Operations strategy optimization based on developed sense and respond methodology

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Abstract
How to make adaptive adjustments on operations strategy in dynamic business environments becomes the very important competitiveness to all kinds of companies. This paper aims to develop sense and respond (S&R) models in agile and dynamic strategic adjustment by introducing scaled critical factor index (SCFI) compared with previous S&R models such as critical factor index (CFI) and balanced critical factor index (BCFI). In addition, the case study in this paper shows the difference among the three S&R models and the advantages of SCFI model. The analysis results show that the SCFI models have contribution to the adaptive operations strategy adjustment based on clear objectives in dynamic and turbulent business environment. Managers can make quick decisions by the analytical models.

Key words: Operational competitiveness; operations strategy; sense and respond (S&R); scaled critical factor index (SCFI); manufacturing industry

1 Introduction

The fierce business competition stimulates enterprises to adjust their strategies for deep and quick development. The new competitive environment causes manufacturing firms make quick response to customer demands, to high quality products, and to flexible industrial system (Skinner, 1986)[1]. However, how to improve the competitiveness of the enterprises becomes the focus of attention.

Competitiveness of enterprises depends on the basic operation factors and the optimization ability to those factors. The traditional factors of operations strategy research are cost, quality delivery and flexibility (Gerwin, 1993)[2]. Recently, research is deeply developed and the research articles are more about technology strategy with knowledge learning (Ahmad and Schroeder, 2011)[3], responsive supply chain (Gunasekaran et al., 2008)[4] and green-type manufacturing (Zeng and Zhang, 2011)[5] etc. Therefore, the operations strategy study in this

paper is based on the previous works which consider manufacturing strategy, technology strategy and leadership (Gyampah and Acquaah, 2008)[6] as important factors and build the strategic assessment model with those factors.

The strategic decision-making is another core research issue of operational competitiveness, for the quality of decision influence the correctness of strategy formulation, manufacturing, sales. Based on this view, many experts analyze the influence factors of enterprise competitiveness from the standpoint of affecting enterprise decision-making ability. The cognitive ability to status quo of enterprise, predictive ability to future of executives[7], and influence degree under the decision-making environment all determine the enterprise decision-making ability, and then determine the competitiveness of enterprise. Besides, the multi-objective decision should not only consider the economic benefits of decision object[8-10]. Therefore, this paper considers quick and adaptive strategic response as core ability to the operational performance development. Sense and respond system is introduced as an effective approach to accurately capture and model the dynamical behavior of business metrics[11]. Besides, during the process of sense and respond, it is important to develop an operational strategy adjustment system by utilizing critical factor evaluation (Liu, 2010)[12].

2 Research Methodology

2.1 Sense and respond theory and its models

The term sense and respond (S&R) as a business concept first appeared in 1992 Management Review article by Haeckel (1992)[13]. The S&R thinking is developed by Bradley and Nolan (1998)[14] and Markides (2000)[15] to analyze dynamic business strategies. The ability to quickly adjusting processes will also become a decisive factor in the concurrent economy. The S&R thought was utilized by Ranta and Takala (2007)[16] to develop the operative management system by introducing critical factor index (CFI). Since then, the S&R model has gone through three stages of development, which are called CFI model, BCFI model, and SCFI model. The difference of those three models can be seen in Table 1. The three models have common parts which are shown in equation (1) to (4). The different parts are the numerator. In addition, there are four critical factors in S&R model, including knowledge & technology management (PT), processes & work flows (PC), organizational systems (OR) and information systems (IT), are introduced into S&R models to analyze CFI of case companies. Besides, 21 critical factor attributes are included to analysis four main factors of enterprise resources which can be seen in Figure 1.
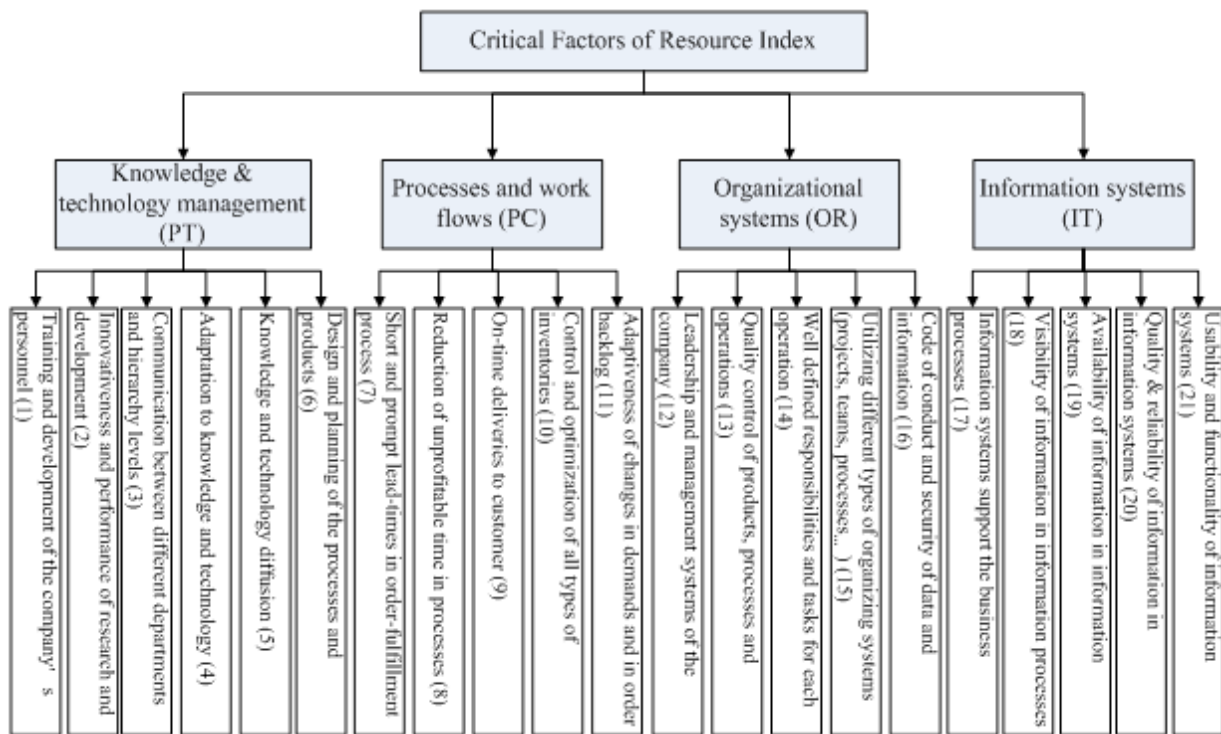
Figure 1 - Critical factors of resource index

The common parts of those three models are listed as following equations (1)-(4).

$$\text{Importance index} = \frac{\text{Average of expectation}}{10} \tag{1}$$

$$\text{Performance index} = \frac{\text{Average of experience}}{10} \tag{2}$$

$$\text{Gap index} = \left| \frac{(\text{avg. of experience - avg. of expectation})}{10} - 1 \right| \tag{3}$$

$$\text{Development index} = \left| (\text{better} - \text{worse}) * 0.9 - 1 \right| \tag{4}$$

The final equations of each model are listed in Table 1 as follows.

Table 1 - The model comparison of CFI, BCFI, and SCFI

Name	Model	
CFI	$$CFI = \dfrac{Std\{experience\} \cdot Std\{expectation\}}{Imprtance\ index \cdot Gap\ index \cdot Development\ index}$$	(5)
BCFI	$$SD\ Expectation\ index = \dfrac{Std\{expectation\}}{10} + 1$$	(6)
	$$SD\ Experience\ index = \dfrac{Std\{experience\}}{10} + 1$$	(7)
	$$BCFI = \dfrac{SD\ Expectation\ index \cdot SD\ Experience\ index \cdot Performance\ index}{Imprtance\ index \cdot Gap\ index \cdot Development\ index}$$	(8)
SCFI	$$SCFI = \dfrac{\sqrt{\dfrac{1}{n} \cdot \sum_{1}^{n}[experience(i)-1]^2} \cdot \sqrt{\dfrac{1}{n} \cdot \sum_{1}^{n}[expectation(i)-10]^2} \cdot Performance\ index}{Imprtance\ index \cdot Gap\ index \cdot Development\ index}$$	(9)

CFI is introduced by Ranta and Takala (2007)[16] for the first time to interpret and evaluate the critical factors of strategic adjustment which can support the strategic decision-making phase. The BCFI model is developed by Nadler and Takala (2010)[17] based on the principle of CFI model. The difference of BCFI model with CFI model is that it is developed the numerator of the CFI formula by changing *Std***{experience}** index and *Std***{expectation}** index into SD Experience index and SD Expectation index, and introducing performance index to the model. The SCFI model is developed by Takala et al. (2011) [18] which adds trend research into the study.

2.2 Case company and data collection
(1) Case company

The study of this paper is based on a high-speed ship engineering enterprise in China, represented by NH enterprise. The main business of NH enterprise is shipbuilding, including passenger ship, super yacht, ocean patrol ship, work boat and so on. It also has other businesses, after-sale service as well. The annual processing capacity of metal materials is 12,000t. Nowadays, the corporation has intension of developing a new market to manufacture leisure Boats or luxury yachts to meet the growing domestic market and Asia market.

(2) Data collection and analysis

The data used for the case study are gathered through the answering questionnaires from three interviewees of NH enterprise, general manager, human resources director and operation manager, who have more than 5 year of working experience and have good knowledge about the operations of the case companies. The analysis results will feedback to the respondents to discuss the results and verify the reliabilities of the data further.

To study the S&R models, the value of each index in the models from (1)-(12) can be obtained by the questionnaire (seen in Table 2) and the value of each attribute in the Figure 1 can be calculated by the models. The smaller the value, the more critical the attribute is. In

the Table 1, direction of development refers to the prediction of development trend in the next three years according to the enterprise performance in the past two years, and development experience refers to the summary of business development in the past two years.

Table 2 - Questionnaire sample

	Expectations	Experiences	Direction of Development			Development experience		
ATTRIBUTES	(1-10)	(1-10)	Worse	Same	Better	Worse	Same	Better
Knowledge & Technology Management								

The S&R models then use the indices introduced in the Figure 1 and calculate the deviations of experiences and expectations. The most critical attributes in operations can be found after making comparison among the 21 factors.

3 Analysis results

The data is collected from the case company, and the past and future CFIs have been calculated in this case study to illustrate the trend of how critical factors change and their development directions. Three different models of CFI calculation are utilized respectively to compare with expert opinions to conclude which model is most reasonably reflect the real situation. Figure 2 shows the calculated S&R results of past and future values using different models CFI, BCFI and SCFI.
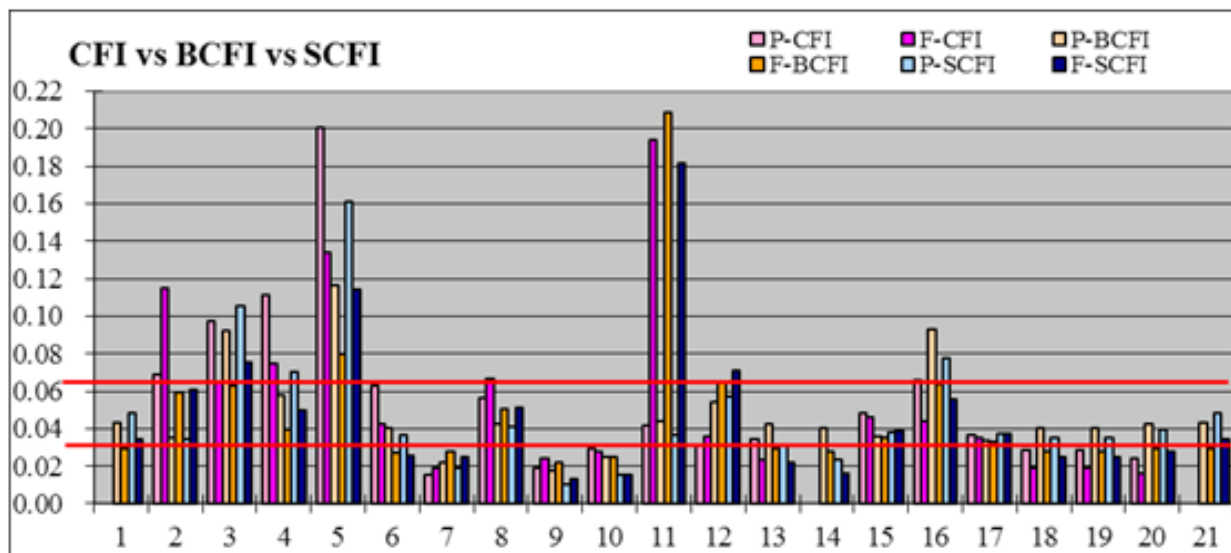

Figure 2 - Results of CFI, BCFI and SCFI

The method of judging under resourced and over resourced attributes are as follow. An attribute falls between the range of 1/3 and 2/3 of average resource level is considered to be balanced, i.e. any attribute which is lower than 1/3 of average resource level is considered to be under resourced, and any attribute which is higher than 2/3 of average resource level is considered to be over resourced. In this case the average resource level is 100%/21=4.76%, so the judging values are 3.17% and 6.35%. That is, for any attributes lower than 3.17% are under

resourced and for any attributes higher than 6.35% are over resourced. Table 2 shows the comparison results between past and future values using different S&R models CFI, BCFI and SCFI, in which the 21 attributes are analyzed one by one. The trend shows how the particular attribute changes from past to future. If both past and future values are good, the trend is considered to be no change and marked with "-". If the values change from good to other, the trend is worse. On the contrary if the values change from other to good, the trend is better. If the values are both over or under, the trend still shows their direction is going better or worse, for instance, over goes lower or under goes higher means better, while over goes higher or under goes lower means worse. In table 3, the consistent results between CFI, BCFI and SCFI are normal marked while the inconsistent results are marked with deep color shading.

Table 3 - Comparison between CFI, BCFI and SCFI

Attribute	P-CFI	F-CFI	Trend	P-BCFI	F-BCFI	Trend	P-SCFI	F-SCFI	Trend
1	invalid	invalid	invalid	good	under	worse	good	good	-
2	over	over	worse	good	good	-	good	good	-
3	over	over	better	over	good	better	over	over	better
4	over	over	better	good	good	-	over	good	better
5	over	over	better	over	over	better	over	over	better
6	good	good	-	good	under	worse	good	under	worse
7	under	under	better	under	under	better	under	under	better
8	good	over	worse	good	good	-	good	good	-
9	under	under	better	under	under	better	under	under	better
10	under	under	worse	under	under	worse	under	under	better
11	good	over	worse	good	over	worse	good	over	worse
12	under	good	better	good	over	worse	good	over	worse
13	good	under	worse	good	under	worse	under	under	worse
14	invalid	invalid	invalid	good	under	worse	under	under	worse
15	good	good	-	good	good	-	good	good	-
16	over	good	better	over	over	better	over	good	better
17	good	good	-	good	good	-	good	good	-
18	under	under	worse	good	under	worse	good	under	worse
19	under	under	worse	good	under	worse	good	under	worse
20	under	under	worse	good	under	worse	good	under	worse
21	invalid	invalid	invalid	good	under	worse	good	good	-

From the comparison results, the following findings can be summarized.

1. The drawback of original CFI model is obvious. Several attributes have resulted 0 index values due to the 0 standard deviation in the collected data which can occur quite commonly. In such case, the 0 index value cannot reveal anything from the real situation. However, despite of the 0 index value problem, the original CFI model is still considered to be the benchmark to interpret critical factors which are under resourced and over resourced.

2. The BCFI and SCFI have solved such problem of 0 index value, and therefore more interpretation can be made through the results. From mathematical point of view the developer of BCFI has manually added 1 to the standard deviation of expectation and experience (Eq. 6 and Eq. 7) which has forced the minimal standard deviation becoming 1 to avoid 0 standard deviation, while SCFI (Eq. 9) does not have similar problem but instead using root mean square to avoid 0 standard deviation and also increase the sensitivity. Theoretically BCFI has ruined the mathematical property of original CFI, and some BCFI leads to opposite results in some extreme cases. Butt (2011a[19], 2011b[20]) has made detailed comparison reports of CFI, BCFI and SCFI for several case studies. For instance in Butt (2011b) [20] some attributes are under re-sourced considering the CFI results, while the same attributes are over resourced in BCFI results, and the author stated that with these contradictions it seems that one of these methods is more likely to lead towards wrong analysis.

3. Apart from the invalid result caused by 0 standard deviation in CFI, there are still more inconsistent results in CFI than BCFI and SCFI. This implies the CFI as the benchmark cannot be really used in real case analysis. Derived formulas such as BCFI and SCFI are better alternative in such way. From this case analysis, BCFI and SCFI do give more consistent results than CFI. In overall, SCFI captures more dynamic sensitive changes than BCFI. For the inconsistent results, the feedback and discussion from the case company can verify which one is telling the truth.

4 Discussions

The analysis results cannot be verified without the feedback from the case company. Therefore in order to validate which S&R model best reflects the real situation of the case company, the top managers have been interviewed again to discuss their opinions towards the analysis results.

Based on the feedback from the case company, the management group has the opinion that analysis results by CFI model have wide gap compared with the real situation, which are considered as invalid model. However, they believe that SCFI is most accurate to reflex their real situation compared to BCFI or CFI. The difference of analysis results is shown in Table 4.

Table 4 - The analysis result compared with feedback from the case company

Attribute	P-BCFI	F-BCFI	Trend	P-SCFI	F-SCFI	Trend	Feedback
1	good	under	worse	good	good	-	-
4	good	good	-	over	good	better	better
10	under	under	worse	under	under	better	better
21	good	under	worse	good	good	-	better

It can be seen in Table 4 that the results by SCFI are more similar to the feedback from case company compared with BCFI model. Especially, based on the managers' opinion, the development trend of the 10th attribute is obvious better which could be supported by the exact information came from inventory statistics of the case company. Therefore, SCFI model can be considered as the best analysis tool to reflect the real situation.

In addition, SCFI model shows advantage particularly for small sample size based on the analysis results of 3 informants in case company. When the sample size goes bigger, in theory the CFI/BCFI/SCFI will likely to give more similar results (the bigger samples the more similar), but for smaller sample size from mathematical point of view SCFI is much more accurate than BCFI. Since most of the case studies are based on the small sample size for the top management group generally has small members, SCFI model is the most suitable tool for the S&R research. To BCFI model, the std+1 in BCFI will be magnified especially when there is only one answer to cause inaccurate results, but it could cover the fabricated data by the tolerance calculation method under big sample size situation.

In the case company SCFI has been considered from the company's feedback to be the most accurate model. In their feedback CFI is not valid for them (at least for such sample size), BCFI and SCFI are closer to reality, but BCFI gives a few contradictory results than reality whereas SCFI gives same as reality. However, the research results need to be further tested in the future case studies with more data supports.

5 Conclusions

This paper introduced several developed sense and respond (S&R) models CFI, BCFI and SCFI to help decision makers to make adaptive adjustments on operations strategy in dynamic business environments such as dealing with different markets and crisis. In addition, the case study in this paper shows the difference among the three S&R models and the advantages of SCFI model. Inappropriate models may lead to wrong or sometimes even opposite opinion in decision-making and therefore in order to make S&R methodology useful a decent model must be well established. The analysis results show that well-developed S&R models have contribution to making adaptive operations strategy adjustment based on clear objectives in dynamic and turbulent business environment which can be verified from the top management of the studied case company.

Notas

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