3

Proactive Crisis Management in Global Manufacturing Operations

Yang Liu and Josu Takala
Department of Production, University of Vaasa
PL 700, 65101 Vaasa
Finland

1. Introduction

From an economic perspective, the future has never seemed clear, but high performance businesses have the ability to navigate through uncertainty and emerge ever stronger. How do they do it? The experience and research with the world's most successful companies show that winners follow certain common principles. Companies that come through the strongest actually use economic disruption to improve their competitiveness. This study is to find out how to make it possible.

Future competitiveness of manufacturing operations under dynamic and complex business situations relies on forward-thinking strategies. The objective of this work is to identify and develop the operational competitiveness in a sustainable manner and implement sustainable competitive advantage (SCA), the highly competitive operations strategy by integrating manufacturing and technology strategies with transformational leadership profiles of the decision makers, for managing proactive operations in global turbulent business environments such as the global economic crisis which has badly hit the whole world's economy.

This study is aiming to create methods and tools to analyze the development of operational competitiveness in global context. These include e.g. the following:

- Observation and evaluation of operational strategy excellence and transformational leadership to support decision making processes.
- Scenario analysis of the development of business environments and methods for identifying successful factors of new business concepts with dynamic decision making for optimizing resource allocations by sense & respond methodology and by integrating manufacturing strategy with transformational leadership and technology level to evaluate and benchmark overall operational competitiveness in technology and knowledge intensive business areas.
- Methods and tools for identifying successful factors to develop sustainable operational competitiveness of new business concepts against the highest benchmarks in the world.

2. Literature review

The strategic importance of manufacturing or operations has long been recognised by Skinner (1974). The theoretical reference framework of competitiveness in manufacturing operations starts from resource-based view of a firm for case study (Wernerfelt 1984; Menguc, Auh & Shih 2007). Companies should typically utilize multi-focused competitive strategies in a holistic way based on their business strategies (Porter 1980). Competitive priorities belong to the first phase of manufacturing strategies, which act as the bridge between business strategy and the manufacturing objectives (Kim & Arnold 1996). Competitive priorities are the crucial decisive variables to manage manufacturing operations in global context and indicate strategies emphasized on developing certain manufacturing capabilities that improve the operational competitiveness. Takala (2002) presents justification of multi-focused manufacturing strategies. Miles & Snow (1978) define four company groups which include prospector, analyzer, defender and reactor. They suggest on the contrary to the three stable groups which are prospector, analyzer and defender, reactor does not lead to a consistent and stable organization and therefore it is advised to change over to one of the other three groups. Based on this theory, Takala et al. (2007b) introduce unique analytical models to evaluate global competitiveness rankings for manufacturing strategies in prospector, analyzer and defender groups according to the company's multi-criteria priority weights of Q (Quality), C (Cost), T (Time/delivery) and F (Flexibility). Such analytical models are used to gain insight into the influences and sensitivities of various parameters and processes on the alteration of manufacturing strategies. In China, the most dynamic market, Liu et al. (2008) first time apply such analytical models to analyze and improve operational competitiveness of one private middle-size manufacturing company by adjusting competitive priorities in manufacturing strategy. Takala et al. (2007a), Si, Takala & Liu (2009), Liu, Si & Takala (2009) and Liu & Takala (2009a; 2010a) compare the operational competitiveness strategies in China and other countries in global context by utilizing same analytical models, in order to analyze different characteristics of manufacturing strategies in different markets and suggest how companies can improve their operational competitiveness. But the adjustment of manufacturing strategy alone is not just enough to improve the overall competitiveness to develop the business under new business situations. Menguc et al. (2007) suggest that improvements of transformational leadership based competencies should lead to marketplace positional advantages through competitive strategies. Therefore manufacturing strategy is one important factor and transformational leadership is another necessary and important factor to improve the overall competitiveness no matter in prosperity or adversity, and can be even more decisive (Bass 1985). Bass & Avolio (1994) provide evidence on the benefits and effectiveness of transformational leadership on leadership and training of leaders. Transformational leaders help their subordinates to learn and develop as individuals, by encouraging and motivating them with versatile repertoire of behavioural and decision making capability (Bass & Avolio 1994; Bass 1997). Takala et al. (2008) introduce unique analytical models to evaluate the level of outcome direction, leadership behaviour and resource allocation of transformational leadership. Tracey, Vonderembse & Lim (1999) suggest that organizations must formulate strategic plans that are consistent with the use of manufacturing technology to be successful in this globally competitive and rapidly changing environment. O'Regan & Ghobadian (2005) suggest that the level of technology deployed will impact on the overall strategic planning process and its main drivers: leadership and organisational culture resulting in differing levels of corporate performance. From these implications, transformational leadership is further extended by adding technology level in this study, which is classified as spearhead technology, core technology, and basic technology, as part of resource allocation. The objective here is to create a holistic model to integrate manufacturing strategy and transformational leadership with technology level together for more comprehensive evaluation of overall competitiveness to identify and develop the operational competitiveness potential in a sustainable manner.

To validate the created analytical models, the empirical research continues case studies in several countries with deeper insight analysis of overall competitiveness of large and medium size manufacturing enterprises and suggests how to make dynamical adjustments in order to improve operational competitiveness potential to manage in turbulent business situations such as the global financial crisis. The related case studies include benchmarking and development of overall competitiveness of multiple case companies in global context, which emphasize more on proactive operations to improve competitiveness potential in regional and global market during crisis and forecasting the ongoing business in economic upturn after crisis.

3. Research methodologies

3.1 AHP

Analytic Hierarchy Process (AHP) method is a multi-attribute decision instrument that allows considering quantitative, qualitative measures and making tradeoffs (Saaty 1980). The AHP is used in this study to deal with the empirical part, which includes analyzing questionnaires and calculating weights of main criteria and sub-criteria. AHP is aimed at integrating different measures into single overall score for ranking decision alternatives with pair wise comparison of chosen attributes (Rangone 1996). It utilizes pair wise comparisons by interviewing the experts within the whole organization. AHP-based models can comprehensively explore the varying degrees of importance of the indicators and drivers of competitiveness (Sirikrai & Tang 2006). The AHP based instruments e.g. forms and questionnaires have been used in our previous case studies for more than 20 years in successful analysis of case companies and some similar applications of AHP are used in e.g. Zahedi (1989), Rangone (1996), Sun (2004), Banuls & Salmeron (2008), and their validity and reliability are proved. The inconsistency ratio (icr) is calculated to assure the internal validity of pair wise comparison results. Only matrixes with icr value of less than 0.10, and less than 0.30 in smaller groups with competent informants, can be used for reliable decision-making. Otherwise the answers are considered as invalid and will not be used. Further more, some redundant open questions are used in addition to the pair wise comparisons in the AHP questionnaires to add more internal validity to the answers.

The procedures of utilizing the AHP in the case studies are as follow. The first step is to establish the model of hierarchy structure for the goal. In this study, the hierarchy models are constructed for the evaluation of manufacturing strategy by Takala et al. (2007b) and transformational leadership by Takala et al. (2008), which serves as theoretical framework. The second step is the comparison of the alternatives and the criteria. They are pair wise compared with respect to each element of the next higher level. The third step is connecting the comparisons to get the priorities of the alternatives with respect to each criterion and the weights of each criterion with respect to the goal. The local priorities are then multiplied by the weights of the respective criteria. The results are summed up to get the overall priority of each alternative.

3.2 Case study

The empirical research is based on doing numerous case studies of companies from different countries to analyze with existing analytical models and to create new analytical models for further evaluation, therefore the selection of case companies must be mostly representative, well performed and highly experienced in managing global turbulent business situations. As a result the empirical studies are focused to case companies in the most dynamic market and best performer in crisis management – China, especially the large and medium-sized manufacturing enterprises, and compare their operational performances in global context. The case companies are chosen among the backbone industries of Chinese economy. They cover industries including iron & steel, non-ferrous metal, mining, chemistry, construction, energy, machinery, equipment, research & development, service and logistics. Based on such wide variation of industries and good performance in exercising of strategy and leadership, the chosen case companies are well representative for China in the empirical study.

For side by side comparisons in performance of crisis management, a number of large and median-sized manufacturing case companies in comparable size and similar industries are also chosen from several European countries, including Finland which is known for its highly competitive technologies, Slovakia which is manufacturing base for many European and multinational companies, Spain which is another major European manufacturing centre, and Iceland which is badly hit by the economic crisis. In each country there are around 4 to 5 case companies that are studied. All the case studies in these countries are carried out using exactly the same methodologies as how the case studies are done in China. All case companies are represented with codes which can be neither recognized nor speculated as their real names. The questionnaires for all the case studies are developed based on manufacturing strategy by Takala et al. (2007b) and transformational leadership by Takala et al. (2008).

3.3 Data collection and analysis

The data of case companies in different countries are collected in the same manner, by asking senior managers or directors to answer the questionnaires from different organizations and departments. The interviewees are normally decision makers and middle management groups in the case companies, who have good knowledge about the operations of the case companies, and the number of informants is depended on the size of case company. From same case company the inconsistent results are left out. Firstly, the managers or directors are trained to understand every item of the questionnaires by email, telephone or interview. Secondly, after they finish the questionnaires the answers are analyzed with AHP software. Thirdly, the discussion with managers or directors reveals the results and verifies the validity and reliability of the data further.

For studying the manufacturing strategy, competitiveness priorities are listed in the AHP questionnaires as main criteria consisting of quality, cost, time/delivery, and flexibility. The main criteria are typical items used in evaluating the competitiveness priorities in multi-focused manufacturing strategies (Spina et al. 1996). They are formed based on typical case studies and instruments used in interviews. The sub-criteria involve 19 criterions, such as low defect rate, low cost, fast delivery, broad product line, etc. The weights are statistically measured for further analysis with analytical models (Takala et al. 2007b).

For studying the transformational leadership, leadership profiles are empirically measured with the theoretical frame of reference by AHP questionnaires (Takala et al. 2006). Statistical tests are made to find out the logics in the leadership profiles to increase accuracy in the profiles, and in parallel the analytical models are built by induction and tested statistically to measure leadership skills by leadership indexes from resource utilizations to leadership behaviours and finally to outcome directions and outcomes. Analytical models are further used to measure the effectiveness of leadership actions within different areas of outcomes and try to find out the correlation between these outcomes and leadership indexes in a forecasting way (Takala et al. 2008).

For studying the technology level, the weights of spearhead technology, core technology, and basic technology are collected by interviewing the expert informants directly (Tuominen et al. 2003).

All the collected answers are further analyzed with analytical models for evaluation of operational competitiveness.

4. Analytical models

In this study, the overall competitiveness is proposed to be evaluated based on two core factors, i.e. manufacturing strategy and transformational leadership. Technology level is proposed to be considered as part of resources of under transformational leadership. Sense & respond model is used to help in dynamic decision making to describe, evaluate, benchmark and optimize lower level resource allocations to meet the performance requirements in all the interest groups inside and outside the organization and in turn to improve higher level strategies.

Existing analytical models of manufacturing strategy and transformational leadership with technology level from Liu & Takala (2009b; 2010b) and sense & respond from Ranta & Takala (2007) are reviewed and examined. These models are integrated to develop as a new holistic model to evaluate and develop overall competitiveness potential.

4.1 Manufacturing strategy

The analytical models for manufacturing strategy are used to calculate the operational competitiveness indexes of companies in the different competitive groups, which are prospector, analyzer and defender (Miles & Snow 1978). According to Takala (2002), the responsiveness, agility and leanness (RAL) holistic model supports the theory of the analytical models using four main criteria, i.e. quality, cost, time and flexibility. The analytical models are developed from our research group based on over 100 case company studies in over 10 countries worldwide, whose industrial branch varies from one to another and company size varies from big to small but they share one thing in common which is that they all compete in a highly dynamic business environment and therefore such analytical models have good transferability.

According to Takala et al. (2007b), the manufacturing strategy index (MSI) is modelled based on the multi-criteria priority weights of Q (Quality), C (Cost), T (Time/delivery) and F (Flexibility), as function $MSI = f_{MSI}(Q,C,T,F)$.

The equations to calculate normalized weights of core factors are as follow.

$$Q' = \frac{Q}{Q+C+T} \tag{1}$$

$$C' = \frac{C}{Q+C+T} \tag{2}$$

$$T' = \frac{T}{Q + C + T} \tag{3}$$

$$F' = \frac{F}{Q + C + T + F} \tag{4}$$

Q = Quality; C = Cost; T = Time/delivery; F = Flexibility
The analytical models to calculate the manufacturing strategy indexes of operational competitiveness in each group (Prospector, Analyzer, Defender) are respectively as follow.

$$MSI_P = 1 - (1 - Q'^{1/3}) \cdot (1 - 0.9 \cdot T') \cdot (1 - 0.9 \cdot C') \cdot F'^{1/3} \tag{5}$$

$$MSI_A = 1 - (1 - F') \cdot \left(abs \begin{Bmatrix} (0.95 \cdot Q' - 0.285) \cdot (0.95 \cdot T' - 0.285) \cdot \\ (0.95 \cdot C' - 0.285) \end{Bmatrix} \right)^{1/3} \tag{6}$$

$$MSI_D = 1 - (1 - C'^{1/3}) \cdot (1 - 0.9 \cdot T') \cdot (1 - 0.9 \cdot Q') \cdot F'^{1/3} \tag{7}$$

4.2 Transformational leadership with technology level

The theoretical frame of the analytical models is based on theory of transformational leadership (Bass 1997). A holistic but very simple model of a human being from resource allocations to behaviour and finally to outcome directions and outcomes has been built basing on psychic, social, functional, organizational and structural factors and put together according to the sand cone model and participation objectives in leadership of an organization (Takala et al. 2006). A modified sand cone model by integrating technology level into part of resource is proposed in Liu & Takala (2010b), based on which the new analytical models are developed. Sand cone model from operations management literature Ferdows & De Meyer (1990) present a model of cumulative layers of manufacturing performance dimensions. The model implies an idea that companies need to develop their performance in certain stages, in order to achieve higher levels of competitive performance. The prescriptive order of mutually supportive and enabling success factors is to proceed from quality, to delivery performance, then flexibility and finally to cost effectiveness. In this manner, the often-competitive dimensions of performance need to be viewed as a whole, to think about performance and capabilities on a longer-term basis. The conceptual model with sand cone has similar basic ideas as the model of deep leadership (Nissinen 2001) in which the potential in professional skills and resources is transformed to outcomes of activities with the help and support of leadership process and behaviour.
Technology is understood as know-how of human competence, a relevant part of resource based strategy, including all types of assets and resources, or strategic networking for collaborations by using partnerships (Braun 1998; Takala 1997). The technology level, which is categorized as spearhead technology (SH), core technology (CR), and basic technology (BS), are defined as follow.
SH: Technologies that are more orientated for the future.
CR: Core competitive technologies that are in use for today.
BS: Technologies that are commonly used everywhere and can be outsourced or purchased from other companies.

Based on analytical models for transformational leadership proposed by Takala et al. (2008), the analytical models are further developed by integrating technology into resource for the evaluations of leadership indexes and its outcomes of transformational leadership. These models are outcome direction index (OI) by balancing the directions, leadership behaviour index (LI) by measuring deep leadership, the maximum of passive and/or controlling leadership and the utilization of the cornerstones of deep leadership in different ways, and resource allocation index (RI) by balancing utilization of human resources. Outcome index (OI) is based on weights of factors i.e. extra effort (EE), satisfaction (SA), effectiveness (EF), therefore OI is modelled as function $OI = f_{OI}(EE, SA, EF)$. Leadership index (LI) is based on weight of factors i.e. deep leadership (DL), passive leadership (PL), controlling leadership (CL) and individualized consideration (IC), inspirational motivation (IM), intellectual stimulation (IS), building trust and confidence (BT), therefore LI is modelled as function $LI = f_{LI}(DL, PL, CL, IC, IM, IS, BT)$. Resource index (RI) is based on weights of factors i.e. people/technology/know-how (PT), processes (PC), information systems (IT), organizations of groups/teams (OR) and technology level index (TI), where TI is based on weights of factors i.e.: spearhead technology (SH), core technology (CR), and basic technology (BS), therefore TI is modelled as function $TI = f_{TI}(SH, CR, BS)$ and RI is modelled as function $RI = f_{RI}(PT, PC, IT, OR, TI)$. The total leadership index (TLI) is still modelled as function $TLI = f_{TLI}(OI, LI, RI)$ as in previous studies, however, the difference of the new definition of TLI is that TI has been considered to be integrated into transformational leadership as a special part of RI in leadership.

The modelling of technology level is different than other variables because of its particularity in transformational leadership. Here a brand new idea to model the effect of technology level index to resource index is proposed. According to the principles how resource index has been built, the effects are defined as follow.

A. The excessive know-how, meaning that caused by not the right technology belongs directly as an extra weight to the warehouse of know-how (PT), and lowers weights in PC, IT or OR, lowering in both cases the resource index RI in a linear manner.

B. The right technology, meaning that fitting to the manufacturing stages increases PC, IT or OR, and decreases the know-how (PT) warehouse that caused by not the right technology, and increases in both cases the resource index RI in a linear manner.

Definitions A and B with the expert opinions from the case companies and equation for modelling RI are used for the analysis. The weights of SH/CR/BS are collected by interviewing the experts especially how significant or how much effect they are or have to be for PT and min(PC, IT, OR) and then the effects of how TI affects RI is analyzed.

Assuming that followed by previous business situation there are new business situations of an economic downturn and then an economic upturn, companies need to deal with the crisis and then recover from the crisis. One example to analyze how TI might affect RI in three phases of different business situations, i.e. before crisis, during crisis, after crisis, is presented in Table 1.

The optimal weights of SH, SR, and BS under different stages of crisis are listed in Table 1. These optimal values are obtained theoretically from the chosen competitor and market benchmark with some tolerance. Then the case company data are compared with the optimal values to get the differences for calculating TI. TI is defined to reflect how good the technology level allocation is by using 1 minus the worst deviation from the optimal weights of technology levels. The higher value of TI directly decrease PT caused by using

	Before crisis (BC)	During crisis (DC)	After crisis (AC)
SH	High, factor 2…, ≥60%	Lower, factor about 1, 20%~30%	High, factor 1.5…2, 45%~70%
CR	Low, factor 1…, ≥30%	Higher, factor about 2, 40%~60%	Lower, factor …1, ≤35%
BS	About 0, ≤10%	Low, factor 0.5…1, 10%~30%	About 0, ≤10%
RI	=RI(BC), with PT low and min(PC, IT, OR) high	=1.2…2×RI(DC), with PT higher and min(PC, IT, OR) lower	=1.05…1.2×RI(AC), with PT high and min(PC, IT, OR) lower
TLI	=TLI(BC)	=1.2…2×TLI(DC)	=1.05…1.2×TLI(AC)

Table 1. How TI affects RI under different business situations

not the right technology and increase min(PC, IT, OR), therefore increases RI eventually. Based on such idea, TI is modelled.

The analytical models for evaluation of leadership are as follow.

Outcome index (OI):

According to Liu & Takala (2009b: 13), different categories of outcome indexes all lead to nearly same total dealership indexes, therefore this empirical research uses OI model without classification:

$$OI = 1 - \max\left\{\left|\frac{1}{3} - EE\right|, \left|\frac{1}{3} - SA\right|, \left|\frac{1}{3} - EF\right|\right\} \tag{8}$$

Categorized OI models (Takala, Kukkola & Pennanen 2008; 2009) are preliminary and will be explored more in future research.

The OI model for prospector group:

$$OI_P = 1 - (1 - EE^{1/3}) \cdot (1 - EF) \cdot (1 - SA) \cdot Std\{EE, SA, EF\}^{1/3} \tag{9}$$

where EE ≥ 0.43 and EF+SA ≤ 0.57

The OI model for analyzer group:

$$OI_A = 1 - (1 - SA^{1/3}) \cdot (1 - Std\{EE, SA, EF\}^{1/3}) \tag{10}$$

where SA ≥ 0.43 and EE+EF ≤ 0.57

The OI model for defender group:

$$OI_D = 1 - (1 - EF^{1/3}) \cdot (1 - EE) \cdot (1 - SA) \cdot Std\{EE, SA, EF\}^{1/3} \tag{11}$$

where EF ≥ 0.43 and EE+SA ≤ 0.57

The OI model for reactor group:

$$OI_R = (OI_P + OI_A + OI_D)/3 \tag{12}$$

where EE < 0.43 and SA < 0.43 and EF < 0.43

EE = extra effort; SA = satisfaction; EF = effectiveness

Leadership index (LI):

$$OI_R = (OI_P + OI_A + OI_D)/3 \tag{13}$$

DL = deep leadership; PL = passive leadership; CL = controlling leadership
IC = individualized consideration; IM = inspirational motivation;
IS = intellectual stimulation; BT = building trust and confidence
Resource index (RI) integrating with Technology index (TI):

$$RI = (1 - PT \cdot (1 - TI)) \cdot (3 \cdot \min\{PC, IT, OR\} \cdot TI) \tag{14}$$

PT = people, technology and know-how; PC = processes;
IT = information systems; OR = organizations (groups, teams)

$$TI = 1 - \max\left\{\left|SH_{optimal} - SH\right|, \left|CR_{optimal} - CR\right|, \left|BS_{optimal} - BS\right|\right\} \tag{15}$$

SH=Spearhead; CR=Core; BS=Basic
Combined total leadership index (TLI):

$$TLI = OI \cdot LI \cdot RI \tag{16}$$

4.3 Overall competitiveness

The overall competitiveness index (OCI) is proposed to be modelled as function:

$$OCI = f_{OCI}(f_{MSI}, f_{TLI}) = f_{MSI} \cdot f_{TLI} = MSI \cdot TLI \tag{17}$$

According to Liu & Takala (2009b: 14), in some cases the OCI can be modelled as reduced function:

$$OCI = f_{OCI}(f_{MSI}, f_{TLI}) = f_{MSI} \cdot f_{TLI} = MSI \cdot OI \cdot TI \tag{18}$$

This is because that the OI of transformational leadership is the key factor to direct the strategic goal of manufacturing strategy and MSI is the driving force of the company, taking the effects of TI into account in which TI are evaluated as approximately constant factors before crisis, during crisis and after crisis. In such cases, OI is more decisive to overall competitiveness but other factors like LI, RI, and TI can be influenced also by government macro control, etc.

5. Empirical research

In this chapter, a complete example by studying the development of operational competitiveness potential of case companies in China, Finland, Slovakia, Spain and Iceland is presented to illustrate the applicability of implementing SCA for proactive operations to manage in economic crisis situation.

5.1 Overview of analysis process

The collected answers from questionnaires are processed and analyzed step by step for evaluation of operational competitiveness and development of operational competitiveness potential. Fig.1 shows the complete process of the empirical research from questionnaires to conclusions illustrated with a flowchart.

5.2 Data processing and analysis

AHP analysis of raw data is the first step of the process. Raw data from answers of questionnaires are processed with AHP software Expert Choice, to convert qualitative criteria to quantitative values. During this step, inconsistency ratios are checked to ensure the internal validity of the answers. Also the results are compared with answers to open questions for added internal validity to the answers. Different business situations, e.g. before crisis, during crisis, after crisis are processed respectively.

Analytical evaluation of MSI and TLI is the second step of the process. The results from AHP are further processed with analytical models introduced in section 4. All the analytical models are programmed with Matlab code for the ease of processing data.

The rankings of MSI are obtained from our global manufacturing strategy database which composes of MSI case studies of over 100 case companies in over 10 countries worldwide. The most competitive case companies in prospector group are from Iceland, China and Finland; in analyzer group are from China, Spain and Finland; in defender group are from Spain, Iceland and China, and the most powerful transformational leadership of case company leaders are from China and Finland.

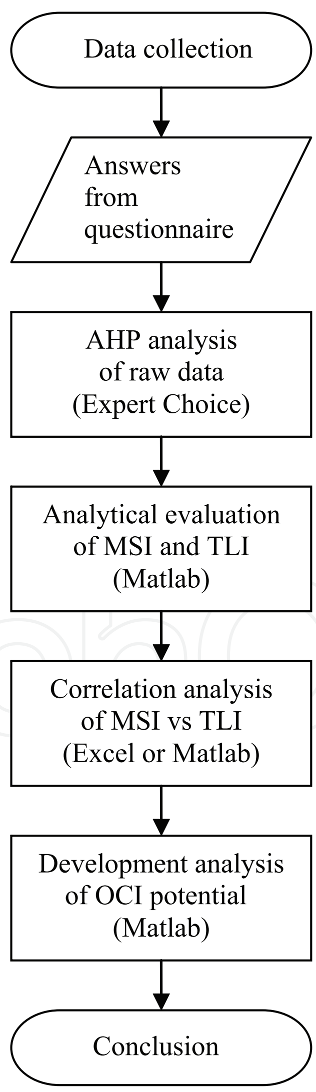

Fig. 1. Flowchart for empirical research

Correlation analysis of MSI vs TLI is the third step of the process. In an organization, TLI is considered as driving force and MSI is considered as outcome, therefore it's meaningful to find the correlation of MSI vs TLI. The results of the case companies, in this example divided by countries, or smaller units such as regions or industries or companies, are plotted with Excel or Matlab to show the correlations of MSI in different groups (prospector, analyzer and defender) versus TLI. The smaller the divided units, the more accurate are the results. In each divided unit to be analyzed, at least 3 answers for each competitive group are required, which make it possible to provide sufficient information for measuring the significance of regression in order to analyze the OCI potential, and more answers reflect the reality better.

Fig. 2, Fig. 3, Fig. 4, Fig. 5, Fig. 6 respectively plot the correlations between MSI and TLI of case companies in China, Finland, Slovakia, Spain and Iceland. It can be seen that the slopes of MSI vs TLI in different groups are quite different. Typically, the group which has the highest slope and the highest significance of the regression measured by R-square is considered to be the most competitive group in the divided unit under that particular business situation.

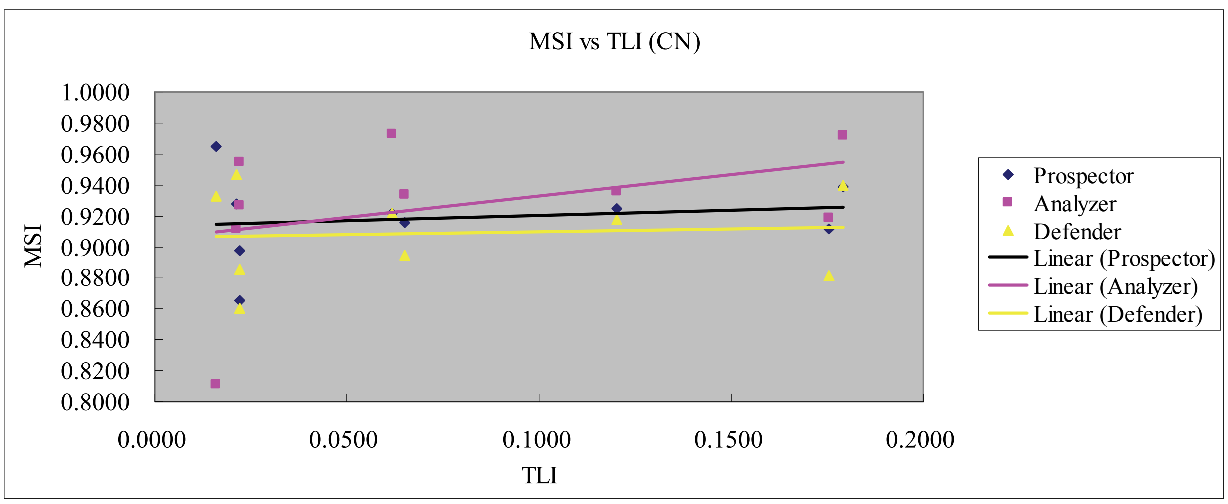

Fig. 2. MSI vs TLI of case companies in China

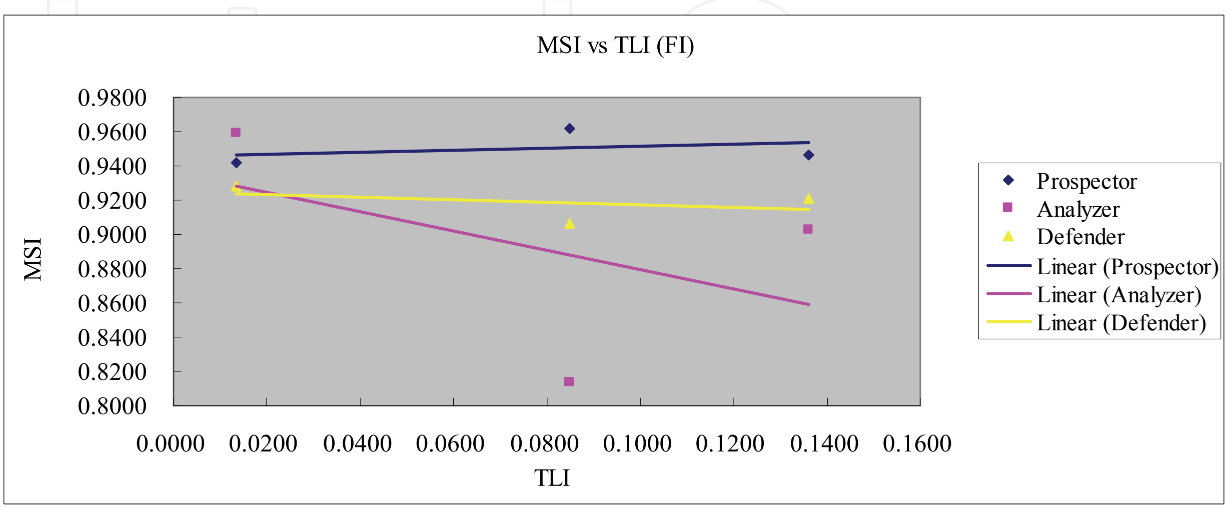

Fig. 3. MSI vs TLI of case companies in Finland

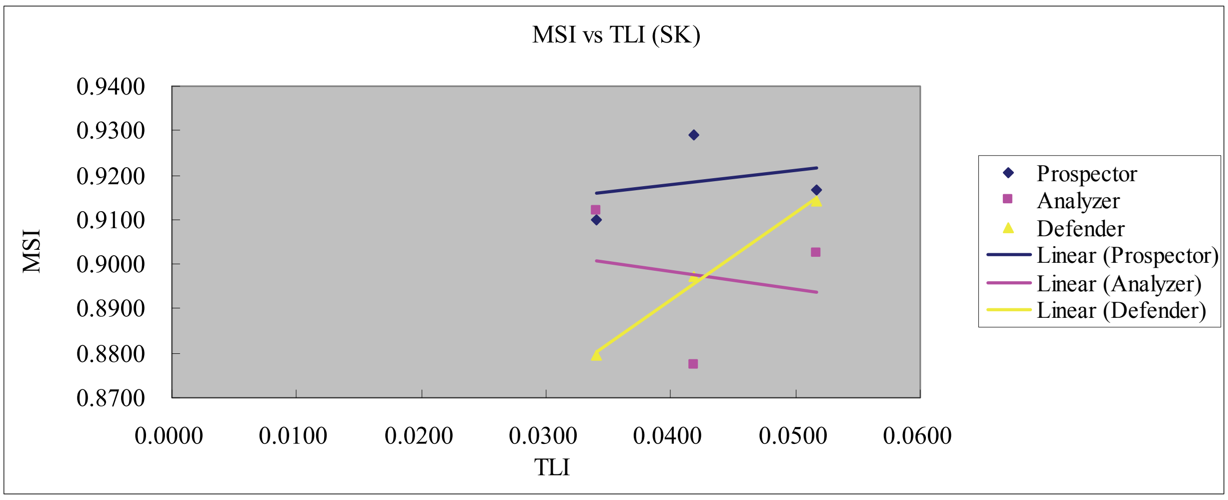

Fig. 4. MSI vs TLI of case companies in Slovakia

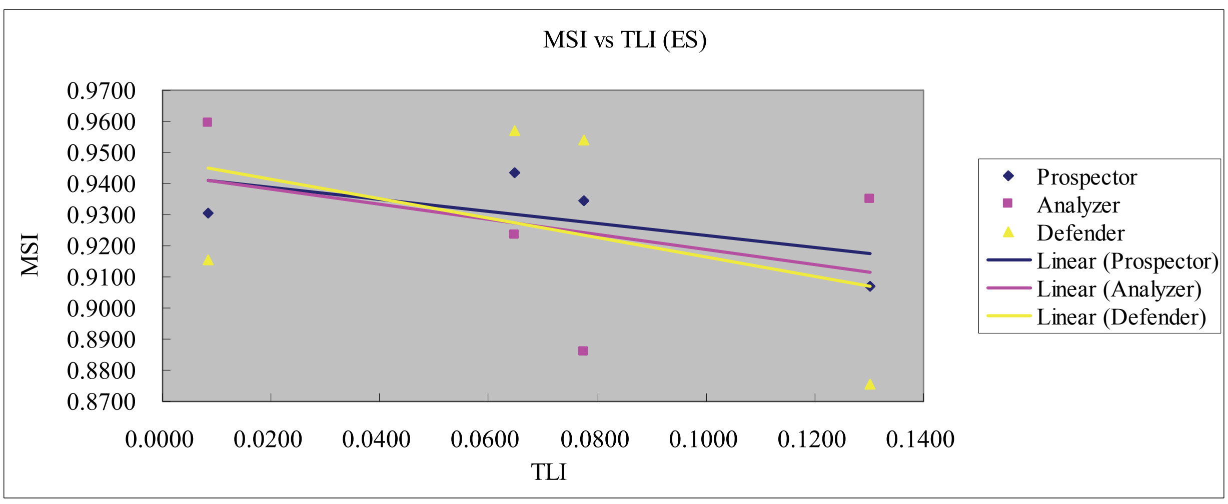

Fig. 5. MSI vs TLI of case companies in Spain

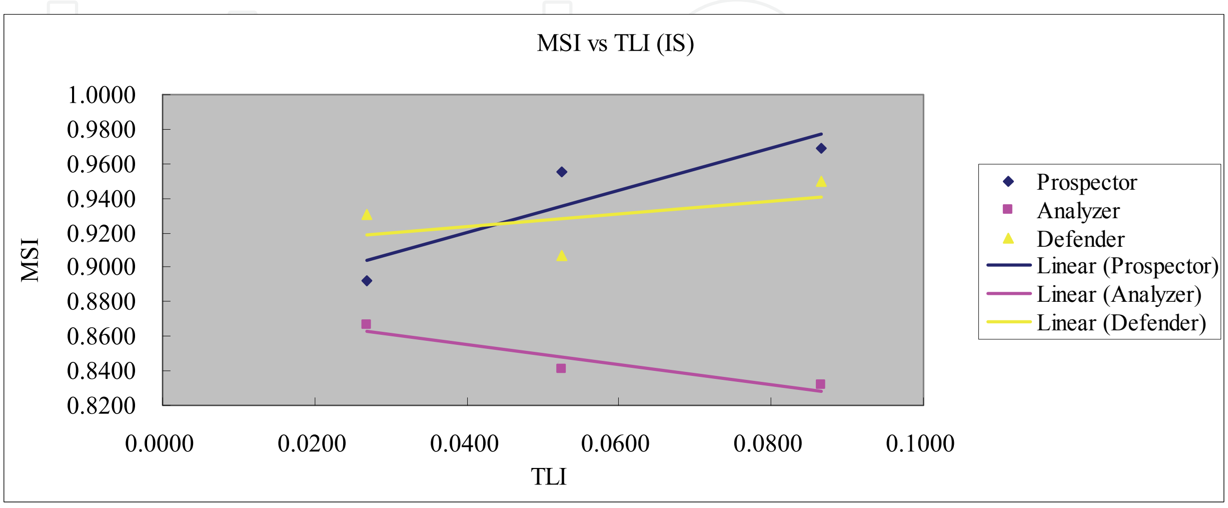

Fig. 6. MSI vs TLI of case companies in Iceland

Development analysis of OCI potential is the fourth step of the process and the most important one. To develop the operational competitiveness potential with the most competitive group in the particular unit, the idea is to break the links between each leader's TLI and the corresponding MSI so that the leader's full potential TLI can be utilized to drive the best possible MSI and in turn to obtain the highest possible OCI potential. This gives "what if" assumptions that leaders are believed to be able to generate better operational competitive performance if they are switched to more suitable positions.

In the particular unit the MSI from most competitive group and corresponding TLI are independently sorted from low to high, and plotted respectively against number of samples. An example of case companies in China with sorted MSI in most competitive analyzer group and sorted TLI form the two linear regression functions as shown in Fig. 7 with

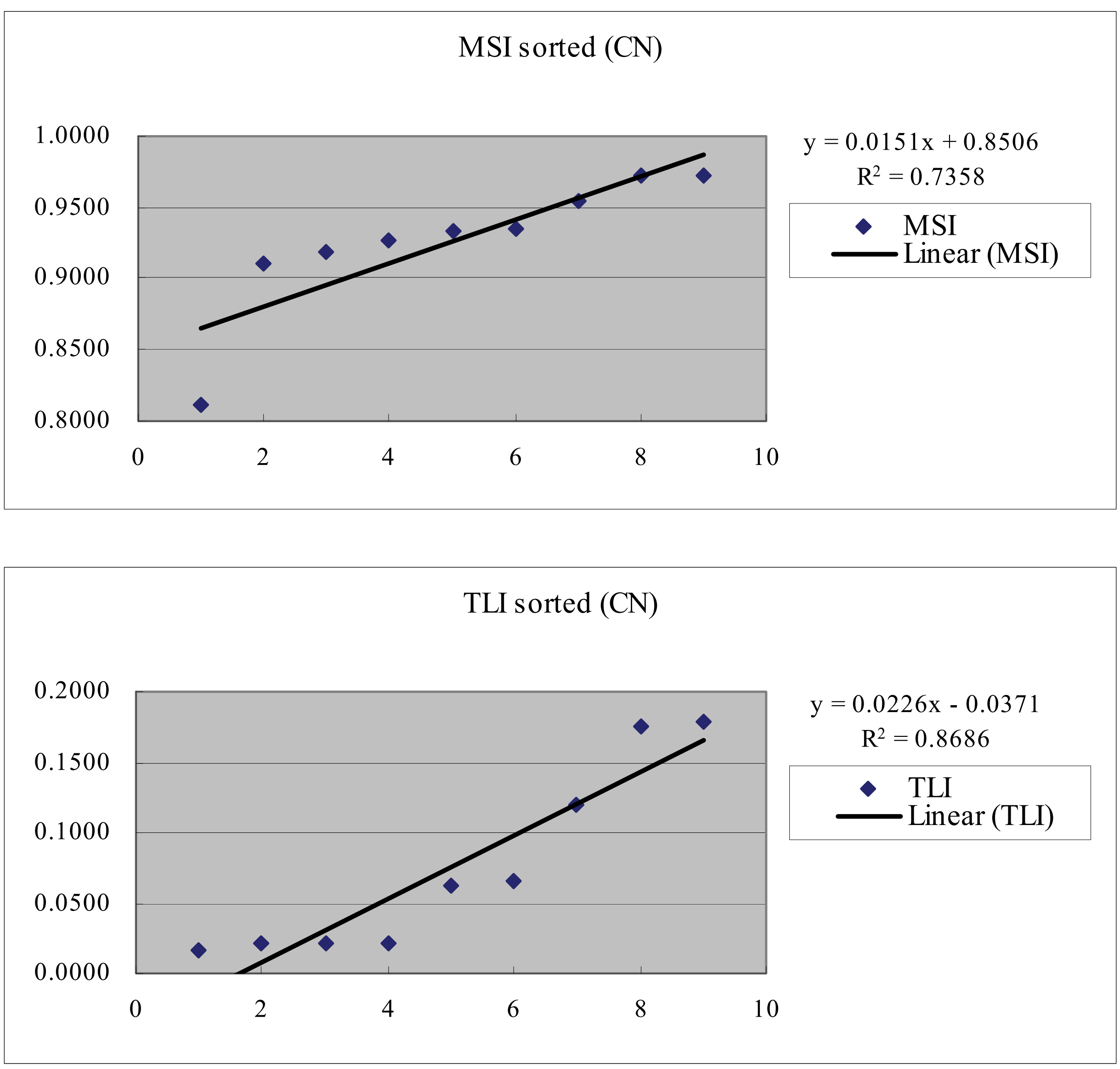

Fig. 7. Linear regression functions of sorted MSI and TLI

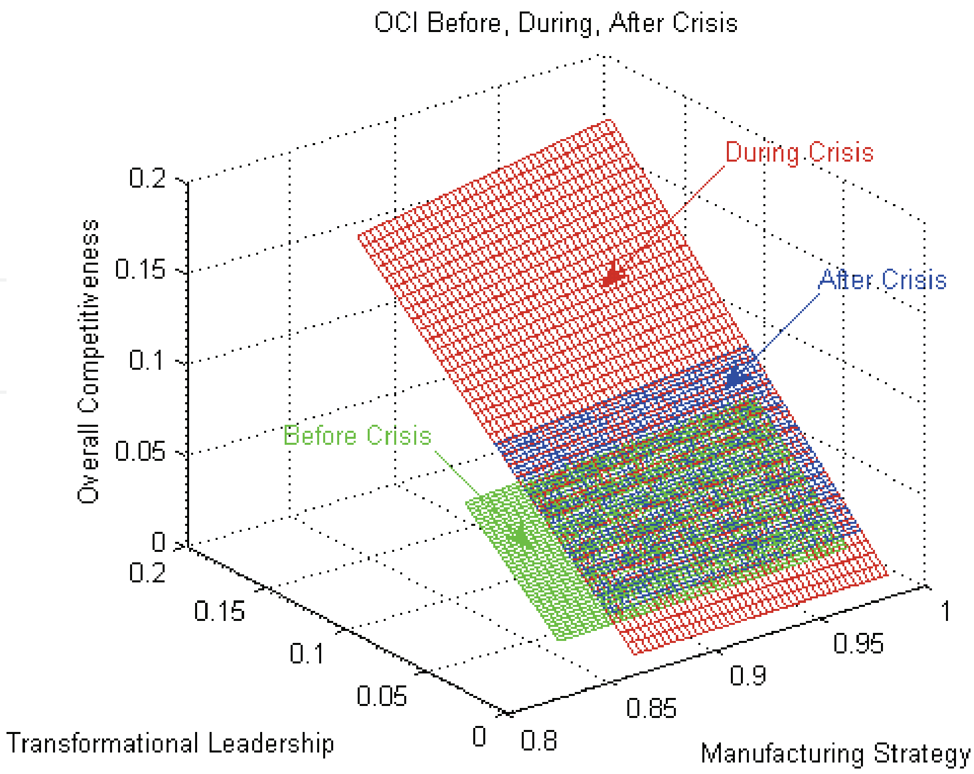

Fig. 8. OCI case comparisons before, during, after crisis

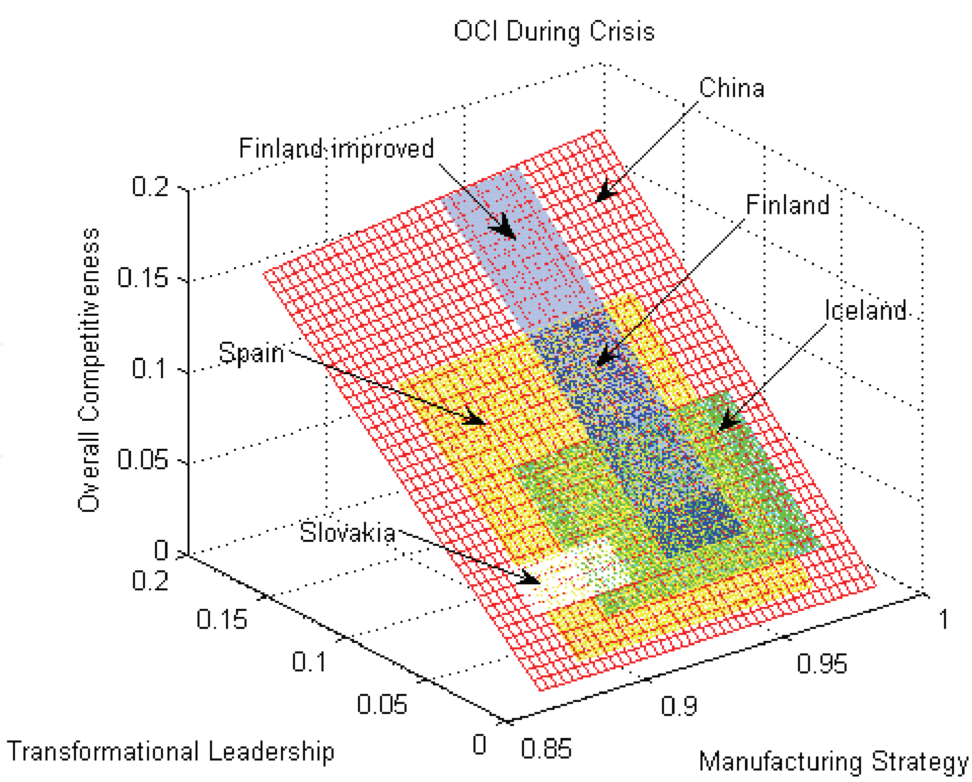

Fig. 9. Improved OCI during crisis with case comparisons

relatively high R-squares can be obtained. The product of these two functions is plotted in Matlab with 3-dimensional mesh function to show the potential region where the OCI can be developed. The plots of OCI potential regions can be used both for horizontal comparisons e.g. to compare the same unit under different business situations and for vertical comparisons e.g. to compare different units under the same business situation. Fig. 8 shows an example of horizontal comparisons which compares OCI before, during and after crisis for the same unit. Fig. 9 shows an example of vertical comparisons which compares OCI from different units during crisis. Through sense & respond model to optimize resource allocations for case companies in Finland, the improved OCI potential regions can be forecasted.

OCI potential analysis and such comparisons can be very helpful to study the effects of dynamic decisions on operational competitiveness under different business situations and develop the competitiveness potential further.

5.3 Findings

The evaluation results of MSI show that case companies from different countries have demonstrated by using different strategies to deal with economic crisis. In prospector group, Icelandic case companies have shown strong competitiveness despite of the seriously threatened economy from Icelandic banking crisis, and the evaluation results indicate that prospector strategy has successfully maintained their best competitiveness to survive during crisis. In analyzer group, Chinese case companies mostly have maintained or have changed to analyzer as the most competitive group and have shown strong competitiveness during crisis. This can be explained by the fact that during crisis the significant decrease in market demand has driven a strict control over costs both in production and administration. Also externally, Chinese government plays a key role at the macroeconomic level which regulates the domestic market more than other case countries (Si et al. 2010). In defender group, Spanish case companies have shown strong competitiveness which reflects realistically that cost effectiveness is their competitive advantage to sustain market shares during crisis.

The evaluation results of TLI indicate that Chinese leaders have demonstrated the most powerful transformational leadership, and this result is consistent with the result from manufacturing strategy. By reviewing evaluation results of MSI, Chinese case companies have shown relatively strong competitiveness in all three different groups. This can be explained by the fact that Chinese government regulation applied to different industries has pointed leaders the clear direction of development, so that they have more clear vision for taking actively courage to the challenge of crisis and making the right adjustments in dealing with the crisis. On the contrary, also some leaders have been left behind, which implies they are passively waiting for the government solutions and trying adjustments in the wrong way because of lacking experience.

From the correlation analysis it can be seen that in different case countries or even under different business situations the slopes of MSI vs TLI may be positive or negative. Especially in Fig. 5 the cases in Spain where MSI vs TLI in all groups have negative slopes, which implies good transformational leadership does not necessarily lead to strong competitiveness in manufacturing strategy. Only exception is the cases in China as shown in

Fig. 2 where MSI vs TLI in all groups have positive slopes, which implies during crisis leadership is really motivated and plays a key role in dealing with the crisis. The slope of MSI vs TLI in analyzer group is highest, which proves transformational leadership makes manufacturing strategy more competitive in analyzer group during crisis. Fig. 3 and Fig. 6 demonstrate how TLI affects MSI for case companies in Finland and Iceland. The slopes of MSI vs TLI indicate they have highest competitiveness in prospector group. These results are corresponding to the fact that most of Finnish firms are advanced in technology as well as good vision in future product development, and Icelandic firms have survived during crisis by aggressively searching for new market and profit from products innovations despite of the serious impact of economic downturn on its economy. Fig. 4 implies that case companies in Slovakia have the highest competitiveness in defender group, which can be explained in practice that Slovakia firms are very cost efficient, and during crisis they use low cost strategy to obtain the market, however the results are not very promising. A general finding is that leaders in China do show active adjustments during crisis, whereas leaders in other countries seem more conservative and that even limit further the competitiveness of manufacturing and technology strategies, causing negative slopes of MSI vs TLI. It is assumed that in China leaders are adventurous to make more competitive decisions since they have strong support from government so that they don't worry too much in taking aggressive decisions. Another significant finding in MSI vs TLI is that typically in analyzer group the plots are scattered which results very low R-square values, whereas in prospector and defender groups the plots usually result relatively much higher R-square values. The causes of such phenomenon will be dealt in future research.

The 3-dimentional plots in Fig. 8 and Fig. 9 show the competitiveness potential of case companies under different business situations and in different countries where the OCI can be developed. It can be seen that transformational leadership has more significant effect than manufacturing strategy to improve overall competitiveness potential. Through such proactive operations to develop sustainable competitive advantage, the forecasted OCI after crisis shows continuous improvement over previous OCI before crisis in Fig. 8 and the forecasted OCI improvement is significant over the previous one in Fig. 9, where the research goal of this work is reached.

5.4 Summary

Compared to previous research results which have been conducted before crisis, such comparative studies to place a number of case studies longitudinally to examine the impact of economic crisis is a unique opportunity to find the solution of how to overcome the crisis and recover after the crisis.

To conclude this empirical research, China shows strong potential in developing overall operational competitiveness compared to other countries, which might explain China's leading role in dealing with global economic crisis from operations point of view. This can be further proved by official statistics. According to The World Bank (2010)'s latest China Quarterly Update released in March 2010, China's economy grew 8.7 percent in 2009 and the growth momentum continued in the first months of 2010 in spite of the global recession. The adjustments in manufacturing strategy and transformation leadership by implementing

SCA through fast strategy are proved to be effective and successful to manage the crisis and keep the high growth of Chinese economy. The experience learnt from this research can thus become a model for crisis management studies globally.

6. Conclusion

This work studies the evaluation and development of overall operational competitiveness in global context using analytical models, which is a novel concept by integrating the evaluation of manufacturing strategy and transformational leadership with technology level together, and through sense & respond proactive operations to improve the competitiveness potential in order to manage turbulent business situations. The empirical research is focused to numerous case studies of companies in China and several European countries to compare their overall competitiveness in global context and conclude the experience of managing the economic crisis, with the purpose in finding solutions to manage turbulent business situations. The influence of "China effect" and global economic crisis are brought together to study how such will impact the operational competitiveness of companies on top of their previous manufacturing strategy and transformational leadership before crisis, and how they will react during crisis to adjust their current manufacturing strategy and transformational leadership to manage the crisis, and even to predict after crisis how they will minimize the negative impacts from the crisis to sustain and develop their optimal operational competitiveness further. The competitiveness in manufacturing operations is evaluated in terms of overall competitiveness performance by integrating the core factors i.e. manufacturing strategy and transformational leadership with technology level, into conceptual analytical models, and through sense & respond to optimize resource allocations to help in dynamic decisions in adjusting strategies and transforming leadership in order to improve the competitiveness potential in a sustainable manner. Implementing such strategic adjustments and transformational capabilities are proposed as the unique SCA for managing in global turbulent business environments.

7. References

Banuls, V. A. & Salmeron, J. L. (2008). Foresighting key areas in the Information Technology industry. *Technovation* 28: 3, 103-111.

Bass, B. M. (1985). *Leadership and Performance beyond Expectations*. New York: Free Press.

Bass, B. M. & Avolio, B. J. (1994). *Improving Organizational Effectiveness through Transformational Leadership*. Thousand Oaks: Sage.

Bass, B. M. (1997). Does the transactional-transformational leadership paradigm transcend organizational and national boundaries? *American Psychologist* 52: 2, 130-139.

Braun, E. (1998). *Technology in Context: Technology Assessment for Managers*. London: Routledge.

Ferdows, K. & De Meyer, A. (1990). Lasting improvements in manufacturing performance: In search of a new theory. *Journal of Operations Management* 9: 2, 168-184.

Kim, J. S. & Arnold, P. (1996). Operationalizing manufacturing strategy: An exploratory study of constructs and linkage. *International Journal of Operations & Production Management* 16: 12, 45-73.

Liu, Y., Li, Y., Takala, J., Kamdee, T. & Toshev, R. (2008). Improve company's operative competitiveness using analytical models. *Proceedings of the 17th International Conference on Management of Technology – IAMOT 2008*. Dubai: International Association for Management of Technology.

Liu, Y., Si, S. & Takala, J. (2009). Comparing operational competitiveness strategies in China and Finland. *Proceedings of the 18th International Conference on Management of Technology – IAMOT 2009*. Orlando: International Association for Management of Technology.

Liu, Y. & Takala, J. (2009a). Crisis management of Chinese state-owned manufacturing enterprises in global context. *Proceedings of Management International Conference – MIC 2009*. Sousse.

Liu, Y. & Takala, J. (2009b). Modelling and evaluation of operational competitiveness of manufacturing enterprises. *Quality Innovation Prosperity* XIII: 2, 1-19.

Liu, Y. & Takala, J. (2010a). Evaluation of global operational competitiveness for crisis management. *Proceedings of the 19th International Conference on Management of Technology – IAMOT 2010*. Cairo: International Association for Management of Technology.

Liu, Y. & Takala, J. (2010b). Competitiveness development of Chinese manufacturing enterprises in global context for crisis management. *International Journal of Management and Enterprise Development* X: Y, 000-000. (forthcoming)

Menguc, B., Auh, S. & Shih, E. (2007). Transformational leadership and market orientation: Implications for the implementation of competitive strategies and business unit performance. *Journal of Business Research* 60: 4, 314-321.

Miles, R. E. & Snow, C. C. (1978). *Organizational Strategy, Structure, and Process*. New York: McGraw-Hill.

Nissinen, V. (2001). *Military leadership, a critical constructivist approach to conceptualizing, modelling and measuring military leadership in the Finnish defence forces*. Finnish National Defence University. Department of Leadership and Management. Dissertation.

O'Regan, N. & Ghobadian, A. (2005). Strategic planning – a comparison of high and low technology manufacturing small firms. *Technovation* 25: 10, 1107-1117.

Porter, M. E. (1980). *Competitive Strategy: Techniques for Analyzing Industries and Competitors*. New York: Free Press.

Rangone, A. (1996). An analytical hierarchy process framework for comparing the overall performance of manufacturing departments. *International Journal of Operations & Production Management* 16: 8, 104-119.

Ranta, J. M. & Takala, J. (2007). A holistic method for finding out critical features of industry maintenance services. *International Journal of Services and Standards* 3: 3, 312-325.

Saaty, T. L. (1980). *The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation*. New York: McGraw-Hill.

Si, S., Takala, J. & Liu, Y. (2009). Competitiveness of Chinese high-tech manufacturing companies in global context. *Industrial Management & Data System* 109: 3, 404-421.

Si, S., Liu, Y., Takala, J. & Sun, S. (2010). Benchmarking and developing the operational competitiveness of Chinese state-owned manufacturing enterprises in a global context. *International Journal of Innovation and Learning* 7: 2, 202–222.

Sirikrai, S. B. & Tang, J. C. S. (2006). Industrial competitiveness analysis: Using the analytic hierarchy process. *The Journal of High Technology Management Research* 17:1, 71-83.

Skinner, W. (1974). The focused factory. *Harvard Business Review* May-June, 113-121.

Spina, G., Bartezzaghi, E., Bert, A., Cagliano, R., Draaijer, D. & Boer, H. (1996). Strategically flexible production: the multi-focused manufacturing paradigm. *International Journal of Operations & Production Management* 16: 11, 20-41.

Sun, S. (2004). Assessing joint maintenance shops in the Taiwanese Army using data envelopment analysis. *Journal of Operations Management* 22: 3, 233-245.

Takala, J. (1997). Developing new competitive strategies for high performance organizations from empirical case studies on relationship between technology management and total quality management. *Proceedings of International Conference on Productivity and Quality Research – ICPQR 1997*. Houston.

Takala, J. (2002). Analyzing and synthesizing multi-focused manufacturing strategies by analytical hierarchy process. *International Journal of Manufacturing Technology and Management* 4: 5, 345-355.

Takala, J., Leskinen, J., Sivusuo, H., Hirvelä, J. & Kekäle, T. (2006). The sand cone model: illustrating multi-focused strategies. *Management Decision* 44: 3, 335-345.

Takala, J., Hirvela, J., Liu,Y. & Malindzak, D. (2007a). Global manufacturing strategies require "dynamic engineers"? Case study in Finnish industries. *Industrial Management & Data System* 107: 3, 328-344.

Takala, J., Kamdee, T., Hirvela, J. & Kyllonen, S. (2007b). Analytic calculation of global operative competitiveness. *Proceedings of the 16th International Conference on Management of Technology – IAMOT 2007*. Orlando: International Association for Management of Technology.

Takala, J., Pennanen, J., Hiippala, P., Maunuksela, A. & Kilpiö, O. (2008). Decision maker's outcome as a function of transformational leadership. *Proceedings of the 17th International Conference on Management of Technology – IAMOT 2008*. Dubai: International Association for Management of Technology.

The World Bank (2010). *China Quarterly Update – March 2010* [Web document]. Beijing: World Bank Office [Cited on 11 May 2010]. Available at: http://siteresources.worldbank.org/CHINAEXTN/Resources/318949-1268688634523/CQU_march2010.pdf

Tracey, M., Vonderembse, M. A. & Lim, J. S. (1999). Manufacturing technology and strategy formulation: keys to enhancing competitiveness and improving performance. *Journal of Operations Management* 17: 4, 411-428.

Tuominen, T., Rinta-Knuuttila, A., Takala, J. & Kekäle, T. (2003). Technology survey: logistics and automation branch of materials handling industry. *Proceedings of the 2nd International Conference on Logistics & Transport – LOADO 2003*. High Tatras.

Wernerfelt, B. (1984). A resource-based view of the firm. *Strategy Management Journal* 5: 2, 170-180.

Zahedi, F. (1989). Quantitative evaluation of micro versus larger database products. *Computers & Operations Research* 16: 6, 513-532.

Products and Services; from R&D to Final Solutions

Edited by Igor Fuerstner

ISBN 978-953-307-211-1

Hard cover, 422 pages

Publisher Sciyo

Published online 02, November, 2010

Published in print edition November, 2010

Todayâ€™s global economy offers more opportunities, but is also more complex and competitive than ever before. This fact leads to a wide range of research activity in different fields of interest, especially in the so-called high-tech sectors. This book is a result of widespread research and development activity from many researchers worldwide, covering the aspects of development activities in general, as well as various aspects of the practical application of knowledge.