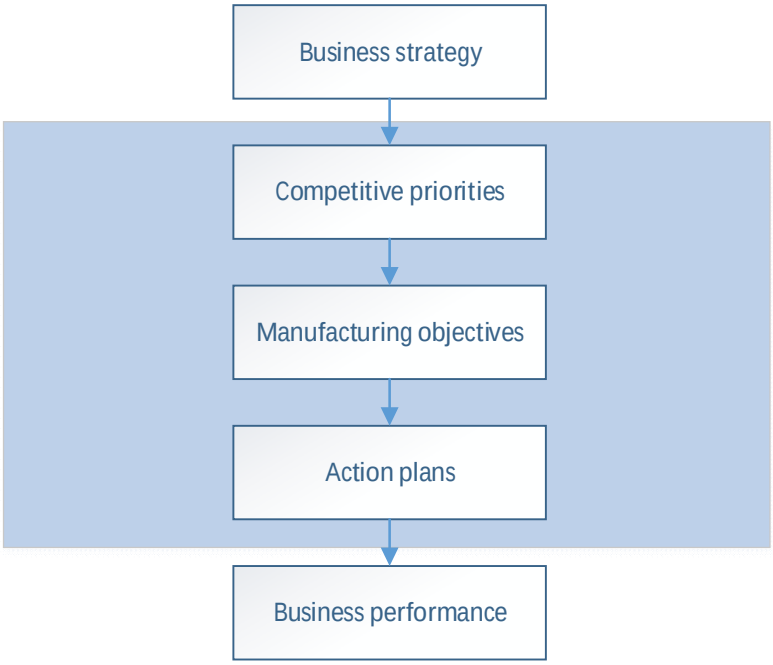

Figure 5. Manufacturing strategy.

3.1 The analytic hierarchy process

Since being introduced by Thomas Saaty at the Wharton School of Business (Forman & Selly 2001: 402), Analytic Hierarchy Process (AHP) has been a predominant tool supporting managers and researchers in almost the applications involved in decision making. AHP is considered as a multi-criteria decision method, in which a decision-maker has to set priorities amongst alternatives based on a wide range of criteria weighting their levels of importance. Then, they shall make the most relevant choice for complex problems where both qualitative and quantitative facets need to be taken into account. AHP focuses on the achievement of objectives, rather than alternatives, criteria or attributes. As a result, the tool gives concrete advices to achieve a rational decision, which will best achieve the objectives of the decision maker.

The most striking feature of AHP is the possibility to deal with complex problems. It supports decision makers through synthesizing judged principles in hierarchical structure, which is identical to a family tree. To be more specific, the tool helps analysts to scrutinize complex decisions by decomposing unstructured problems into a hierarchy of elements such as criteria and alternatives and then calibrating the numeric scale of those elements. The scale ranges from 1/9 for “least important than” to 9 for “absolutely more valued than”, with 1 for “equal” covering the wide span of the comparison (Figure 6). The relative score of each element is calculated based on the combination of all relevant criteria and their par-wise comparison; thereby the effect of elements or alternative at the lowest level on the overall objective is evaluated. General speaking, AHP facilitates organizing a system into reciprocal alternatives and criteria, and incorporating them by evaluating and rating the impact of these elements on the whole system (Josu Takala 2007: 312 - 325).

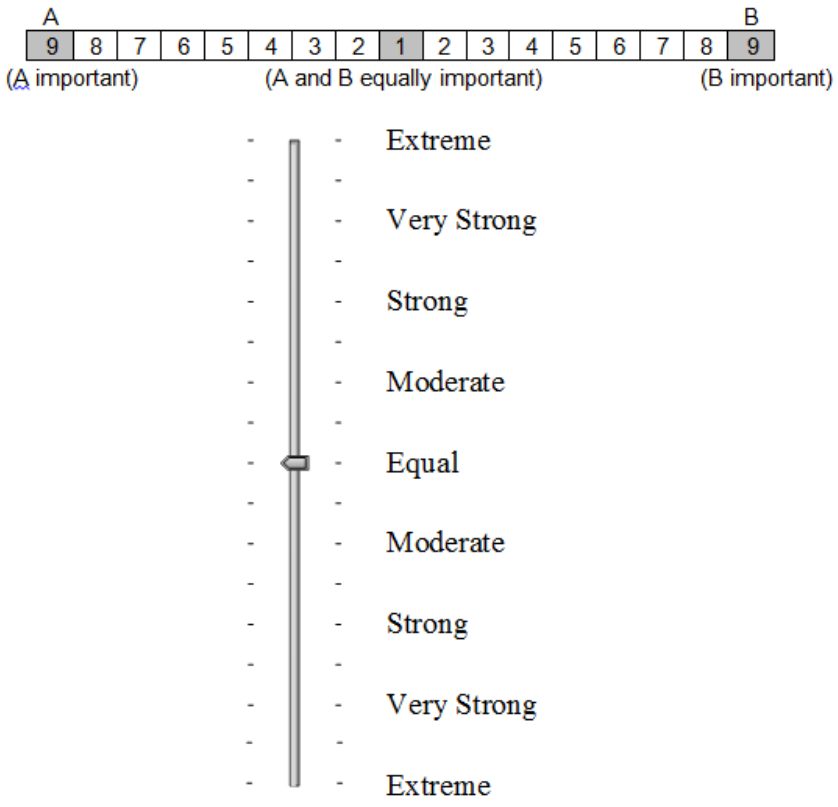

Figure 6. Scale ranking for each pair of criteria.

By converting the evaluations to numerical values, AHP can assess and compare amongst the alternatives. Apparently, calibrating the numerical scale of these elements allows us to judge elements that have no common measurement standard or incommensurable elements and make them comparable in a rational way. This can be developed in planning implementation and enhance policy-making (Toshev 2010: 14 - 18). It is this capability that makes the AHP distinguishable from other decision-making techniques.

There are three main advantages in using AHP model. Firstly, it is the only known multi-criteria decision method model that can evaluate the consistency of a conclusion made by decision maker. Secondly, it allows decision maker to classify crucial aspects of a problem into a structural hierarchy. Finally, pair wise comparison enables accurate estimation of the influence of criteria or alternatives. AHP synthesizes empirically measured information available.

There are three main fundamental principles which AHP is based on, including decomposition of unstructured problem, evaluation of the alternatives and combination of the priorities. The first step involves in synthesizing judged principles in hierarchical structure. The final destination of the hierarchy is the ultimate goal of the decision, such as “Optimal Allocation of Research Resources”. The lower levels include the criteria relevant to this goal and at the base level the alternatives are scrutinized. The next step is evaluating the alternatives and the criteria. More specifically, those are analyzed in pairs with regard to each element of the next higher level. To compare them, a decision-maker utilizes the calibration methodology, which scales the comparisons in the corresponding numbers. The last step is synthesizing all the comparisons to make the most relevant choice, which needs to be prioritized.

Generally, AHP are performed in three steps:

- Decompose a problem into structural hierarchy.
- Compare elements of the same levels with each other with respect to element in the next higher level using a scale from 0-9. Using the “eigenvalue” method to estimate the relative weights of decision elements.
- Incorporate the relative weights of decision elements to attain ratings for the decision alternatives.

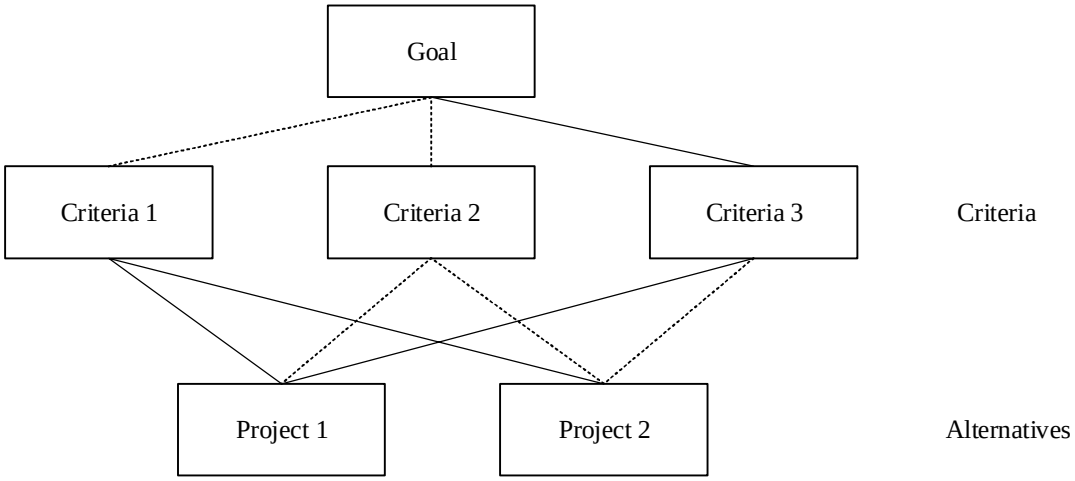

Figure 7. The decision problem in a hierarchy.

AHP characteristics and features:

Analytic

AHP helps to measure and synthesize the multitude of factors involved in complex decisions (Forman & Selly 2001: 13).

Hierarchy

The most powerful method of classification is common for virtually all complex systems of which we have knowledge. It consists of ordering experience, observations, entities and information (Forman & Selly 2001: 13).

Process

Series of actions, changes, or functions that support decision-makers to find the result that best meets the objectives (Forman & Selly 2001: 14).

3.2 RAL concept

RAL is a concept for analyzing multi-focused manufacturing strategies based on business goals developed by Josu Takala (2007: 313 - 325). The initial purpose of the model was to estimate the success factors in logistic. Later, it was elaborated to evaluate manufacturing strategy and operational competitiveness of organizations. RAL is an abbreviation of Responsiveness, Agility and Leanness. RAL concept is targeted for manufacturing as well as service sector strategy. The basic principal behind RAL concept is priority allocation between quality, time and cost. These three capabilities have an inter-related relationship. If some capabilities are improved, it will result in the loss of other capabilities. According to Takala (et. Al. 2011: 1000 - 1115), RAL concept should take flexibility into consideration. In order to achieve a good manufacturing strategy, the optimization of the RAL model components (responsiveness, agility and leanness) should be pursued by adjusting suitable, balanced priorities between cost, quality, time and flexibility.

- Responsiveness: Responsiveness is the “speed by which the system satisfies unanticipated requirements”. According to Holweg (2005: 603 - 622), organizational responsiveness is the ability to acknowledge and respond to customer request or demand within the promised time period and cost margin. Organizational responsiveness also represents the ability to react quickly to changes in turbulent business environment.
- Agility: Agility is the “speed by which the system adapts to optimal cost structure”. According to Yauch (2011: 12 - 21), process agility is the capability to deliver requested or demanded product or service on time with good quality at optimal cost.
- Leanness: Leanness is to “minimize waste in all resources and activities”. Leanness targets systematic elimination of all waste time and none value adding processes. Leanness implementation will help business to deliver quality product or service with acceptable price. Especially in mass production, leanness minimizes operating cost and unexpected fault of products (Senaratne & Wijesiri 2008: 34 - 48).

- Flexibility: According to Slack (2005: 1190), flexibility is the system ability of quick adaptation to changes in environmental condition, including quality, cost and time. Flexibility in manufacturing operation allows organization to cope with changes in turbulent business environment, emerging competitors and keep sustainable competitive advantage in the market.

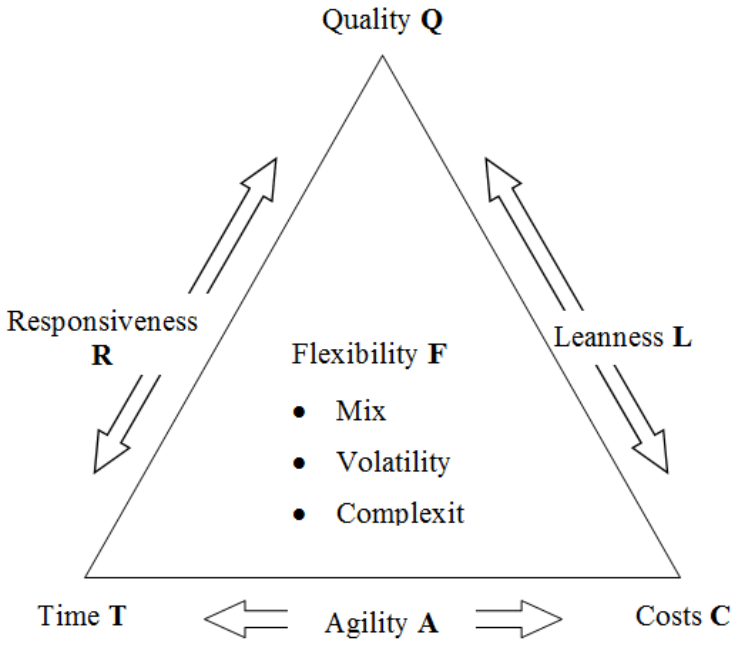

Figure 8. RAL concept.

As can be seen in above figure, if a company concentrates on quality then it should follow the strategy, in which responsiveness and leanness need to be considered. In other word, the Company should speed up its ability to recognize and respond to the market demand timely to maintain its operating effectively.

Each of the variables of the function (Quality, Cost, Time, and Flexibility) is calculated by the following equations (Takala et al. 2007: 313 - 325):

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

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

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

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

(Q = Quality; C = Cost; T = Time/delivery; F = Flexibility)

3.3 Manufacturing Strategy Index

Miles & Snow (1978: 547) have classified four organization types: prospector, analyzer, defender, and reactor. Among those types, reactor is for prompt circumstances which need responding immediately so basically it serves little purpose. According to Takala et al (2007: 312), the results of competitive priorities calculated utilizing AHP method can be applied to identify type of an organization – prospector (group A), analyzer (group B), defender (group C).

The following equations (Takala et al. 2007: 312) represent analytical models for identifying manufacturing strategy index (MSI) corresponding to each organization type. These results can then be used to classify the operational competitiveness of a company.

The MSI model for prospector group:

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

The MSI model for analyzer group:

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

The MSI model for defender group:

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

Classification rules table:

Table 1. Classification rules.

	Group						
Rule	A	C	B	B	A	C	B
(Q>= 0.43)							
(C>=0.43)							
(T>=0.43)							
B (0.23<=(Q, C, T) <=0.43							
RAL concept	R, L	A, L	R, A	L	R	A	R, A, L

3.4 Sense and Respond

According to Nadler and Takala (2009: 1333 - 1339) the Critical Factor Index (CFI) is a tool to support strategy decision which is based on real-life expectation and experiences. Quality of service can be measured by calculating the gap between expectations and experiences of customer. The combination between standards deviation of expectation and experiences leads to CFI measurement. Compared to CFI, Balanced Critical Factor Index Formula (BCFI) provides more reliable indication of critical factors and offers more comprehensive analysis tool. In addition critical factors can be defined exactly and can easily be recognized with BCFI. Later, Liu and Takala (2011: 1000 - 1115) developed a new model called Scaled Critical Factor Index (SCFI) which better reflected S&R theory.

CFI, BCFI and SCFI are calculated using the following equations (source: Takala et al. 2007: 313 - 325):

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

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

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

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

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

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

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

$$BCFI = \frac{SD\ expectation\ index * SD\ experience\ index * Performance\ index}{Importance\ index * Gap\ index * Deelopment\ index} - 1 \quad (15)$$

$$SCFI = \frac{\sqrt{\frac{1}{n}\sum_{i=1}^{n}(experience(i)-1)^2} * \sqrt{\frac{1}{n}\sum_{i=1}^{n}(expectation(i)-10)^2} * Performance\ index}{Importance\ index * Gap\ index * Deelopment\ index} \quad (16)$$

(SD: Standard deviation)

The evaluation of attributes includes expectations and experiences, direction of development for future and past, compared with competitors, knowledge and technology requirement. As a conclusion of BCFI method, attributes can be categorized to critical (reds, yellows) to non-critical (greens). Thanks to these classifications, company can easily define the new strategy to adjust the resources like knowledge and technology according to their role in the general performance.

3.5 Technology Ranking

Technology ranking helps to determine different technological levels and which are dominating ones within technology-based businesses. It has impacts on the strategy implementation and to the chosen competitive category (Takala, Hirvelä, Liu, Malindžák 2007: 326 - 344). In other words, technology ranking plays an important part on resource allocation process of S&R following a specified operations strategy.

There are three levels of technology ranking, which are spearhead technology, core technology and basic technology. Spearhead technology is to predict and focus on the future technology. Core technology is the core competence in current marketing position. Basic technology is commonly used in the industry and can be purchased or outsourced (Takala, Hirvelä, Liu & Malindžák 2007: 326 - 344).

Based on the validation of the analytical models in the study, it is possible to find out the correlation between the technology and operation strategies preferred in global markets. More particularly, dynamic decisions must be made with consideration of specific resource allocations and technology ranking.

3.6 Sense and respond validation

In order to validate the result of sense and respond method, a method used to convert BCFI values of all technologies and knowledge to values of elements in RAL model has been developed. Attributes from S &R questionnaire are classified to one of four groups; each group represents one element in the RAL model (Quality, Time, Cost, Flexibility). One attribute can belong to more than one group if it relates to many elements. After that, the total sum of BCFI of attributes within each group is calculated and its normalized value represents BCFI of one of the above elements in the RAL model. These values can be used to identify MSI again using equations 1 - 7.

There are two methods to calculate the normalized value of each element in the RAL model: average and root means squared.

$$Normalized\ Value = \frac{\sum_n BCFI_i}{n} \tag{17}$$

$$Normalized\ Value = \frac{\sqrt{\sum_n {BCFI_i}^2}}{n} \tag{18}$$

(n: Number of elements in each group)

After MSI values of the company are generated by using two different methods, if the two values are close to each other, it can be concluded that the MSI value is reliable. Thus SCA of the company is validated and the legitimacy of sense and respond method is verified. On the other hand, if the two values have substantial variation, the MSI values are inconsistent and there are possibly issues in S&R methodology.

Moreover, SCA analysis is performed to see if resource allocation is utilized with dynamic capabilities in accordance with the chosen strategy. Angle values were decided to be used for calculation instead of actual MSI values, due to the fact that they reflect the direction of strategy implementation more precisely, thus they can provide more reliable result. In order to reach an acceptable level of reliability, three methods of validation are used: MAPE (absolute percentage error), RMSE (root means squared error) and MAD (maximum deviation). As the SCA value approaches to 1 the consistency between resource allocation and strategy becomes stronger.

MAPE (absolute percentage error):

$$SCA = 1 - \sum_{\alpha,\beta,\gamma} \left|\frac{BS-BR}{BS}\right| \tag{19}$$

RMSE (root means squared error):

$$SCA = 1 - \sqrt{\sum_{\alpha,\beta,\gamma} \left(\frac{BS-BR}{BS}\right)^2} \tag{20}$$

MAD (maximum deviation):

$$SCA = 1 - max_{\alpha,\beta,\gamma} \left| \frac{BS-BR}{BS} \right| \quad (21)$$

(BS, BR: Angle in prospector, analyzer, defender, triangle calculated using MSI and S&R methods accordingly)

4. RESEARCH METHODOLOGY

In this chapter, the methodologies implemented in this research are introduced. There are two methods involved in evaluating and validating operations strategy of a company: MSI and S&R. MSI method evaluates the operations strategy of the Company. On the other hand, S&R method analyzes if the Company is dynamically allocating its resources in adaptation to changes in the business environment in order to follow its targeted operations strategy. Consequently, these two methodologies are closely related to each other in a sense that they reflect the strategy and their resource allocation of the targeted strategy. Therefore, the results of the two methods are convertible and can be validated against each other.

4.1 Manufacturing strategy index

This part identifies and analyzes the business strategy of the chosen company by evaluating its performance, internal and external environment, macro-environmental factors and priorities in manufacturing process. This section was completed by implementing qualitative research method – case study. More particularly, data collection is gathered from questionnaire from CEO of the Company and the analysis of the available public information concerning the Company and particular business field. The questionnaires are constructed by using AHP method, in order to prioritize and integrate provided criteria to consistent result. Competitive criteria of the Company were structured in Expert Choice program according to the questionnaire answers provided by the CEO. Finally, RAL model is used for identifying MSI, which is used for calculating the operational competitiveness classification of the Company.

The method utilizes the Expert Choice program to analyze questionnaire result in order to get the importance proportions (in percentage) of company's main priorities. Among those main priorities, the study concentrate on the key elements of RAL model which are quality, cost, time and flexibility. Those values from Expert Choice are inserted to equations 1-7 to calculate MSI value which indicates how strong the Company is as a prospector, analyzer or defender. Moreover, company classification is done using classification rule.

Expert Choice program implementation provides several possibilities in decision making process such as:

- To structure and evaluate defined objectives/criteria;
- To combine statistically proven numbers and intuitive judgments utilizing the power of the AHP to value alternatives;
- To optimize complicated decisions and compromising multiple alternatives.

As the result, multiple choice criteria are structured into a hierarchy, by applying pair-wise comparisons, and single overall score for ranking decision alternatives is calculated with respect to relevance of components of the IT company's manufacturing strategy. According to the further calculations, level of competitiveness and organizational type of the Company was determined.

4.2 Sense and Respond method

The S&R method evaluates direction of development in order to keep the Company's sustainable competitive advantages. In order to gather information from different personnel in the Company, totally different questionnaire related to Sense and Respond methodology is used. The questionnaire contains questions about attributes related to critical factors which can influence the firm strategy decision in the near future. Three operational level employees were asked to fill out the questionnaire and then result is analyzed. Through analysis of the result, it is possible to find out the gap between experiences and expectations in order to know whether the Company's expectations match the reality and the actual experience. Furthermore, there is investigation about the changes of technology dominance during the past and future and formation of a diagram related to the theory of technology ranking. With the result of technology ranking and difference between expectation, past and future, the study points out the critical and non-critical technologies or knowledge and development direction in the future.

4.3 Result validation

In this section, results from the two separate studies mentioned above are compared to validate against each other. The compared outcome can validate the legitimacy of S&R method. In this specific case study, this comparison verifies if the operations strategy the Company is operating and its focuses in key leaders' perspectives are in line with each other.

In the first part of the study, MSI of the Company is calculated and its operational competitiveness classification is identified. In the second part of the study, BCFI of every attribute is calculated. In this section, attributes are classified to one of four groups, each group represent one element in the RAL model (Quality, Time, Cost, Flexibility). One attribute can belong to more than one group if it relates to many elements. After that, the total sum of BCFI of attributes within each group is calculated and its normalized value represents BCFI of one of the above elements in the RAL model. These values can be used to identify MSI again using equations 1 - 7.

S&R method can be validated by comparing MSI values calculated from the two different methods. If the two values are close to each other, we can conclude that the MSI value is reliable thus SCA of the Company is validated and the legitimacy of sense and respond method is verified. On the other hand, if the two values have substantial variation, the MSI values are inconsistent and there may be issues in sense and respond methodology.

Last but not least, a weak market test (WMT) is conducted to practically validate the result of S&R. During this part, the result of the study is presented with the Company representative to validate how calculation of this model meets the reality. The discussion can give an advice if the manager can utilize this model in the future to monitor strategic operation process of the Company.

5. RESULT AND DISCUSSION

The implementation and result of this study is described in detail in the background information annexed to this document. Below are some general results of the study.

5.1 Manufacturing strategy index

Based on company introduction, the Company's target is to increase the market share by extending existing market by improving current products and services and seeking for new markets by attracting new customers from other geographic areas. By exploiting this strategy, company wants to increase the profit margin as unit costs drop and new market grows. Consequently, the software company has to increase working capital and this creates a high risk for it. From the Company's point of view, which is being a client company for big global corporations, quality is the most important feature in order to gain customer trust. Furthermore, cost takes nearly the least role in their strategy. From these original observations it can be seen that the Company belongs to the prospector type. This strategy can be proved with the analysis presented in background information section annexed to this document.

Collected data were entered into the Expert Choice software and the results were extracted and analyzed. The results were reliable enough based on the inconsistency ratio 0.06 which is considered as acceptable (under 10%). Results of AHP analysis are described in more detail in the background information annexed to this document.

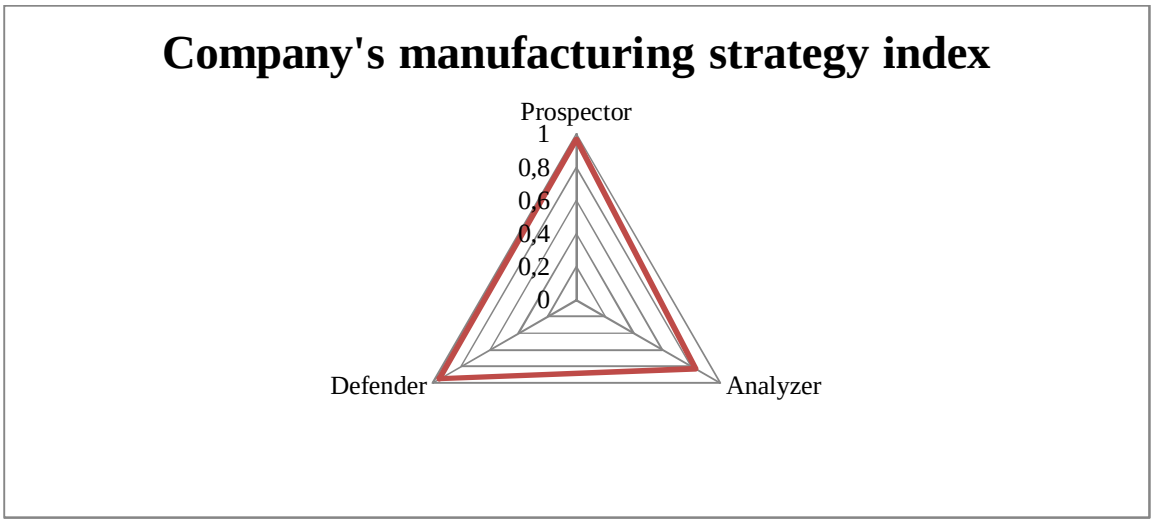

Figure 9. Company's manufacturing strategy index.

5.2 Sense and respond

In this part of the study, S&R method is used to evaluate critical technologies in the company. The data for investigating and analyzing the company performance together with defining the critical performance attributes was gathered by opinion survey questionnaire. The questionnaire which was developed by Ranta and Takala (2007: 312 - 325) based on S&R method includes questions in four categories: knowledge and technology management, processes and workflows, organizational systems, and information systems. The questionnaire is sent to three operational level employees in the company. Based on answers from these three informants, the data is analyzed and interpreted. The result is described in detail in the background information annexed to this document.

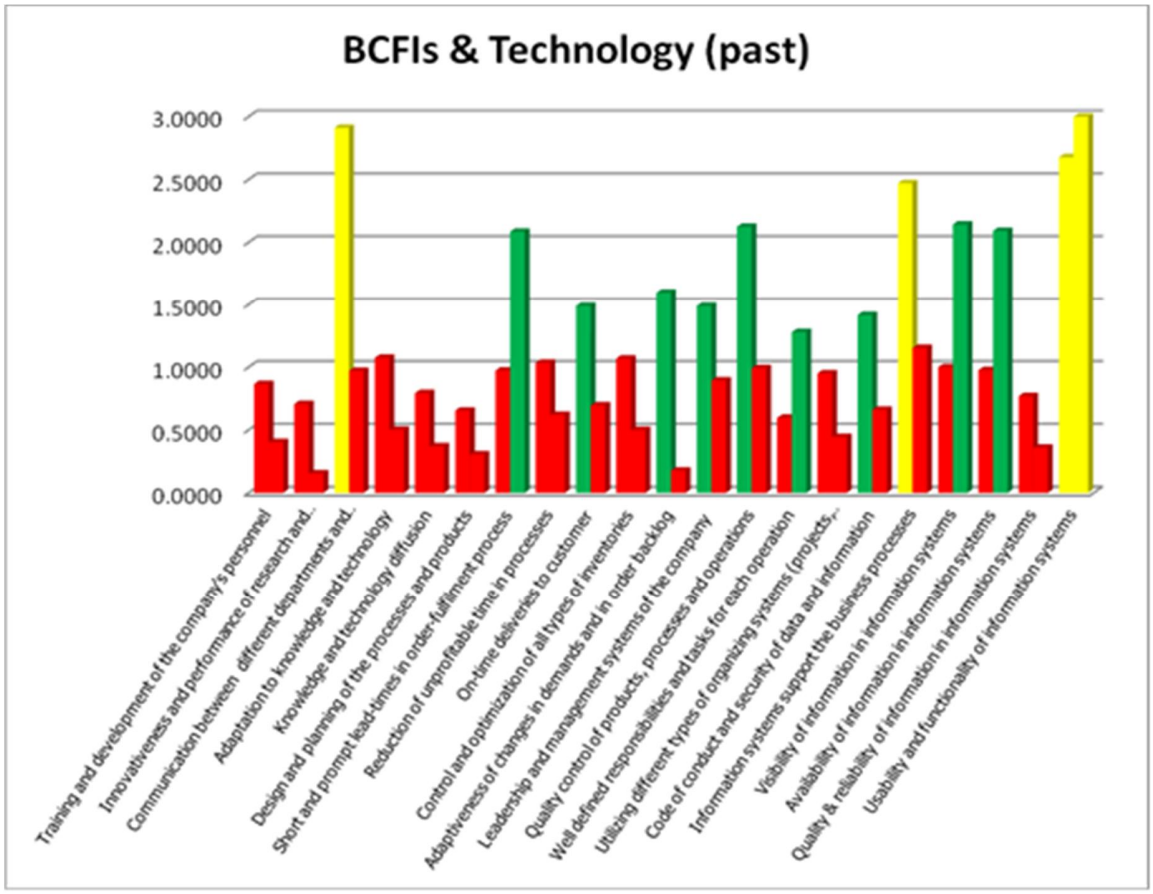

Figure 10. BCFI vs BCFI K/T (Past).

5.3 Sense and respond validation

In this part of the study, results from the two separate studies are compared to validate against each other. The result of this part can validate the legitimacy of sense and respond method. In this specific case study, this comparison verifies if the operations strategy the company is operating and its focuses in key leaders' perspectives during the last two years and in the near future are in line with each other. The validation result is described in detail in the background information annexed to this document.

6. COMPANY FEEDBACK

Last but not least, a weak market test (WMT) is conducted to practically validate the result of S&R. During this part, the result of the study is presented with the company representative to validate how this model meets reality. It has been discussed with the company's financial manager and in general the company representative agreed with the output. In addition to that, they also give thoughts on possible reasons of the changes. Finally, needed changes to catch up with the new situation, eliminate weakness and take advantage of company strength are discussed and proposed. The result is described in detail in the background information annexed to this document.

7. CONCLUSION

It is vital for managers to understand their company's operational strategy. By employing sense and response method, companies can react quickly to the changes in the business environment and make immediate corrections which will have a positive influence on their long term capability to maintain a sustainable competitiveness. The sense and respond method presented in this paper will help management to gain control over the strategic target by employing dynamic resource allocation. The result indicates that the company's strategy belongs to Prospector type which focuses on technology development and quality of the product.

Moreover, the study also indicates that there is a relation between sense and respond method and MSI method regarding operations strategy. They both give similar result on the company's operational strategy and its competitiveness in the market. This also confirms that the company is dynamically allocating its resources in adaptation to changes in the business environment in order to follow its targeted operations strategy.

However, there are still some limitations in this research which can be improved. First, the informants were only a few technology leads in the company. A larger number of informants could improve the accuracy and reliability of the study. Second, the questionnaire to categorize each knowledge/technology requirement among Basic, Core and Spearhead is difficult to handle. Most of the informants do not know how to estimate the percentage every group will take and thus give unreliable estimations. Sense and respond method shall employ a better method to categorize every technology requirements in order to improve the correctness of the result. In conclusion, the research can be further developed in the following directions:

- Increase the number of informants.
- Employ a better method to categorize technology requirements.

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