REALIZING THE STRATEGIC PLAN OF A TOP-TIER UNIVERSITY IN TAIWAN

A Multi-criteria Evaluation and Alignment

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Abstract: The major objective of higher education is to meet the international and local demand for top talent, the core driving force in enhancing its international competitiveness. Since Taiwan is facing increasingly fierce international competition as it begins to open its education market, the government's "Plan for Developing World-class Universities and Top-tier Research Centers." is aimed at building world-class universities to improve the overall quality of higher education. There is therefore a great need for a set of evaluation criteria and an alignment model to realize the strategic plan of achieving the educational objectives. This paper presents a framework to measure the extent to which the strategic objectives of a top-tier university in Taiwan are aligned with the results obtained through the Balanced Scorecard (BSC). To achieve this, the Multi-Criteria Decision Analysis (MCDA) techniques will be used to create a strategic map. With the cause-and-effect relationship extracted from the strategy map, one can discover gaps that exist between the strategic objectives and the present status. Our study conducted a case study on Taiwan's higher education, using National Cheng Kung University's implementation of the top-tier university plan as an example.

1 INTRODUCTION

Higher education plays a key role in the modernization of a country, as it allows for the upgrading of national competitiveness and prioritizes the cultivation of human talent to meet the international and local demand. Many countries have embarked upon a path of higher education reform for excellent academic achievement, such as the "Beacon Schools" program in the U.K., the "Blue Ribbon School Program" and "Baldrige National Quality Program" in the U.S., the "211 Project" and "985 Project" in China, and the "Brain Korea 21 program (BK21)" in Korea. In recent years, the Ministry of Education in Taiwan has faced rapid social changes, including increased political freedom, rapid economic growth, changes in the industrial structure, and diversification of values (Ministry of Education, Republic of China, 2011). Consequently, it has developed a series of specific policies in an effort to strengthen the structure and competitiveness of higher education institutions, among which the "Plan for Developing World-class Universities and Top-tier Research Centers" is aimed at improving the overall quality. Therefore, there is a great need for a set of managerial and strategic tools to determine appropriate courses of action and to monitor performance for achieving the educational objectives.

This study proposed a supportive framework based on the BSC and used a structured manner to realize the strategic plan. With the BSC concept as the basis, two MCDA methods - Analytic Network Process (ANP) and Decision Making Trial and Evaluation Laboratory (DEMATEL) - are used to evaluate a series of BSC indicators, construct strategy maps which are network structure, and elucidate the cause-and-effect relationship and weights between the BSC indicators. They are used to determine key performance indicators (KPIs) and specifically quantify the target value of KPIs as this set of objectives. With the cause and effect relationship extracted from the strategy map, one can discover the gap that exists and perform a diagnosis in terms of the strategic objectives and the present status. Finally, our study conducted a case study on Taiwan's higher education using the implementation of the top-tier university plan as an

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example for realizing the strategic plan of a top-tier university, which will help managers in education-wide alignment of strategies.

2 LITERATURE REVIEW

2.1 Balanced Scorecard (BSC)

The BSC is a performance measurement system and a strategic management system, as well as a management and communication tool that allows the decision-makers, employees, and other stakeholders to communicate results and drive performance (Kaplan and Norton, 1992; Niven, 2002). The BSC involves interpreting organizational vision and goals while taking into consideration both the financial and non-financial aspects, which correspond to the four dimensions of "finance", "customer", "internal process", and "learning and growth".

Because the BSC is designed to overcome the limitations of systems that are focused primarily on financial achievements, applications of the BSC have been successfully implemented by public and private non-profit organizations, such as in the healthcare industry (Oliveira, 2001; Berler et. al., 2005) and in government and public sector organizations (Griffiths, 2003). The BSC has also been used in the educational field in the past, such as in the development of KPIs for education (Karathanos and Karathanos, 2005; Umashankar and Dutta, 2007), in discussions on the appropriateness of its use as a management tool for measuring education performance (Storey, 2002; Hamid et. al., 2008; Yu et. al., 2009), and as an application in the strategic management of the school to improve the quality of education (Chen et. al., 2006; Lawrence and Sharma, 2002; Asan and Tanyas, 2007). Many education institutions, including the Institute of Education, University of Southern California, Ohio State University, University of California, Akron University in Ohio, Edinburgh University in the UK, and several others have adopted the BSC to measure the effectiveness of academic programs. Literature shows that the BSC is worth exploring and trying in measuring performance in the field of education, but so far most research has focused on financial results assessment as the goal, or discussed how to develop indicators for measuring educational performance.

2.2 Strategy Map

The strategy map proposed by Kaplan & Norton is also called the cause-and-effect linkage of strategy map. It describes the interaction of organizational strategies and promotes the performance drivers in strategy results, in order to achieve the desired strategic goal. In terms of the role played by strategy maps and the BSC in the field of education, they essentially form the bridge between strategic objectives and action plans (Chen et. al., 2006; Umashankar and Dutta, 2007; Asan and Tanyas, 2007). Regarding the methods used in constructing the strategy map, Solano et al. argued that a strategy map can create value by linking tangible and intangible assets. One can meet the financial indicators using a strategy map built with dynamic simulation techniques and based on the BSC and observing the organization's system quality and the financial situation during a five-year period (Solano et. al., 2003). Tseng argued that past studies on the independence of the BSC indicators do not accurately reflect the impact they have on each other; he therefore proposed to integrate the Fuzzy ANP and DEMATEL methods in order to explore the managerial implications and deal with the interaction and dependencies within the perspectives and guidelines, and to construct a visualized cause-and-effect linkage using more valuable information (Tseng, 2010).

This study considers the fact that the dynamic simulation method of Solano et al. is unable to ascertain the extent of influence and the weight between various indicators, that Tseng did not explain the concept of strategy map and KPIs, and that other existing research of the strategy maps focused on hierarchical structures that were based upon financial top-level results. Therefore, using the MCDA method can assist individuals or groups in decision-making and generate a network structure in strategy map rather than financial top-level results. The DEMATEL and ANP methods can determine the network structure among KPIs, which can in turn work out the cause-and-effect linkage and degree of relevance between the indicators and derive the relative weights of each performance indicator through the analysis of network procedures and the assessment scales.

3 THE METHOD OF CREATING A STRATEGY MAP PROCESS

A completed BSC not only needs to include measurable indicators of performance evaluation, but it also must construct cause-and-effect linkages of four major perspectives to form a strategy map. This study transformed the strategy map into a top-

to-bottom hierarchical structure, which involves the relationships between mission, vision, and the four major perspective of the BSC and the second-tier relationships are those between finance, customer, internal process, learning and growth. ANP can represent a non-linear structure that deals with sources and transforms into a hierarchy with the goal at upper level and alternatives at lower level. The DEMATEL not only can convert the relationships between cause and effect into a structural model, but it also can be used as a way to handle the inner dependences within a set of criteria. Hence, we combined the ANP and DEMATEL methods to create a strategic map. The steps are as follows:

Step 1. Questionnaire design and fill in: The questionnaire was developed based on performance dimensions selected from the BSC, and each decision maker was asked to fill in a positive/negative sign and numbers for each question that compared two indicators.

Step 2. Generate the direct relation matrix by integrating views of decision makers: Deriving direct relationship matrix **A** after integrated $n \times n$ by adding up the direction of influence and extent of the n criterion within each decision maker's questionnaire matrix, and a_{ij} in the matrix represents the extent of influence of criterion i on criterion j.

Step 3. Normalize the direct relation matrix and attain the total relation matrix: On the base of the direct relation matrix **A**, the normalized direct-relation matrix **X** can be obtained by using formula (1)-(2). The total relation matrix **T** can be acquired by using formula (3), in which **I** is denoted as the identity matrix:

$$\mathbf{X} = k \times \mathbf{A} \tag{1}$$

$$k = \frac{1}{\max\limits_{1 \le i \le n} \sum\limits_{j=1}^{n} a_{ij}}, \quad i, j = 1,2,...,n \tag{2}$$

$$\mathbf{T} = \mathbf{X}\left(\mathbf{I} - \mathbf{X}\right)^{-1} \tag{3}$$

Step 4. Determine ANP paired comparison module: Design the ANP questionnaire according to the network architecture established in the previous steps, and compare the decision makers to the groups using paired comparison. The ANP assessment used 1-9 scale proposed by Saaty as an indication of level of importance, and a consistency test was done in order to establish weight architecture for indicators.

Step 5. Construct and solve the supermatrix: Each assessment scale within the matrix represents the impact that elements within a group have on elements in other groups (external dependencies), or the influence on elements within their own groups (internal dependencies).

After forming the supermatrix, the weighted supermatrix is generated by transforming and unifying all column sums to unity. This step is used to ensure that the sum of the probabilities of all states equals 1. Then, we use the weighted super matrix to generate a limiting supermatrix by using formula (4) to calculate overall weights.

$$\lim_{k \to \infty} W^k \quad (W : \text{weighted matrix}) \tag{4}$$

Step 6. Combine the interrelations between criteria of DEMATEL and the weights of ANP: The weighted supermatrix (the adjusted unweighted supermatrix) from Step4 and Step5 can be raised to limiting powers to calculate the overall priorities. However, before forming the unweighted supermatrix, the treatment of inner dependences needs to employ the DEMATEL. The treatment of inner dependences can theoretically use the ANP, but DEMATEL might be a better option as it can produce more valuable information for making decisions. Tamura et al. proposed a composite importance of DEMATEL to compensate for the above-mentioned problems (Tamura et. al., 2002). We defined the weight of performance criteria is

$$Weight = \left[w_1, w_2, ...w_n\right]$$

The nth element of the column vector obtained by multiplying the direct/indirect matrix **T**, denotes the importance of factors resolved by resolving factor n. Then, taking into account the importance of factor n itself the composite importance of each element could be evaluated as formula (5).

$$z = Weight + \mathbf{T} \times Weight \tag{5}$$

Step 7. Produce a causal diagram: After ANP is applied to obtain the weights of each potential alternative, the cause-and-effect relationships of the perspectives and criteria involved should be analyzed and evaluated to identify their direct, indirect and total influences among the groups. Following the procedure of the DEMATEL method, we determine the intensity of the influence between each perspective and criterion through the use of scale and pairwise comparisons.

Once the relationships between those factors have been measured by the decision makers, the initial direct-relation and the normalized direct-relation matrix can be produced. Using the values of

(*D*-*R*) and (*D*+*R*) where R is the sum of columns and D is the sum of rows in matrix **Z'**, the level of influence on the others and the level of relationship with the others are defined, as shown in formulas (6)-(8) (Wu and Lee, 2007).

$$\mathbf{Z'} = \left[t_{ij}\right]_{n\times n}, \quad i, j = 1,2,...,n \tag{6}$$

$$D = \left[\sum_{i=1}^{n} t_{ij}\right]_{n\times 1} = \left[t_i\right]_{n\times 1} \tag{7}$$

$$R = \left[\sum_{j=1}^{n} t_{ij}\right]_{n\times 1} = \left[t_j\right]_{n\times 1} \tag{8}$$

Criteria having positive values of (*D*-*R*) have higher influence on one another and are assumed to have higher priority; these called dispatchers; Those having negative values of (*D*-*R*) and receive more influence from another are assumed to have a lower priority and are called receivers (Seyed-Hosseini, 2006). Meanwhile, it should be emphasized that factors with high (*D*+*R*) values that play a central role, and factors with high (*D*-*R*) values that mainly dispatch influence to other factors. Thus factors with low (*D*-*R*) values mainly receive influence from the other factors.

4 CASE STUDY

4.1 Case Background

To apply the proposed model of Academic Performance Measurement (APM), this study conducted a case study of National Cheng Kung University (NCKU)'s implementation of the top-tier university program to describe the working of the proposed research model and show how it helps a top-tier university realize its strategic plans and fulfil its objectives. The BSC of APM model integrated decisive indicators or critical success factors, and these reinforced each other through cause-and-effect linkage between measurement, vision, and goals.

Our study invited the decision-makers of NCKU to set, through open discussion, the mission of the school's top-tier university program as **"'Comprehensive enhancement with featured development,' with the aim to become one of the world's top 100 universities.**" Based on this vision and the criteria set by the Ministry of Education for the top-tier university assessment, five strategic objectives were outlined, while decisive indicators were designed for top-tier universities and transformed into specific practices, including:

F_{11}: Advancement on three major fronts: research, teaching, and industry-academia collaboration. (Finance, Customer, Internal process, Learning & growth)

F_{12}: Training future social leaders and global citizens. (Finance, Customer, Internal process, Learning & growth)

F_{13}: Reforming undergraduate education with emphasis on humanity, creativity, international vision, social concerns and students with leadership. (Customer, Internal process, Learning & growth)

F_{14}: Recruitment of senior talents. (Finance, Internal process, Learning & growth)

F_{15}: Developing world-class research centers. (Finance, Customer, Internal process, Learning & growth)

Later, the action plans were deployed in performance-driving indicators of the BSC's four perspectives (Table 1), and complex problems were systematically presented in the form of a hierarchy, where the upper level contains strategic objectives, the second level contains the indicator dimensions of financial, customers, internal processes, and learning and growth, and the third level contains the sub-dimension indicator items.

4.2 Evaluating the Strategy Plan

The decision-makers were asked to provide their views on a series of paired comparisons, after which the assessment of the decision-makers in ANP was integrated using geometric mean, while the assessment in DEMATEL was integrated using arithmetic mean. The direct relationship matrix then integrated the impact direction and impact extent of the organization's DEMATEL, and cause-and-effect mapping and rank calculations on direct and indirect relationship matrix were conducted. A two-dimensional graphic with (*D*+*R*) as the horizontal axis and (*D*-*R*) as the vertical axis was then produced by cause-and-effect mapping using the rank results calculated. The purpose of using a graphical expression is to simplify a complex cause-and-effect relationship into a simple visual structure so that one can clearly see the intensity of impact between these indicators. Decision-makers can determine whether the indicator characteristics should be classified as "cause" or "result" based on the location of target features, as well as how much the KPIs affect and are affected by them.

By the very nature of education, the financial measurements are not forward-looking and are exclusionary to nonfinancial measures. This study proposed a strategy map with a network structure,

and the cause-and-effect mapping generated through DEMATEL was used to form the ANP structural diagram, which produced clusters based on the BSC's four perspectives. After a paired comparison between the indicators' internal relationships and the ANP cause-and-effect linkage of the mutually affecting clusters and elements, the weights calculated in ANY will become the weights of the follow-up KPIs.

Table 1: The indicators of the BSC's four perspectives.

	Indicator items
A_1: Finance	A_{11}: The amount of industry-academia collaboration or technology transfer. (F_{11}, F_{13}, F_{15}) A_{12}: The amount of corporate sponsorship. (F_{11}, F_{15}) A_{13}: The number of patents or technology licensing. (F_{11}, F_{15}) A_{14}: The number of signed international cooperation projects with project funding. (F_{11}, F_{15})
B_1: Customer	B_{11}: The number of collaborated with national research institutes. (F_{11}, F_{12}, F_{15}) B_{12}: The number Of foreign student recruitment. (F_{13}) B_{13}: The number of subsidized students for international exchange and visiting. (F_{12}, F_{13}) B_{14}: The number of students for the dual degree of transnational study. (F_{12}, F_{13}) B_{15}: The number of students for cross-institutional course enrollments. (F_{12}, F_{13}) B_{16}: The number of established cross-institutional course programs. (F_{12}, F_{13}) B_{17}: Early Admission plan for senior high school students. (F_{12}, F_{13})
C_1: Internal process	C_{11}: The number of major international conferences organized. (F_{12}, F_{14}) C_{12}: The number of recruiting inter/nationally-acclaimed scholars. (F_{12}, F_{14}) C_{13}: The teacher-student ratio. (F_{12}, F_{13}, F_{14}) C_{14}: The number of holding the international communication. (F_{12}, F_{14})
D_1: Learning and growth	D_{11}: The growth rate of the international journals. (F_{12}, F_{14}, F_{15}) D_{12}: The growth rate of the international journal citations. (F_{12}, F_{14}, F_{15}) D_{13}: The number of editors for the international journals/magazines. (F_{12}, F_{14}, F_{15}) D_{14}: The number of inter/national rewards for the important prizes. (F_{12}, F_{14}, F_{15}) D_{15}: The number of rewarded excellent teachers. (F_{12}, F_{15}) D_{16}: The number of professional literatures and journals. (F_{12}, F_{14}, F_{15}) D_{17}: The number of promoting all sorts of courses to be conducted in English. (F_{12}, F_{13}, F_{14}) D_{18}: Approving the upper-intermediate GEPT. (F_{12}, F_{13})

4.3 Data Analysis

In analyzing the top-tier university program using a strategy map, the cause-and-effect diagram (Figure 1) formed by integrating ANP and DEMATEL with the organization's strategy map was divided into four quadrants according to center (*D*+*R*) and reason (*D*-*R*) and plotted on the axis. The one with high center and reason values was the financial dimension, indicating the core projects that affect other conditions, while the one with high center value and low reason value was the customer dimension, indicating the core projects affected by other conditions. In analyzing the reason behind the failure to meet the target in the "internal processes" dimension, the perspective of the internal processes dimension was influenced by the financial perspective and influenced the customer and learning and growth perspectives, in which "the number of major international conferences organized" was the core project in internal processes perspective, and "the number of signed international cooperation projects with project funding" was the core project in the financial perspective. Based on these findings, a review and alignment was done and improvement measures were put forward.

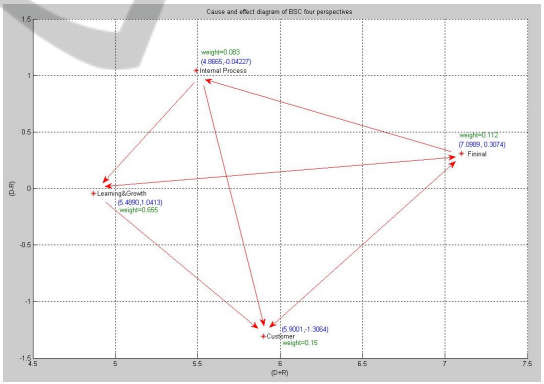

Figure 1: The strategy map of BSC perspectives.

5 CONCLUSIONS

Performance management is a key issue in the academic domain. The strategy of the top-tier university is a mean of focusing performance management and aligning towards the strategy plan of an objective. This study tabled a framework based on the BSC for strategy planning of a top-tier university in Taiwan by using a multi-criteria evaluation and alignment. It was then applied in the performance management of educational institutions, taking into consideration the following:

- Determine the appropriate action plans through strategic objectives, deploy them in the BSC's four perspectives, and apply to the development of top-tier university indicators;
- With the use of the MCDA techniques - ANP and DEMATEL, evaluate a series of BSC indicators to construct the cause-and-effect linkage of strategy map, obtain the relevant strengths and weights between BSC indicators and form objective functions;
- Review the strategic gap between implementation and organizational objectives through target value of KPIs, in order to carry out strategy alignment and possibly improve the quality of education and international competitiveness.

Strategic objectives are implemented to adapt to environmental changes, one must continually review the cause-and-effect linkage between strategy and performance during the policy enforcement process. As for the strategic gap, it represents the difference between what the organization should do and what it can do. Sometimes this means that the capacity is greater than the demand, and sometimes it can mean the opposite, indicating danger in organizational operation. The greater the gap, the greater the danger (Zack, 1999). Similar to business strategy, an academic institution must align its strategy by examining the achievement rate of its KPIs or target values over time, changes in the environment, and the status of implementation of each unit, in order to achieve its strategic objectives.

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