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The Best Supply Chain Management of NB via the Analytic Hierarchy Process and Sensitivity Model

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Abstract—This work presents a selection model that adopts several important criteria, enabling the manager to select the supply chain management (SCM) of NB are the most appropriate. Major criteria weights are analyzed using the analytic hierarchy process (AHP) and sensitivity analysis. Analysis results indicate that the proposed selection model enables the manager to select the supply chain management of NB more objectively by allowing them to deploy effectively. The proposed model can also be applied to other high technology factories, thus enhancing Taiwanese competitive advantage.
Keywords— Supply chain management, analytic hierarchy process, sensitivity analysis, location-allocation.

1. INTRODUCTION

The foundry industry of the Notebook PCs in Taiwan recently has developed its own unique OEM/ODM product and become the main clients of the important international factories, depending on its productive flexibility and sensitivity and on its superiority of the lower costs comparing with other countries such as Europe, America and Japan. However, with the universal of the global notebook computers, the price and the life cycle of NB products have declined day by day, and the whole NB products market is assaulted on the growing demand for the products of the customization. Due to that, the whole productive types are gradually changed into the production and sales model of BTO and CTO from BTF. Therefore, the logistics and the supply chain not only have the highly attention to the link of the business running, but also is the focal point that every enterprise competitively rises improves the competitiveness.

Porter (1996) emphasized that the only way to resist the continuously increased competitive pressure and bring the irreplaceable advantage of competition to the enterprises was to combine the global resources and the supply chain of production and sales effectively. And if we would like to figure out how to face the competitive environment nowadays, only when we effectively enforce the supply chain management, we can maintain the competitive advantage of the enterprises. What our country's manufacturers need to face is all powerful rivals, such as Europe, America, Japan and Korea, etc. And these enterprises constantly raise their supply chains on the operation efficiency, which make our country's manufacturers deeply feel that they need to pursue the progressive growth pressure at all times. While the foreign large manufacturers put a lot of money into SCM one after another, many domestic NB manufacturers also join one after another with the high quality, low cost and the best efficiency to achieve SCM (Bowersox and Closs，1996).

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Supply chains are the complicated network combined by an enterprise and its related companies, so SCM will be not only a technologic question, but also emphasize the problems of the enterprise's logistic strategy and management. Moreover, it will emphasize not only enterprise's inner integration, but also the integration between two enterprises (Simchi-Levi et al., 2000). It mainly explains the supply chain models of the main clients, such as HP, DELL and Toshiba, etc. The main places of Taiwanese NB industries to produce are located in Taiwan factory and China factory, and the product markets chiefly center around the America, Europe, and Asia.

In fact, the decision and operation of each link on a supply chain can influence the proceeding and the result of the next link, and then influence the operation performance of the whole supply chain (Laudon and Laudon，2000).Therefore, the effect is minimal to realize and improve the whole operation condition by only paying attention to one of logistics（Outbound Logistics and inbound logistics）, cash flow or information flow. Only when the whole operation of the supply chain is entirely and deeply realized, it could be impossible to help the performance of supply chain in Taiwanese NB industries effectively.

As the competition of the business environment has been aggravated, the life cycle of the notebook computer products are generally extremely short, so the critical factor that decides the victory or defeat is to see whether the dealer possesses the excellent ability of the global supply chain project management. However, the supply chain project management is not feasible to develop in Taiwan, because its time and cost of the procedure are rather high and there are few researches and cases related to the supply chain project management of the NB manufacture.

Therefore, this research chooses out the influential factors of the supply chain project management through analytic hierarchy process (AHP) and then proposes the concept of sensitivity analysis. Meanwhile, taking the examples by three NB manufacturers in Taiwan (Quanta , Compal and Inventec) to choose the manufacturer with the best managing performance. This research offers the supply chain project management which can improve enterprise's competitiveness, reduce time and cost of trade to reach better performance, and it can become reference for the supply chain project management of Taiwanese NB to estimate the standard operation procedure.

2. MODEL APPLICATION AND RESULT

The analytic hierarch process (AHP) is a well known and useful method for solving multi-criteria decision problems and can be used to prioritize each alternative in decision making problems (Satty, 1980). AHP incorporates the evaluations of all decision makers into a general consensus, without having to elicit their utility functions on subjective and objective answer (Satty, 1990). AHP has thus been successfully applied to a diverse area of problems. For example, Harbi (2001) applied AHP in the field of project management to select the best contractor. Khalil (2002) used AHP to select the most appropriate project delivery method as key project success factor. Ngai (2003) used AHP for selection of Web sites on online advertising. Takamura and Tone (2003) proposed an application of the AHP model for relocating Japanese government agencies in Tokyo. Aras *et al.* (2004) used AHP method for a wind observation station location. Lin *et al.* (2006) presents the employment of the AHP to select the model for the location of Taiwanese hospitals. Therefore, this paper use AHP and sensitivity analysis demonstrates the applicability and ease of the model for the ideal SCM performance selection.

The process proposed in this study for selecting the SCM performance of NB companies comprises the following steps.

Step 1: <u>Confirm the evaluative criteria and establish a hierarchical framework.</u>

This study selected the criteria identified from pertinent literature and interviews with experts. Eight experts participated in a group that adopted the focus group. Based on the experts obtain criteria. After, a general consensus among experts can be reached to establish a hierarchical structure. The SCM performance of NB companies can be selected and evaluated based on six evaluation criteria, twenty evaluation sub-criteria and, finally, the alternatives (see Figure. 1)

<< Figure 1: Hierarchical structure to select the SCM performance of NB companies >>

Step 2: <u>Establish each factor of the pair-wise comparison matrix.</u>

In this step, the elements of a particular level are compared pair-wise, with respect to a specific element in the immediate upper level. A judgment matrix is formed and used for computing the priorities of the corresponding elements. First, a criterion is compared pair-wise with respect to the goal. The judgment matrix, denoted as A, will be formed using the comparison. Each entry a_{ij} of the judgment matrix is formed comparing the row element a_i with the column element a_j

$$A = [a_{ij}],\ i,\ j = 1,\ 2,\ \ldots,\ n. \tag{1}$$

The comparison of any two criteria C_i and C_j with respect to the goal is made using the questions of the type: of the two criteria C_i and C_j which is more important and how much. Saaty (1980) suggests the use of a 9-point scale to transform the verbal judgments into numerical quantities representing the values of $a_{ij.}$ Table 1 lists the definition of 9-point scale. Larger number assigned to the pair-wise comparisons means larger differences between criteria levels. The entries a_{ij} are governed by the following rules:

$$a_{ij} > 0,\ a_{ji} = \frac{1}{a_{ij}},\ a_{ii} = 1 \quad \text{for all } i \tag{2}$$

Table 1: The pair-wise comparison scale (Saaty, 1980)

Intensity of Importance	Definition
1	Equal importance both element
3	Weak importance one element over another
5	Essential or strong importance one element over another
7	Demonstrated importance one element over another
9	Absolute importance one element over another
2, 4, 6, 8	Intermediate values between two adjacent judgments

This scale can be applied with ease to criteria that can be defined numerically as well as to those cannot be defined numerically. Relative importance scale is presented. The decision maker is supposed to specify their judgments of the relative importance of each contribution of criteria towards achieving the overall goal. For this reason, an AHP questionnaire was devised to find out an expert opinion in the form of a pair-wise comparison. Therefore, purposive sampling is applied to sample eight respondents comprised of directors and policymakers from NB companies in this paper. Based on the weighted value that experts finally assign, the geometry mean value is used to compute decision-making community scores of all experts in order to formulate the weighted values selected for SCM performance of NB companies. Table 2 presents the main criteria as the sample.

Table 2: Aggregate pair-wise comparison matrix for criteria of level 2

Goal	C_1	C_2	C_3	C_4	C_5	C_6
C_1	1	1.189	0.500	1.565	0.707	1.682
C_2	0.841	1	0.595	1.861	0.841	2.060
C_3	2.000	1.682	1	2.449	1.565	2.711
C_4	0.639	0.537	0.408	1	0.408	1.414
C_5	1.414	1.189	0.639	2.449	1	2.449
C_6	0.595	0.485	0.369	0.707	0.408	1
$\lambda_{\max} =$ 6.039; *C.I.* = 0.008; *R.I.* = 1.24 ; CR = 0.006 ≤ 0.1						

Step 3: Calculate the eigenvalue and eigenvector.

Having recorded the numerical judgments a_{ij} in the matrix A, the problem now is to recover the numerical weights $(W_1,\ W_2,\ \cdots,\ W_n)$ of the alternatives from this matrix. In order to do so, consider the following equation:

$$\begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \cdot & \cdot & \cdots & \cdot \\ \cdot & \cdot & \cdots & \cdot \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} \simeq \begin{bmatrix} W_1/W_1 & W_1/W_2 & \cdots & W_1/W_n \\ W_2/W_1 & W_2/W_2 & \cdots & W_2/W_n \\ \cdot & \cdot & \cdots & \cdot \\ \cdot & \cdot & \cdots & \cdot \\ W_n/W_1 & W_n/W_2 & \cdots & W_n/W_n \end{bmatrix}, \tag{3}$$

Moreover, let us multiply both matrices in Eq. (3) on the right with the weights vector $W = (W_1,\ W_2,\ \cdots,\ W_n)$, where W is a column vector. The result of the multiplication of the matrix of pair-wise ratios with W is nW, hence it follows:

$$AW = nW\ , \tag{4}$$

This is a system of homogenous linear equations. It has a non-trivial solution if and only if the determinant of $A-nI$ vanishes, that is, n is an eigenvalue of *A*. *I* is an $n\times n$ identity matrix. Saaty's method computes *W* as the principal right eigenvector of the matrix *A*; that is,

$$AW = \lambda_{\max} W \ , \tag{5}$$

where $\lambda_{\max}$ is the principal eigenvalue of the matrix *A*. If matrix *A* is a positive reciprocal one then $\lambda_{\max} \geq n$, (Saaty, 1990). If *A* is a consistency matrix, eigenvector *X* can be calculated by

$$(A-\lambda_{\max} I)X = 0 \ , \tag{6}$$

Here, Using the comparison matrix (such as in Table 2), the eigenvectors were calculated by Eq. (5) and (6). Table 3 summarizes the results of the eigenvectors for criteria, sub-criteria and three NB companies selection. Besides, the results for each level relative weight of the elements are showed in Table 3.

Table 3: Eigenvectors (weights) for Level 2 to Level 4

Criteria	Weights for level 2	Sub-criteria	Weights for level 3	Weights for level 4		
				Quanta	Inventec	Compal
C_1	0.157	SC_1	0.272	0.360	0.307	0.333
		SC_2	0.147	0.353	0.325	0.322
		SC_3	0.246	0.376	0.303	0.321
		SC_4	0.211	0.352	0.318	0.330
		SC_5	0.124	0.369	0.317	0.314
C_2	0.167	SC_6	0.296	0.334	0.325	0.341
		SC_7	0.372	0.372	0.296	0.332
		SC_8	0.332	0.384	0.303	0.313
C_3	0.278	SC_9	0.414	0.330	0.317	0.353
		SC_{10}	0.586	0.333	0.311	0.356
C_4	0.102	SC_{11}	0.333	0.333	0.315	0.352
		SC_{12}	0.315	0.352	0.340	0.308
		SC_{13}	0.352	0.353	0.307	0.340
C_5	0.210	SC_{14}	0.296	0.341	0.326	0.333
		SC_{15}	0.266	0.352	0.293	0.355
		SC_{16}	0.235	0.330	0.314	0.356
		SC_{17}	0.203	0.340	0.296	0.364
C_6	0.086	SC_{18}	0.278	0.384	0.285	0.331
		SC_{19}	0.371	0.384	0.303	0.313
		SC_{20}	0.351	0.364	0.308	0.328

Step 4: Perform the consistency test.

The eigenvector method yields a natural measure of consistency. Saaty (1990) defined the consistency index (*CI*) as

$$CI = (\lambda_{\max} - n)/(n-1) \ , \tag{7}$$

where $\lambda_{\max}$ is the maximum eigenvalue, and *n* is the number of factors in the judgment matrix. Accordingly, Saaty (1990) defined the consistency ratio (*CR*) as

$$CR = CI / RI \ , \tag{8}$$

for each size of matrix *n*, random matrices were generated and their mean *CI* value, called the random index (*RI*). Where *RI* represents the average consistency index over numerous random entries of same order reciprocal matrices. Table 4 was developed by Ockridge National Laboratory and Whartor School (Satty, 1977). The consistency ratio *CR* is a measure of how a given matrix compares to a purely random matrix in terms of their consistency indices. A value of the consistency ratio $CR \leq 0.1$ is considered acceptable. Larger values of *CR* require the decision-maker to revise his judgments.

Table 4: The Random Index (Saaty, 1977)

Numbers of element	1	2	3	4	5	6	7	8	9
R.I.	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45

According to Eq. (7) and (8) the criteria comparison matrix of consistency for each criterion is calculated, as shown in Table 2. Results of the consistency test and the *CR* of the comparison matrix from each of the thirteen experts are all ≤ 0.1, indicating "consistency". Furthermore, the *CR* of the aggregate matrix is also ≤ 0.1, also indicating "consistency".

Step 5: Calculate the overall level hierarchy weight to select the ideal SCM performance of NB companies.

The composite priorities of the alternatives are then determined by aggregating the weights throughout the hierarchy. The composite priorities of the alternatives are showed in Table 5. According to Table 5, "Quanta" company is used to select the evaluation outcomes and evaluate the ideal SCM performance of NB companies.

Table 5: The evaluation outcomes and evaluate the ideal SCM performance of NB companies

Criteria	Weights	Quanta	Inventec	Compal
		Synthesis Value	Synthesis Value	Synthesis Value
C_1	0.157	0.362	0.312	0.325
C_2	0.167	0.365	0.307	0.328
C_3	0.278	0.332	0.313	0.355
C_4	0.102	0.346	0.320	0.334
C_5	0.210	0.341	0.308	0.351
C_6	0.086	0.377	0.300	0.323
Result	Aggregate score	0.349	0.311	0.340
	Rank	*1*	*3*	*2*

3. PERFORM SENSITIVITY ANALYSIS

The final priorities of the alternatives are heavily dependent on the weights attached to the main criteria. Small changes in the relative weights significantly impact the final ranking. Since the relative weights are generally based on highly subjective judgments, the stability of the ranking under varying criteria weights must be tested. Sensitivity analysis thus can be performed using scenarios that reflect alternative future developments or different views regarding the relative importance of the criteria. Increasing or decreasing the weightings of individual criteria can observe the resulting changes in the priorities and the ranking of the alternatives. Sensitivity analysis thus provides information regarding the stability of the ranking. Careful review of the weights is recommended if the ranking is highly sensitive to small changes in the criteria weights. Moreover, additional decision criteria should be included in situations where a highly sensitive ranking indicates weak discrimination potential of the present set of criteria. The weights of the important criteria thus were altered separately, simulating weights between 0% and 100% (notably, the weights of the other criteria change accordingly, reflecting the relative nature of the weights - i.e. the total weights must add up to 100%). The local priority weights of the chosen subjective factors are varied using the Expert Choice 2000 2nd Edition software. Sensitivity analyses are necessary because changing the importance of criteria requires various levels of "Logistics", "Cash flow", "Information flow", "Product flow", "Personnel flow" and "Customer flow" to ensure selection of the ideal SCM performance of NB companies. Table 6 lists the results of changing the criteria for "Logistics (C_1)", "Cash flow (C_2)", "Information flow (C_3)", "Product flow (C_4)", "Personnel flow (C_5)" and "Customer flow (C_6)".

Table 6: The results of sensitivity analysis

Company / Priority / Change Condition	Quanta Rank/ Weight	Inventec Rank/ Weight	Compal Rank/ Weight
Original Priority	1 (0.349)	3 (0.311)	2 (0.340)
C_1 increasing 10%	1 (0.350)	3 (0.311)	2 (0.339)
C_1 increasing 20%	1 (0.352)	3 (0.311)	2 (0.337)
C_2 increasing 10%	1 (0.351)	3 (0.310)	2 (0.339)
C_2 increasing 20%	1 (0.353)	3 (0.310)	2 (0.337)
C_3 increasing 10%	1 (0.347)	3 (0.311)	2 (0.342)
C_3 increasing 20%	2 (0.344)	3 (0.311)	1 (0.345)
C_4 increasing 10%	1 (0.349)	3 (0.311)	2 (0.340)
C_4 increasing 20%	1 (0.348)	3 (0.313)	2 (0.339)
C_5 increasing 10%	1 (0.348)	3 (0.310)	2 (0.342)
C_5 increasing 20%	1 (0.347)	3 (0.310)	2 (0.343)
C_5 increasing 30%	1 (0.346)	3 (0.310)	2 (0.344)
C_5 increasing 40%	2 (0.354)	3 (0.310)	1 (0.346)
C_6 increasing 10%	1 (0.352)	3 (0.309)	2 (0.339)
C_6 increasing 20%	1 (0.355)	3 (0.308)	2 (0.337)

(I) Performance sensitivity of alternatives:

The performance graph (see Fig. 2) shows how the different alternatives perform under scenarios with various parameters.

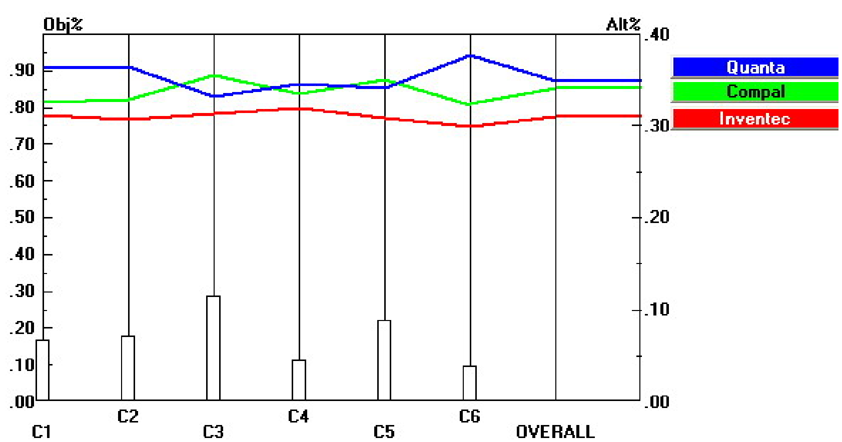

Figure 2: Performance sensitivity of alternative

(II) Logistics (C_1), Cash flow (C_2) and Customer flow (C_6) increase by 10% to 20%:

Performance sensitivity of alternatives is analyzed when logistics (C_1), cash flow (C_2) and customer flow (C_6) are increased from their current level by 10% to 20%. Increasing logistics (C_1) by 20% increases the global weight of "Quanta" from 0.349 to 0.352 (see Fig. 3). Increasing cash flow (C_2) by 20% increases the global weight of "Quanta" from 0.349 to 0.353 (see Fig. 4). Moreover, increasing customer flow (C_6) by 20% increases the global weight of "Quanta" from 0.349 to 0.355 (see Fig. 5). The weights of "Inventec" and "Compal" have negative trend under these two situations. The generated results correspond to the current SCM performance of "Quanta" company.

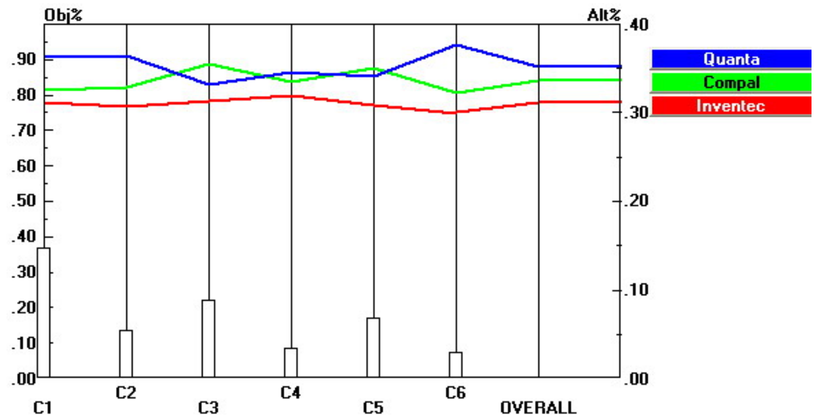

Figure 3: Performance sensitivity of alternatives when logistics (C_1) is increased by 20%

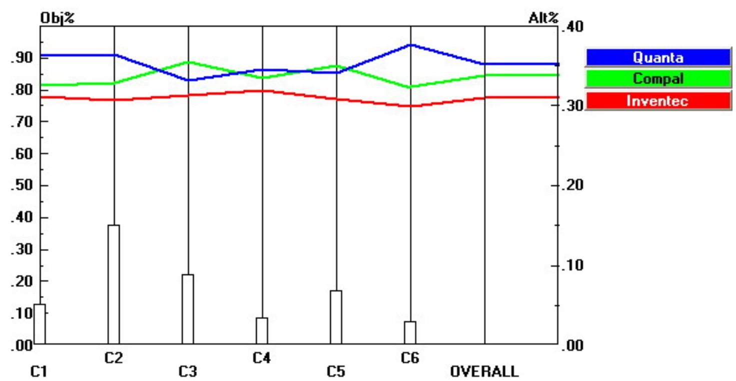

Figure 4: Performance sensitivity of alternatives when cash flow (C_2) is increased by 20%

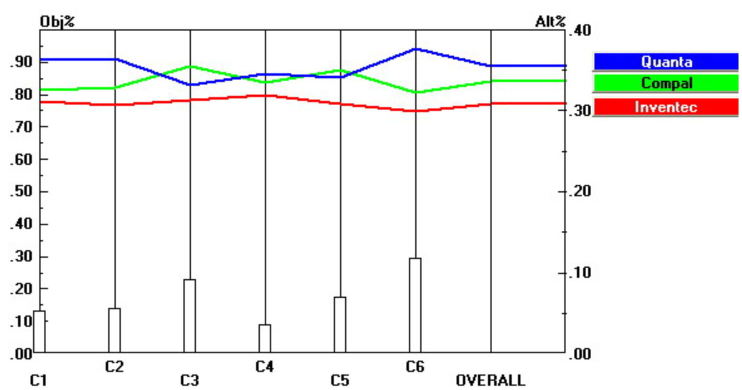

Figure 5: Performance sensitivity of alternatives when customer flow (C_6) is increased by 20%

(III) Product flow (C_4) increases 10% to 20%

The performance sensitivity of alternatives is analyzed when product flow (C_4) is increased by 10% to 20%. Figure 6 show that increasing product flow (C_4) by 20% increases the global weight of "Inventec" from 0.311 to 0.313. Under this situation the weight of "Inventec" increases, but its rank remains unchanged.

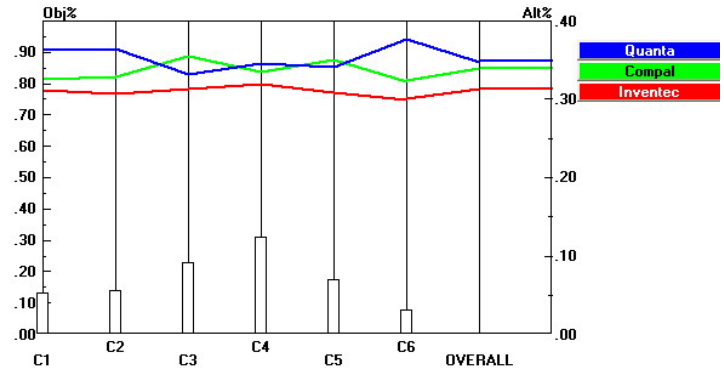

Figure 6: Performance sensitivity of alternatives when product flow (C_4) is increased by 20%

(IV) Information flow (C_3) increases 10% to 20%:

The performance sensitivity of alternatives is analyzed where information flow (C_3) was increased by 10% to 20%. Figure 7 show that increasing information flow (C_3) by 20% could increase the global weight of "Compal" from 0.340 to 0.345. Simultaneously, the analytic outcomes of the rank become "Compal", and thus the SCM achieves the ideal performance.

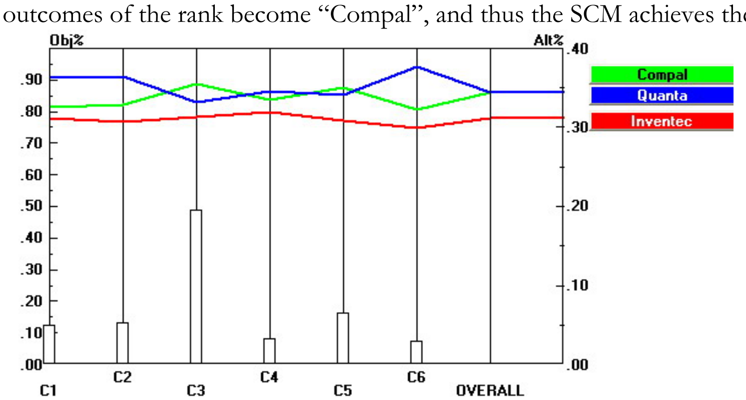

Figure 7: Performance sensitivity of alternatives when information flow (C_3) is increased by 20%

(V) Personnel flow (C_5) increases 10% to 40%:

The performance sensitivity of alternatives is analyzed when personnel flow (C_5) is increased by 10% to 20%. Figure 8 show that increasing personnel flow (C_5) by 40% increases the global weight of "Compal" from 0.340 to 0.3. Simultaneously, the analytic outcomes of the rank become "Compal", but its sensitivity relatively is low.

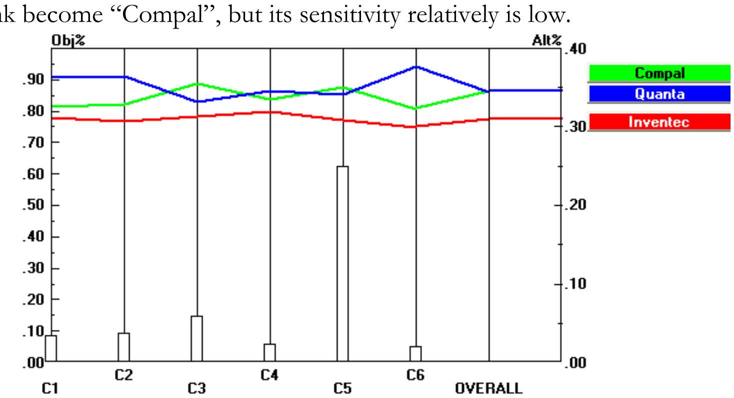

Figure 8: Performance sensitivity of alternatives when personnel flow (C_5) is increased by 40%

The above situation demonstrates the conclusion of the sensitivity analysis: when information flow (C_3) is changed to 20% and personnel flow (C_5) is changed to 40% the estimated order is changed. However, regardless of how logistics (C_1), cash flow (C_2), product flow (C_4) and customer flow (C_6) are changed; the estimated rank remains unchanged.

The establishment that the information turns is the root of the enterprise. The information system plays the support enterprise more; the supply chain operates everyday of aggressive meaning. In abroad in the top-grade company, the perfect information's turning is create the high-quality supply chain manages of essential condition. The information turns in the home to also begin to be gradually universal in recent years. In the high-tech industry, the enterprise that has no information to turn is really got to trust of the foreign customer's. To management of the supply chain, the meaning that duct into these systems lies in the information that keeps a necessity. The information and the assistance enterprise of the sharing necessity do to optimize of production and sales decision. In personnel flow, the method to change management makes person's working even more. Let SCM must use the smooth push so.

4. CONCLUSIONS

The operation efficiency of the supply chain is very important key factor in the management performance of the company. It is not efficient to supply chain of operation to represent a production and sales can't get good coordination. At the economic prosperity isn't good, the bad supply chain of operation efficiency usually will cause the stock go up. Be that as it may, the enterprise body that grows up to the certain scale also cognizes to the SCM necessity. It is very important of the SCM is the necessary tool that supports a company to reach various different enterprise operation mode. The enterprise can take this as foundation to go to select the SCM system that the ducting suits after must know well future operation mode of enterprise. AHP is a popular method used in finding a solution to the problem of MCDM. One of the reasons for the popularity of AHP as an applicable method is the fact that it takes into consideration not just tangible but also intangible criteria. For instance, determining ideal hospital of medical disputes processes is a problem that involves both many numerical and non-numerical criteria. Therefore, AHP sensitivity-based method seems to be an easily applicable method in finding a solution to the problem of where exactly to build selecting SCM of NB. Specifically, the proposed algorithm can assist SCM of NB in similar muilt-criteria questions by offering an objective and systematic means of selecting the SCM of NB is the most difficult in terms of the SCM quality. More important, the proposed model can assist the high-tech industry to assess the SCM selection of factories, making it highly applicable for academia and commercial purposes.

REFERENCES

1. Aras, H., Erdogmus, S. and Koc, E. (2004). Multi-criteria Selection for a Wind Observation Station Location Using Analytic Hierarchy Process, *Renewable Energy*, 29: 1383-1392.
2. Bowersox, D. J. and Closs, D. J., Logistical Management: The Integrated Supply Chain Process, New York: McGraw-Hill, 1996.
3. Harbi, K.M. (2001). Application of AHP in Project Management, *International Journal of Project Management*, 19(4): 19-27.
4. Khalil, M. I. (2002). Selecting the Appropriate Project Delivery Method Using AHP, *International Journal of Project Management*, 20: 469-474.
5. Laudon, K. C. and Laudon, J. C., Management Information Systems: Organization and Technology in the Networked Enterprise, Sixth Edition, Prentice Hall International Editions, 2000.
6. Lin, C. T., Wu, C. R. and Chen, H. C. (2006). Appling the Grey Relational Analysis for Selecting the Location of Taiwanese Hospitals on Competitive Advantage, *The Journal of Grey System*, 18(3): 263-274.
7. Ngai, E. W. T. (2003). Selection of Web Sites for Online Advertising Using AHP, *Information and Management*, 40(4): 233-242.
8. Porter, M. E. (1996). What is strategy, *Harvard Business Review*, 74(6): 133-149.
9. Satty, T. L. (1990), The Analytic Hierarchy Process, 2nd edition, 151-155, RWS Publications.
10. Saaty, T. L. (1980), The Analytic Hierarchy Process, New York: McGraw Hill.
11. Satty, T. L. (1977). A Scaling Method for Priorities in Hierarchical Structural, *Journal of Mathematical Psychology*, 15: 274-281.
12. Simchi-Levi, D., Kaminsky, P. and Simchi-Levi, E., Designing and Managing the Supply Chain, McGraw-Hill, 2000.
13. Takamura, Y. and Tone, K. (2003). A Comparative Site Evaluation Study for Relocating Japanese Government Agencies in Tokyo, *Socio-Economic Planning Sciences*, 37(2): 85-102.

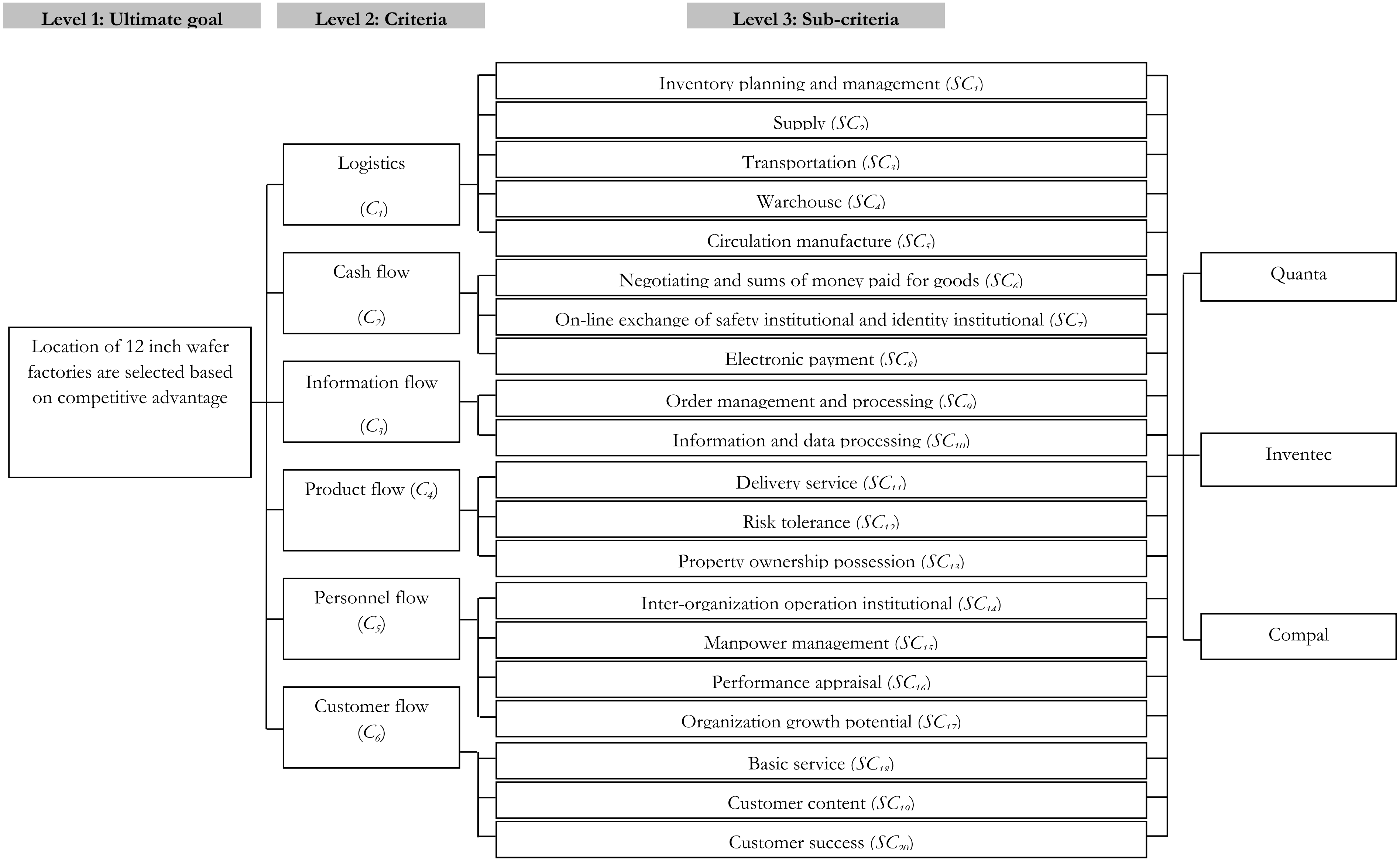

Figure 1: Hierarchical structure to select the SCM performance of NB companies