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An efficient resource allocation in strategic management using a novel hybrid method

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Abstract

Purpose – The purpose of this paper is to suggest a novel hybrid method by integrating a decision sciences approach with balanced scorecard (BSC) in order to scientifically enable the efficient strategic management of an organization under limited resources. The proposed research model endeavors to improve critical basis deficiencies of the original BSC as well as formerly improved forms of BSC by appropriately integrating three disparate methods: BSC, analytic network process (ANP), and zero-one goal programming (ZOGP).

Design/methodology/approach – The designed approach is separated into three major parts. At first, the traditional BSC, concentrating on both financial and intellectual capital, was adopted as the strategic management framework, and then priorities as well as the importance of tactical drivers derived from BSC application were consecutively identified by the application of ANP. Finally, the study further applied the obtained results of integrated BSC and ANP to ZOGP in order to scientifically identify the optimal strategic investment under simulated constraints of the considered organization.

Findings – An application of BSC, ANP, and ZOGP with a case study of an academic institution provided an improved strategic management approach for optimally and scientifically utilizing the limited resources of the organization. The suggested results indicated that only 11 of the 23 strategic projects should be executed. Moreover, the selected tactical tasks would efficiently use less than 36 percent of the strategic expenses of the traditional management approach.

Originality/value – Based on the intensive literature reviews, the proposed method could be determined as a novel hybrid approach. It newly conveyed the practical management approach by innovatively including the proper decision sciences method to BSC. This improvement scientifically considered on the resource allocation process that has never been studied before in formerly improved BSC.

Keywords Strategic management, Balanced scorecard (BSC), Intellectual capital, Multi-criteria decision making (MCDM), Analytic network process (ANP), Zero-one goal programming (ZOGP)

Paper type Research paper

1. Introduction

The contemporary competitive business approach has changed from a monotonic emphasis on tangible asset or financial asset management (Lerro and Schiuma, 2013) to more diverse concentrations by comprehensively including intangible resources or intellectual capital (IC) (Stewart, 1997). The novel concept of IC was first suggested by the economist Galbraith (1969), but it was not widely known until 1993, when Skandia commercially applied IC management and also disseminated its results in its annual report (Roos *et al.*, 1997). From this inspiration, several well-known organizations such as Dow Chemical and Canadian Imperial Bank of Commerce followed Skandia's approach by implementing the concept of IC. In the 1990s, several empirical studies

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argued that traditional management centered solely on financial assets is insufficient for surviving in global competition anymore (Waterhouse and Svendsen, 1998). Therefore, IC has been broadly identified as a critical management method (Bontis, 1996; Caddy, 2002; Mouritsen, 2004; Kale, 2009). It has been highly acknowledged and extensively applied for both commercial and academic purposes, and management of intangible assets is now concurrently considered with tangible resources and respected as a means of achieving a sustainable competitive advantage (Ordóñez de Pablos, 2005; Solitander and Tidström, 2010).

For enhancing competitive advantage, several strategic tools and methods have been proposed in recent decades, including SWOT analysis, the five force model, value chain, and balanced scorecard (BSC). Among these diverse managerial methods, BSC is a distinguished strategic management technique that expansively concentrates on the management of both tangible and intangible assets, which are indispensable to business competition. BSC is a managerial tool that transfers a strategic plan to a practical approach by applying measurement and assessment tools for conducting unidirectional operations of the organization (Kaplan and Norton, 2000). Furthermore, it is also identified as a crucial technique for measuring and managing IC (Andriessen, 2004). Because of BSC's several advantages, it has been extensively applied in diverse studies, both for business and academic purposes (Öztayşi and Uçal, 2009) and in private and public organizations. However, the more the tool is used, the more it is criticized. Several difficulties in the use of BSC have also been identified (Wu *et al.*, 2009; Hsu *et al.*, 2011; Yüksel and Dağdeviren, 2010; Bentes *et al.*, 2012): comparisons among perspectives and indicators that are dissimilar in characteristics and measurement units; the vagueness of contributions and resource allocations to BSC's dimensions or key performance indicators (KPIs); the identification of summarized quantitative results; and the sophisticated appraisal and management of several objectives and indicators. Especially, a distinctive deficiency in the methodological basis of BSC is the scope limitation. Typically, the original BSC finally provides an organizational strategy map concurrent with its strategic performance measures. Nevertheless, the technique does not further convey an obvious linkage as well as resolution between the strategic elements and the available budgets or restricted resources of organizations. Therefore, in general, most executives embrace intuition as a decision method for further allocating limited resources, although this approach has been identified as a troubling tool (Miller and Ireland, 2005). Generally, a sustainable management critically requires reliable and also comprehensive information (Meena and Thakkar, 2014). Therefore, because of this weakness, several enterprises with limited resources may be reluctant to apply this complicated strategic system (Hoque, 2003).

As mentioned previously, the BSC approach has several critical deficiencies. Therefore, a number of scholars have tried to resolve some of the aforementioned deficiencies by applying multi-criteria decision making (MCDM) methods such as the technique for order of preference by similarity to ideal solution (TOPSIS), analytic hierarchy process (AHP), or analytic network process (ANP) as MCDM methods have a distinctiveness fitting to the weaknesses and complexions of BSC, especially multiple criteria consideration. Therefore, in the past decade, various MCDM methods have been applied to BSC, and AHP is one such method that has been substantially applied (e.g. Huang *et al.*, 2011; Bentes *et al.*, 2012). Hence, AHP has been empirically identified to add several advantages to BSC such as multi-criteria prioritization, comparative analysis of business performance, and qualitative and quantitative determination. Nevertheless, for numerous applications, there are still some criticisms as far as

integration of BSC and AHP is concerned, specifically for the lack of dependency consideration within BSC's dimensions and indicators. Therefore, ANP, an improved form of AHP, was suggested and used with BSC to cope with the dependency issue as well as other deficiencies of BSC. Nevertheless, the number of these hybrid studies is still limited, and most of them concentrate on finding weightages or priorities of BSC's perspectives, strategies, strategic objectives, or KPIs.

Furthermore, regardless of the prioritization and importance identification of BSC's elements, critically, the BSC still lacks resource allocation consideration, especially under the typical limitation of organizational resources. Generally, because of insufficiency of resources, organizations, whether, profit or non-profit, are confronted with the problem of deciding which strategic projects they should initially execute and how much resource they should allocate to those tactical activities. Managements or decision makers face the arduous task of optimally selecting critical projects. Since budgets and resources of organizations are limited, firms cannot execute entire strategic projects, and, especially, activities do not convey critical impacts to organizational vision and missions. Therefore, organizations have to identify and select the most viable strategic activities as well as cost-beneficial projects for optimizing the resource usages of companies. Hence, the strategic resource allocation problems should be addressed, and companies require a more extensive strategic management method. Surprisingly, even BSC, the comprehensive strategic method, and also earlier improved BSC still have never expansively considered this critical issue. There are some existing linkages between resource allocation and strategic management under the BSC approach (e.g. Niven, 2005; Kalamo, 2012); nevertheless, the BSC along with its improved approaches still have not taken into consideration the limited resources of organizations. Therefore, the improvement of this issue will provide a practical strategic management approach in real-life managerial situations.

From the perspective of the importance of integrating resource allocation consideration to the BSC as well as the deficiencies of previously improved BSC studies, the main contribution of this study lies in its objective to improve upon the deficiencies of BSC with the decision sciences method to convey a more comprehensive and scientific approach for enabling the allocation of limited resources of an organization.

The remainder of this paper is separated into five main sections, as follows. In the next section, theoretical concepts are briefly examined and reviewed. Thereafter, the proposed framework is described and applied with a real case study of an academic institution, and the obtained results are discussed. Finally, the conclusions are given.

2. Methods and literature review

2.1 BSC

Traditionally, financial assets were solely accepted as the key resource of organizations. Several popular financial measures such as return on assets (ROA), net present value (NPV), and internal rate of return (IRR) have been widely applied for several decades. Nevertheless, measurement of organizational performance using traditional financial methods is currently insufficient (Lerro and Schiuma, 2013) and more irrelevant to actual value of organization (Malhotra, 2000). The accounting value of an organization traditionally represents the real value of the company's assets. Nevertheless, this approach could not reveal hidden values inherent in human and organizational structure (Fernandez, 2003; Ordóñez de Pablos, 2005). Because of this issue, several studies attempted to disclose these intangible assets, and found that the management of IC could bring several advantages to organizations, such as enhanced

wealth for companies (Guerrini *et al.*, 2014), supplying of a new resource-based view (RBV) (Bontis, 1996), and so on. Therefore, in recent decades, several methods were developed to manage the intangible assets, such as invisible balance sheet, intangible assets monitor, BSC, economic value added (EVA™), IC-index, technology broker, Skandia navigator, and so on. Nevertheless, among these methods, the BSC remains a distinctive and widely applied approach since it comprehensively takes into consideration both financial and non-financial capital. Especially, it also addresses the critical deficiency of traditional management methods by connecting the organizational long-term strategy with short-term performances (Kaplan and Norton, 1996). BSC was invented by Kaplan and Norton (1992). It is a comprehensive method that provides a systematic framework that suggests conversion processes from the vision, mission, and strategy of an organization to coherent strategic objectives and relative KPIs. Therefore, this strategic method includes not only management but also measurement consideration in its framework (Yüksel and Dağdeviren, 2010). The method considers both lagging and leading measures through four considered perspectives, including financial, customer, internal process, and learning and growth (Janeš, 2013). A brief description of each perspective is presented as follows:

(1) The financial perspective traditionally concentrates on the financial security of the organization, and is often measured by liquidity, profitability, revenue growth, or return on capital.

(2) The customer perspective seeks to deliver value to the buyer, and its indicators typically include market share, customer acquisition rate, customer retention rate, and customer profitability.

(3) The internal process perspective encourages the enhancement of process efficiency and effectiveness, and the dimensions of the process could be classified as operations, customer management, innovation, and regulation and society. The indices of measurement could include defect rate, delivery time, and new product launching time.

(4) The learning and growth perspective focusses on the improvement of intangible assets, including those of human capital, information technology (IT) capital, and organizational capital (Kaplan and Norton, 2004). These can be evaluated by customer satisfaction rate, rate of accomplishment on IT, and culture dissemination rate.

Of the mentioned dimensions, the first perspective accounts for the traditional management of tangible assets, whereas the others consider the management of non-financial assets or IC. These different assets were empirically identified for the distinctive characteristic that is the cause-and-effect relationship (Bento *et al.*, 2012; Cohen *et al.*, 2008; Bryant *et al.*, 2004). These linkages of resource bundles could beneficially impact the strategic performance of an organization because this advantage was explicitly indicated in several RBV studies (Lippman and Rumelt, 1982; Wernerfelt, 1984; Rumelt, 1984; Dierickx and Cool, 1989; Barney, 1991). Moreover, as indicated in other RBV researches, companies could also enhance strategic performances by efficiently utilizing internal resources as well as organizational competences (Penrose, 1959; Mills *et al.*, 2002). Therefore, managements should conceive what the critical strategic resources are and how they can optimally apply the limited resources to impact organizational vision.

Kaplan and Norton (1996) proposed four different perspectives that theoretically need to be balanced, although some companies still make decisions only based on ROA and company's stock price to the detriment of other measures. Nevertheless, in most cases, the BSC enabled the evolution of strategic considerations from traditionally short-term or past performance to long-term or future performance. BSC is a comprehensive method that provides a systematic approach to transform the vision and missions of the company to strategic objectives, strategy maps, and, finally, to a performance measurement system. Therefore, the BSC is used to indicate as well as to reinforce the current strategic planning as well as relative managerial management of a business. Nevertheless, some organizations may apply the method for responding to a political reason or for innovating a dissimilar strategy. Because of its distinguished characteristics and several advantages (discussed in Section 1), this technique has been substantially applied in several studies and diverse domains in recent decades.

Although the BSC was originally designed for business organizations, this strategic technique is also adaptable to non-profit organizations (O'Neil *et al.*, 1999). Since nowadays competitions in any society have become more complex and intense, the BSC approach could impart excellent effects to both commercial and non-commercial organizations. Therefore, non-profit organizations also require this strategic method as much as profit organizations. They also require the BSC which would allow organizations to efficiently allocate resources in a strategically relevant approach (Chen *et al.*, 2006). Typically, academic institutions are identified as non-commercial organizations (Drucker, 1990), especially public universities. Therefore, they traditionally have not been confronted with the pressures of survival. Budgets and resources of most academic institutions do not directly come from products or services as in the case of profit-seeking organizations. Therefore, in non-commercial organizations, the resource allocation of activity does not typically depend on the NPV, options analysis, or project review analysis. On the other hand, a cost–benefit analysis which relies on social or organizational advantages is more acknowledged (Treasury, 2003). Generally, the financial support of academies comes mostly from governments. Thus, financial focus in the educational domain is less important than concentration on other perspectives of BSC (Kettunen, 2005). Nevertheless, universities still measure their excellence in business in a manner similar to profit businesses, but they mostly focus on academic measures rather than concentrating on financial management. Therefore, identifying managerial approaches for financial as well as customer perspective in a university can be difficult and dissimilar to doing the same for a profit organization.

Therefore, studies on BSC in academia are still limited (Cullen *et al.*, 2003; Nistor, 2009), especially applications for strategic management in higher education (O'Neil *et al.*, 1999; Sutherland, 2000; Cullen *et al.*, 2003; Chen *et al.*, 2006; Armitage and Scholey, 2004; Papenhausen and Einstein, 2006; Umashankar and Dutta, 2007; Philbin, 2011; Aljardali *et al.*, 2012; Schobel and Scholey, 2012; Özpeynirci *et al.*, 2015). From the numerous usages of BSC in both commercial and academic studies, several of its deficiencies have been identified, which are discussed in Section 1. One critical issue is the importance or priority identification of BSC's elements, as the typical BSC method does not assign a level of importance to its perspectives or indicators. BSC is generally perceived as that in which the priorities of all perspectives are balanced (e.g. Jiang and Liu, 2014). Therefore, from this recognized characteristic, if the management completely equilibrates all considered objectives, they need to equally concentrate and allocate resources to all diverse elements, and this strongly contradicts real-life managerial approach.

Because of these difficulties of the BSC approach, several scholars attempted to improve upon this technique by applying a proper method corresponding to the

characteristics of BSC, and, as a result, MCDMs have been substantially suggested for the multiple criteria consideration that is a characteristic of BSC (Lee *et al.*, 2008; Yüksel and Dağdeviren, 2010; Hsu *et al.*, 2011). Several MCDMs were suggested and applied to BSC in recent decades, but the most suitable method to address the characteristics and deficiencies of BSC is ANP. This MCDM concept has distinctive identities that fit BSC beyond other methods as ANP could consider qualitative or quantitative data and also dependency among elements for the entire model, as shown in Table I. Therefore, on account of these distinguished characteristics, this research applied ANP to resolve the criticisms of BSC. The ANP method and the relevant studies will be examined in the coming section.

2.2 ANP

ANP is recognized as an improved or general form of AHP. The two methods were proposed by Saaty in 1980 and 1996, respectively. To avoid the limitation of AHP, generally known as the rank-reversal problem, ANP was developed by considering the dependency and feedback among elements (Saaty, 1996). It is a mathematical theory that provides a systematic approach to consider multiple criteria. The achievement of ANP could be perceived from diverse applications and areas of usage such as the economy, business, education, manufacturing, social, politics, etc. (e.g. Kuo and Lin, 2012; Tavana *et al.*, 2013; Moalagh and Ravasan, 2013; Wudhikarn *et al.*, 2015a, b).

Saaty (1996) identified a framework of ANP that can be concluded as follows. Identify the multiple criteria problem along with objectives, criteria, and sub-criteria. Specify the control groups or clusters and classify each criterion or sub-criterion into a relative cluster. Determine the dependency of each element and cluster for the entire network model. Perform pairwise comparisons of elements, and then assign the obtained results to the proper column of the unweighted supermatrix. Perform cluster comparisons, and multiply the perceived vector by the coherent part of the unweighted supermatrix to obtain the weighted supermatrix. Calculate the limit supermatrix by increasing the powers of the weighted supermatrix until all columns are similar. Obtain and analyze the results.

Features	ANP	AHP	TOPSIS	ELECTRE I	ELECTRE II	ELECTRE III
1. Core process	Constructing network model and making pairwise comparisons	Constructing hierarchy model and making pairwise comparisons	Computing shortest distance and longest distance to ideal points	Measuring concordance and discordance degrees	Measuring concordance and discordance degrees (with the threshold approach)	Measuring concordance and discordance degrees (pseudo-criteria and outranking degree considerations)
2. Consistency verification	Yes	Yes	No	No	No	Yes
3. Types of data	Quantitative or qualitative data	Quantitative or qualitative data	Objective and quantitative data	Objective and quantitative data	Objective and quantitative data	Objective and quantitative data
4. Dependency consideration	Yes	No	No	No	No	No
5. Proposed by	Saaty (1996)	Saaty (1980)	Hwang and Yoon (1981)	Benayoun *et al.* (1966)	Roy and Bertier (1971)	Roy (1978)

Sources: Adapted from Özcan *et al.* (2011) and Wudhikarn (2015)

Table I.
Characteristics of MCDM methods

As previously mentioned, the ANP is more suitable for ameliorating the deficiencies of BSC than other MCDM methods. Therefore, some studies tried to adopt the ANP along with the BSC to deliver more reasonable results. All studies aimed to identify the best alternative and/or to prioritize BSC's elements, its strategies, perspectives, strategic objectives, and indicators, and to realize a gap of improvement as well as the importance of strategic management. The improved approach was first proposed by Ravi *et al.* (2005). The research integrated BSC and ANP to evaluate the best alternative to end-of-life computers. A year after the first work was published, Leung *et al.* (2006) suggested an integrated framework of BSC and ANP and provided a numerical example. Thakkar *et al.* (2006) also proposed the same approach to identify the weightages of the perspective levels. Leem *et al.* (2007) employed this hybrid method to identify the measuring system and also to prioritize the indicators as well as BSC's perspectives of the logistic center. Lee (2007) also used ANP along with BSC to consider the relationships and to identify the orders and weights of KPIs. After that, Yüksel and Dağdeviren (2010) newly applied BSC and fuzzy ANP to identify perspectives and KPI rankings. Nevertheless, the study only partially considered the relationships between the perspective levels. Later, Hsu *et al.* (2011) applied the ANP with the sustainability BSC to prioritize and identify the five critical measures of sustainable performance. Similarly, Bautista *et al.* (2012) and Chang (2013), respectively, used the hybrid approach to identify the best company from three plastic manufacturers and to specify the best new product development project. Two recent studies further integrated other methods with the BSC and the ANP. Bhattacharya *et al.* (2014) applied a fuzzy ANP-based BSC and green supply chain to identify the best sub-construct performance and green environmental practices, while Boj *et al.* (2014) integrated ANP with IC and BSC to consider the dependence and impact between the strategic objectives of BSC and IC.

Although the improvements achieved by integrating ANP and BSC have been increasingly studied over the past decade, all of the mentioned studies are still limited to the areas of manufacturing and business. Applications of the improved method in higher education, which is generally a non-profit organization, are still very rare. Only two studies have been conducted in the past. Wu *et al.* (2011) used the ANP and the BSC to identify the crucial BSC perspectives as well as the KPIs of the extension education centers in universities. The study found that the internal process perspective and the financial perspective were highly important for performance evaluation. In 2003, there was another higher education application that used a hybrid between BSC and ANP, enabling the consideration of relationships among BSC's components to identify critical strategies and prioritize BSC's dimensions.

Nevertheless, whether in applications of business cases or academic studies, all earlier reviewed studies aimed only to prioritize BSC's elements, to identify their importance, or to specify the best alternative. Though these suggested approaches could eliminate most fundamental weaknesses of BSC, the critical deficiency of BSC related to resource allocation decision still remains. Nowadays, both profit and non-profit organizations are typically confronted with the critical problems of resource allocation (Phillips and Bana e Costa, 2007). In particular, benefits are qualified by multi-objectives which are generally contradictory (Phillips, 1992), and the final result appears to be non-optimal use of organizational resources, if the available resources are diffusely allocated to all organizational divisions determined separately (Phillips, 1990). These problems emphasize the requirement of improved BSC, which would enable decision makers to efficiently allocate the resources of organizations. As mentioned, both the traditional and the improved BSC still lack a suitable approach for allocating resources and budgets to

relative strategic projects. Even though some studies (Niven, 2005; Kalamo, 2012) attempted to expand the scope of BSC by including the resource identification process, these improved approaches still do not take care of the classical constraint of most enterprises which is the limitation of organizational resources.

Identifying the significant strategic projects under limited resources is a crucial managerial activity that was empirically identified in several studies (e.g. Santhanam and Kyparisis, 1995; Chen and Cheng, 2009). The suitably selected projects could bring competitive advantages to a business (Chen and Cheng, 2009). Nevertheless, selecting a set of optimal projects is a delicate process completely dependent on the available resources of an organization. As previously mentioned, the improved forms of BSC do not inclusively consider the limited resources of an organization. Therefore, these strategic methods still could not optimally deliver an efficient strategic management as well as strategic competitive advantages to an organization. Nevertheless, the result of the BSC improved by ANP could be further enhanced by the goal programming (GP) method since perceived weightages could be beneficially used with the zero-one goal programming (ZOGP) method for determining the optimal resource allocation of companies (Wey and Wu, 2007; Polat, 2010; Alias *et al.*, 2013). Hence, to fulfill the gap of formerly improved methods, this research suggests the usage of ZOGP after the hybrid approach of BSC and ANP. This programming method along with the related studies will be concluded and reviewed in the next section.

2.3 ZOGP

GP is a multi-objective optimization technique first proposed by Charnes *et al.* (1955). This tool is rooted in the linear programming (LP) method. Nevertheless, there are some dissimilarities between the methods in terms of purposes as well as the number of objectives. GP accounts for multiple objectives and minimizes the deviations among the considered goals, whereas LP takes into account a single objective problem as well as the minimization or maximization of a goal. GP has been developed into several models over the past decades, including lexicographic GP, weighted GP, min-max GP, mixed binary GP, and zero-one GP (ZOGP).

Among the diverse GP methods, ZOGP is identified as an appropriate technique for enabling alternative and resource selection and prioritization (Schniederjans and Sanathanam, 1993). Furthermore, the integration of ZOGP and ANP is especially suggested as a more efficient approach for allocating resources under budget constraints and other managerial limitations (Chen and Shyu, 2006; Wey and Wu, 2007; Wei and Chang, 2008; Chang *et al.*, 2009; Polat, 2010) because the programming method does not account for the trade-off issue among criteria (Reza *et al.*, 1988). The ZOGP model for optimizing limited resources by considering the obtained weights of ANP as well as multiple conflicting goals (Polat, 2010) can be shown as follows:

$$\text{Minimizing } Z = P_k\left(w_j d_j^+, w_j d_i^-\right)$$

$$\text{Subject to } a_{ij}x_j + d_i^- - d_i^+ \leqslant b_i \text{ for } i = 1,\ 2,\ 3,\ \ldots,\ m,\ j = 1,\ 2,\ 3, \ldots,\ n$$

$$x_j + d_i^- = 1 \text{ for } i = m+1,\ m+2,\ \ldots,\ m+n,\ j = 1,\ 2,\ 3,\ \ldots,\ n$$

$$x_j = 0 \text{ or } 1$$

where m is the number of constraints for optimizing resources; n the number of alternatives; w_j the weights of $j = 1, 2, 3, \ldots, n$ alternatives obtained from ANP results; P_k the goals in the model with tentative priorities k; d_i^+ the positive deviation of ith variable; d_i^- the negative deviation of ith variable; a_{ij} the jth activity usage parameter of the ith resource; b_i the ith available resource or constraint of factors.

As previously mentioned, the BSC has a basic deficiency that could be properly amended by ANP, but most studies aimed only to rank and identify the orders and weights of the elements of BSC. The recognition of current positions and managerial priorities could provide a gap and channel for improvement, but managements still manage organizations under limited resources and multiple objectives. Thus, to enable efficient strategic management of an organization, the formerly improved BSC should be further developed by integrating it with an appropriate GP method, that is, the ZOGP, because of its distinctive advantages over ANP as empirically identified in past studies. Therefore, to improve on past strategic management approaches, this study proposes a comprehensive decision support technique that integrates BSC, ANP, and ZOGP.

3. The proposed model

Based on an intensive literature review, the theoretical framework of this study mainly depends on three proper methods including BSC, ANP, and ZOGP. First, the BSC approach is theoretically applied to identify the strategic management approach of an organization, and afterward, ANP is applied along with the obtained results from BSC to identify the weights and priorities of BSC's elements. Finally, to suggest an improved approach from the former hybrid method, the derived outputs together with the constraints of the institution are considered by ZOGP. The framework of this study is depicted in Figure 1.

Step 1: identifying the vision, business strategies, strategic objectives, and relative KPIs.

This step is a typical procedure of BSC. A company needs to declare its vision, and, to achieve this long-term goal, it also requires the identification of proper strategies as well as a relative measurement system that considers both relative strategic objectives and indicators.

Step 2: classifying the KPIs into related BSC perspectives.

After the KPIs are specified in the former stage, they are classified into one of four dimensions of BSC.

Step 3: structuring the strategy map (indicator level) and relationships as well as the ANP model.

In this stage, the classified KPIs are applied to create the strategy map. Each KPI is placed into the respective sections of the map, and the relationships among all KPIs are identified by the expert via a questionnaire. This complete strategy map could also represent the ANP model of the considered problem.

Step 4: performing pairwise comparisons for element level and cluster level along with a consistency check.

Another questionnaire considering the comparisons of associated clusters and related elements is created in this step and then sent to the expert for identifying the different importance values among all of the relative BSC dimensions as well as KPIs. Thereafter, the obtained data are applied to consider the consistency. If the consistency ratio (CR) is poor (lower than 0.10), the most inconsistent comparisons and subordinate orders must be reconsidered until the ratio is acceptable.

Step 5: calculating the unweighted supermatrix, weighted supermatrix, and limit supermatrix.

In this step, the consistent data are applied to sequentially calculate the unweighted supermatrix, weighted supermatrix, and limit supermatrix. The details of the calculating processes can be found in several published books and studies (e.g. Saaty, 1996).

Step 6: obtaining the weights and priorities of KPIs.

The results of the limit supermatrix from the previous stage are applied for identifying the priorities as well as the weightages of KPIs. The orders and weights represent the levels of importance of the KPIs.

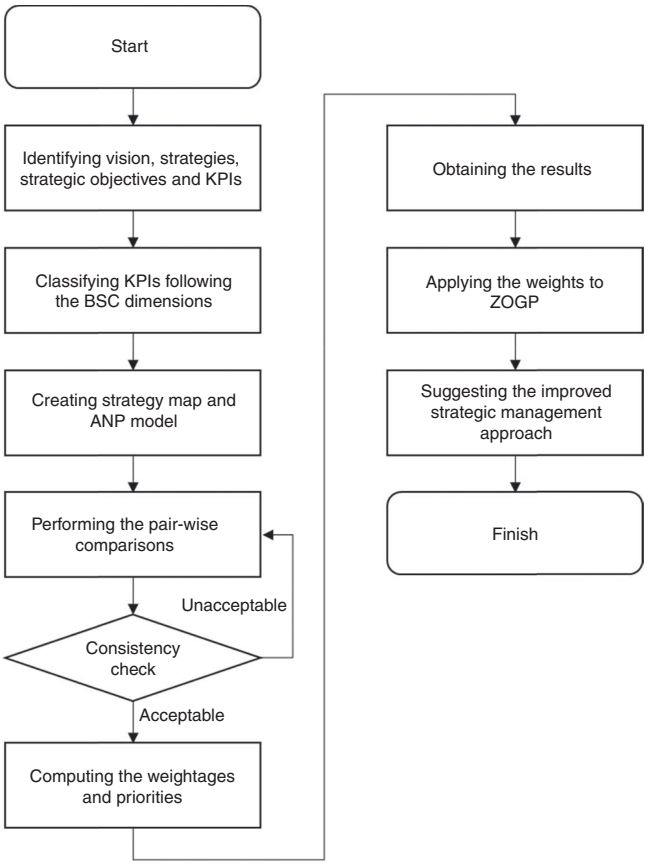

Figure 1.
The research framework

Step 7: applying the acquired weightages and constraints of an organization to ZOGP.

After the weightages of the KPIs are identified, these calculated weights are used along with other data, that is, resource data and goal constraints, as inputs to ZOGP for considering the optimal goal under the limited resources of the focussed organization.

Step 8: suggesting an efficient strategic management approach from the obtained results.

Finally, the obtained results are used to suggest efficient resource consumption for the strategic management of the organization. Moreover, a comparison between the traditional and the suggested approaches is also carried out.

4. Application of the proposed model, and results

The research framework proposed in the previous section was implemented to discover an improved strategic management approach in the case study of an academic institution. Similar to most organizations, the considered academy, the College of Arts, Media, and Technology, affiliated with Chiang Mai University, is managed under limited resources. Nevertheless, there are still several dissimilarities between universities and other profit-seeking organizations that should also be acknowledged (discussed in

Section 2). In this case study, from the estimation of the organizational income, the revenue of the college will significantly decline based on several factors. Hence, to efficiently use the limited budget, the college highly requires an improved investment directly serving the vision and the strategic objectives of the organization. Therefore, the suggested research model was applied to the strategic management of the college. In order to minimize the bias results, all decision making in this studied case was solely executed by the top management of the focussed institution because the dean did not have direct interest in any strategy, indicator, or strategic activity unlike other executives who directly took on responsibilities as regards specific strategic objectives. The processes and results of this focussed case are identified as follows.

4.1 Identifying the vision, business strategies, strategic objectives, and relative KPIs

This step aims to identify the strategic management of an organization. In this study, the considered institution had already established its current managerial approach in 2014, and the vision, strategies, and related strategic objectives, which are presented in Table II, as well as the strategic objectives and relative KPIs, which are shown in Table III.

4.2 Classifying the KPIs into related BSC perspectives

In this step, the previously identified KPIs were classified into the related dimensions of BSC, including the financial perspective (F), customer perspective (C), internal process perspective (I), and learning and growth (L). All of the strategic KPIs were classified and verified by management, and these classifications are presented in Table III.

In this case study, there was no objective or indicator focussing on the financial perspective, as the academic institution is a college in a self-autonomous university. The academy does not aim to seek a profit, and receives some financial support from the government.

4.3 Structuring strategy map (indicator level) and relationships as well as the ANP model

The classified KPIs were applied to create a strategy map that is comparable to the ANP model. This visualized map was developed by arranging the KPIs in the respective sections of the strategy map. After that, the dependencies among the KPIs were specified by the expert (the dean) via a constructed questionnaire, and the obtained answers were then used to demonstrate the connections or relationships in the strategy map. Nevertheless, because of the complexity of the relationship between the KPIs, the created model could, understandably, visualize only the relation between the BSC perspectives, as shown in Figure 2, whereas the interrelationships between the KPI levels was differently demonstrated in a zero-one matrix, as presented in Table IV. From Figure 2, it is clear that the relationships between the dimensions can be identified by arcs as well as arrowheads. If the arrowhead points to any circle cluster, it is an indication that the cluster was influenced by another cluster from where the arc originated. Hence, if there is a two-way arrow between two spheres which points to the two spheres, it means that the two circle clusters influence each other. As for relationships on the indicator level, a value in the matrix, or as presented in Table IV, represents the influence between the indices. In other words, if a segment has a value equal to one, it means that the KPI in the vertical axis influences the KPI in the horizontal axis, whereas a zero value of a segment indicates that there is no influence between the two KPIs.

Vision An international, leading college aims for excellence in creative technology and innovation Strategy/strategic objectives	Acronym
Strategy 1: improving academic programs to be on par with international standards and cooperating with the industry to focus on work-integrated learning approach	S1
Strategic objectives of strategy 1	
Arranging study formats by focussing on work-integrated learning	G1-1
Arranging excellent education on national level	G1-2
Arranging international programs	G1-3
Providing resources by encouraging graduates' employment	G1-4
Strategy 2: creating and developing studies that concentrate on international recognition, industry linkage, and student involvement	S2
Strategic objectives of strategy 2	
Conducting research involving students	G2-1
Creating research by cooperating with international academia	G2-2
Creating research by connecting with the industry	G2-3
Strategy 3: improving academic service, focussing on international excellence level, industry linkages, and student involvement	S3
Strategic objectives of strategy 3	
Providing excellent academic services involving students	G3-1
Providing excellent academic services with the aim of connecting with the industry	G3-2
Providing excellent academic services by focussing on the international level	G3-3
Strategy 4: integrating research with Thai arts, and religious and local culture	S4
Strategic objectives of strategy 4	
Integrating studies with Thai arts, and religious and local culture	G4-1
Strategy 5: developing universality by creating networks within regional and international academia	S5
Strategic objectives of strategy 5	
Developing universality by creating networks within regional and international academia	S5-1
Strategy 6: enhancing human ability as well as management system efficiency to be on par with international levels	S6
Strategic objectives of strategy 6	
Developing the proficiency of the staff in English	G6-1
Developing the up-to-date knowledge and skills of the staff	G6-2

Table II.
Vision, strategies, and strategic objectives of considered institution

4.4 Performing pairwise comparisons for element level and cluster level along with consistency check

In the fourth step, a pairwise comparison questionnaire was created to explore the degree of influence between the BSC perspective and the BSC perspective as well as between KPI and KPI. In this study, three major comparison questions for BSC dimensions and eight main inquiries for KPI comparisons were built. Thereafter, the constructed survey form was delivered to and answered, as well, by the top management of the organization, that is, the dean of the college. After that, the data of the questionnaire were inputted to the Super Decision software version 8.5, and then examined for the consistency of the pairwise comparisons. At first, there were one and three inconsistencies, respectively, in the compared results in the BSC perspective and the KPI levels. The expert was then informed of these critically unreliable answers,

Strategic objective	Acronym	Key performance indicator/perspective of BSC	
G1-1	I1-1	Percentage of 4th year students entering work-integrated learning programs	I
	I1-2	Number of organizations involved with customized study programs	I
	I1-3	Percentage of final projects of 4th year students that are about the real problems of industry	I
	I1-4	Percentage of courses taught by experts from industry	C
G1-2	I1-5	Number of national awards bagged by students	I
	I1-6	Number of departments submitting students to national competitions	I
G1-3	I1-7	Number of international programs and bilingual programs	I
	I1-8	Number of international students transferring grades or scores between universities	I
G1-4	I1-9	Percentage of 4th year students obtaining pass in English job interview examination	C
	I1-10	Percentage of employed graduates after one year	C
	I1-11	Percentage of 4th year students starting up private companies	C
G2-1	I2-1	Percentage of research projects supporting involvement of undergraduate students	I
G2-2	I2-2	Percentage of lecturers working on international research projects and publishing academic papers with foreign professors	L
G2-3	I2-3	Percentage of research projects serving the industry	L
G3-1	I3-1	Percentage of academic service projects supporting the involvement of undergraduate students	I
G3-2	I3-2	Percentage of lecturers cooperating with industry and organizations	I
	I3-3	Percentage of academic service projects arranged on the Lamphun campus	C
G3-3	I3-4	Number of foreign experts providing up-to-date knowledge	C
G4-1	I4-1	Number of research projects applying or integrating Thai arts, and religious and local cultures	I
G5-1	I5-1	Number of projects creating international academic network and collaboration	I
G6-1	I6-1	Percentage of lecturers who are able to teach in English	L
	I6-2	Percentage of academic staff who can communicate in English	L
G6-2	I6-3	Number of lecturers certified by acknowledged institutions	L

Table III.
Strategic objectives and relative KPIs of case study

and the most inconsistent comparisons were inquired about, again, at another time using a new survey document. In this second attempt, the respondent improved upon all the previously inconsistent results to present an acceptable level (in which CR is lower than 0.10). The calculated CR and the improved results are presented in Table V.

4.5 Calculating unweighted supermatrix, weighted supermatrix, and limit supermatrix

In this stage, all the input data that were previously verified and determined to be consistent were sequentially applied to compute the unweighted supermatrix, weighted supermatrix, and limit supermatrix. First, all the pairwise compared data between all the relative KPIs were applied to calculate the eigenvectors or weights of the indicators. All the pairwise comparisons between the relative KPIs and also the local computed weights of the indicators are shown in Table VI. All the obtained weights were specifically introduced into their respective segments to create the unweighted supermatrix.

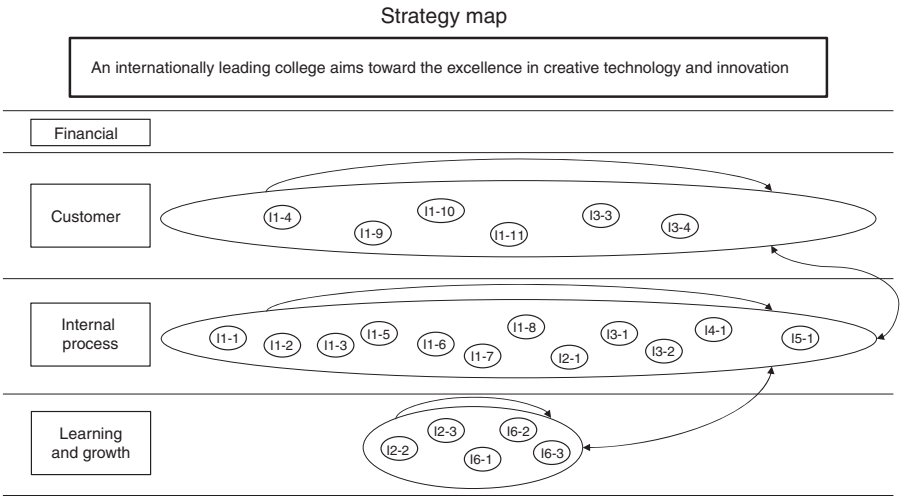

Figure 2.
Strategy map and ANP model of the case study

After that, to calculate the weighted supermatrix, the pairwise comparisons were executed again but for the BSC perspective level. Similar to the pairwise comparisons of the KPI level, comparisons of the perspectives were also conducted in each relative pair and were then calculated for the weightages of the dimensions, as shown in Table VII.

Thereafter, the obtained weights, as presented in Table VII, were multiplied by the concordant part of the unweighted supermatrix in order to compute the weighted supermatrix. Finally, the limit supermatrix was calculated by raising the powers of the previously obtained supermatrix until all of the columns were completely similar; these convergent values denote the weights of the KPIs. Nevertheless, in this study, all the three matrices were automatically calculated by Super Decision software version 2.2.6 by inputting the relationship data presented in Table IV and the pairwise comparison data presented in Tables VI and VII, and the program automatically calculated all of the mentioned matrices and delivered the final weightages.

4.6 Obtaining weights and priorities of KPIs

The weights of the limit supermatrix from the previous step denote the different importance values of the KPIs and also the strategic management focus of the organization. To identify the priorities of the KPIs, the obtained weightages were ranked from the highest to the lowest in importance, as depicted in Figure 3.

In this study, only eight of the 23 KPIs were identified to be important, whereas the remainder were specified as weightless. In the coming step, all the weighted KPIs are assigned to the ZOGP model to optimally allocate the scarce resources of the organization.

4.7 Applying acquired weightages and constraints of an organization to ZOGP

In this section, the obtained weightages of the KPIs were considered as priorities in the programming formulation of the ZOGP model along with the hypothetical goal constraints and resource data of the organization. In the case study, there

Table IV.
Zero-one influence matrix

		C						I												L			
		I1-4	I1-9	I1-10	I1-11	I3-3	I3-4	I1-1	I1-2	I1-3	I1-5	I1-6	I1-7	I1-8	I2-1	I3-1	I3-2	I4-1	I5-1	I2-2	I2-3	I6-1	I6-2	I6-3
C	I1-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	I1-9	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	I1-10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	I1-11	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	I3-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	I3-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I	I1-1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	I1-2	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	I1-3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	I1-5	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	I1-6	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	I1-7	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0
	I1-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
	I2-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	I3-1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	I3-2	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	I4-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	I5-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0
L	I2-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	I2-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	I6-1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0
	I6-2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
	I6-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Comparison of	CR before revision	CR after revision
Relative perspectives affecting C	0.00000	–
Relative perspectives affecting I	2.00696	0.00000
Relative perspectives affecting L	0.00000	–
Relative KPIs of C affecting I1-10	0.00000	–
Relative KPIs of I affecting I1-10	0.17546	0.09893
Relative KPIs of I affecting I1-3	0.40980	0.07348
Relative KPIs of L affecting I1-7	0.00000	–
Relative KPIs of I affecting I3-2	0.00191	–
Relative KPIs of L affecting I5-1	0.28344	0.00000
Relative KPIs of I affecting I6-1	0.00000	–
Relative KPIs of I affecting I6-2	0.00000	–

Table V. Consistency ratio of pairwise comparisons

I1-10	I1-9	I1-11		Weights
I1-9	1	2		0.667
I1-11	1/2	1		0.333
I1-7	I6-1	I6-2		Weights
I6-1	1	9		0.900
I6-2	1/9	1		0.100
I1-3	I1-1	I1-2	I3-2	Weights
I1-1	1	8	7	0.786
I1-2	1/8	1	5	0.129
I3-2	1/7	1/5	1	0.085
I5-1	I2-2	I6-1	I6-2	Weights
I2-2	1	1	1	0.333
I6-1	1	1	1	0.333
I6-2	1	1	1	0.333
I6-2	I1-7	I1-8		Weights
I1-7	1	1		0.500
I1-8	1	1		0.500

I1-10	I1-1	I1-2	I1-3	I1-5	I1-7	I3-1	Weights
I1-1	1	7	7	7	7	7	0.555
I1-2	1/7	1	1/2	6	1	1	0.100
I1-3	1/7	2	1	4	1	1	0.112
I1-5	1/7	1/6	1/4	1	1/5	1	0.038
I1-7	1/7	1	1	5	1	4	0.131
I3-1	1/7	1	1	1	1/4	1	0.064
I3-2	I1-1	I1-2	I1-3				Weights
I1-1	1	8	7				0.789
I1-2	1/8	1	1				0.103
I1-3	1/7	1	1				0.108
I6-1	I1-7	I1-8	I5-1				Weights
I1-7	1	1	5				0.455
I1-8	1	1	5				0.455
I5-1	1/5	1/5	1				0.090

Table VI. Local weightages and pairwise comparisons of indicators

C	C	I		Weights
C	1	1		0.500
I	1	1		0.500
I	C	I	L	Weights
C	1	1	2	0.400
I	1	1	2	0.400
L	1/2	1/2	1	0.200

L	I	L	Weights
I	1	1	0.500
L	1	1	0.500

Table VII. Local weightages and pairwise comparisons of BSC perspectives

were four obligatory and three flexible goals of strategic management of the organization, and they are presented in Table VIII, whereas the KPIs, expenses of strategic management on relative projects, and other related information are shown in Table IX. All of the mentioned data were applied to formulate the ZOGP model, as illustrated in Table X.

The ZOGP model of this study was solved by Lingo software version 15.0, and the obtained results are presented as follows:

$$x_1 = x_4 = x_5 = x_6 = x_7 = x_8 = x_{13} = x_{15} = x_{20} = x_{21} = x_{22} = 1$$

$$x_2 = x_3 = x_9 = x_{10} = x_{11} = x_{12} = x_{14} = x_{16} = x_{17} = x_{18} = x_{19} = x_{23} = 0$$

$$d_1^+ = d_2^+ = d_3^+ = d_4^+ = d_5^- = d_8^- = d_9^- = d_{10}^- = d_{11}^- = d_{12}^- = d_{17}^- = d_{19}^- = d_{24}^- = d_{25}^- = d_{26}^- = d_{28}^- = d_{29}^+ = d_{29}^- = d_{30}^+ = 0$$

$$d_6^- = d_7^- = d_{13}^- = d_{14}^- = d_{15}^- = d_{16}^- = d_{18}^- = d_{20}^- = d_{21}^- = d_{22}^- = d_{23}^- = d_{27}^- = 1$$

$$d_1^- = 42.4,\ d_2^- = 10.31,\ d_3^- = 13.59,\ d_4^- = 9.48,\ d_{28}^+ = 0.14,\ d_{30}^- = 0.19$$

From these obtained results, an efficient managerial approach has been suggested in the next section.

4.8 Suggesting an efficient strategic management approach from the obtained results

Based on the results obtained in the earlier step, only ten of the 23 projects were recommended to be executed in strategically organizational management. All the projects responding to weighted KPIs, including x_5, x_6, x_7, x_8, x_{13}, x_{20}, x_{21}, and x_{22}, were selected, and these strategic projects directly served the encouragement of the internationalization of the organization. Nevertheless, there were also three additional strategic scenarios that were not specified as important from the ANP calculation

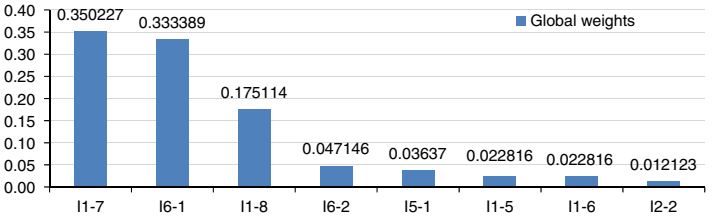

Figure 3.
Weights and priorities of KPIs

Simulated goal	Description
Obligatory goals	1. The annual maximum strategic management budget is $144,100 (7% of annual revenue)
	2. The annual maximum strategic management budget for work-integrated learning (WIL) projects is $20,910
	3. The annual maximum strategic management budget for internationalization projects is $95,590
	4. The annual maximum strategic management budget for industrial linkage projects is $18,580
Flexible goals	1. The yearly minimum strategic budget for work-integrated learning (WIL) projects expected to be expended is $10,455
	2. The yearly minimum strategic budget for internationalization projects expected to be expended is $82,000
	3. The yearly minimum strategic budget for industrial linkage projects expected to be expended is $9,290

Table VIII.
Obligatory and flexible goals of ZOGP model

KPI	Weight of KPI	Supporting project for KPI	Project budget (Thousand USD)	Project category
I1-1	$w_1 = 0.000000$	x_1	$E_1 = 4.7$	Work-integrated learning
I1-2	$w_2 = 0.000000$	x_2	$E_2 = 4.4$	Work-integrated learning
I1-3	$w_3 = 0.000000$	x_3	$E_3 = 0.0$	Industrial linkage
I1-4	$w_4 = 0.000000$	x_4	$E_4 = 9.1$	Industrial linkage
I1-5	$w_5 = 0.022816$	x_5	$E_5 = 9.4$	Internationalization
I1-6	$w_6 = 0.022816$	x_6	$E_6 = 13.2$	Internationalization
I1-7	$w_7 = 0.350227$	x_7	$E_7 = 2.9$	Internationalization
I1-8	$w_8 = 0.175114$	x_8	$E_8 = 14.7$	Internationalization
I1-9	$w_9 = 0.000000$	x_9	$E_9 = 24.7$	Internationalization
I1-10	$w_{10} = 0.000000$	x_{10}	$E_{10} = 2.9$	Work-integrated learning
I1-11	$w_{11} = 0.000000$	x_{11}	$E_{11} = 4.4$	Work-integrated learning
I2-1	$w_{12} = 0.000000$	x_{12}	$E_{12} = 1.5$	Work-integrated learning
I2-2	$w_{13} = 0.012123$	x_{13}	$E_{13} = 0.0$	Internationalization
I2-3	$w_{14} = 0.000000$	x_{14}	$E_{14} = 8.8$	Industrial linkage
I3-1	$w_{15} = 0.000000$	x_{15}	$E_{15} = 5.9$	Work-integrated learning
I3-2	$w_{16} = 0.000000$	x_{16}	$E_{16} = 2.9$	Industrial linkage
I3-3	$w_{17} = 0.000000$	x_{17}	$E_{17} = 2.9$	Academic service
I3-4	$w_{18} = 0.000000$	x_{18}	$E_{18} = 1.8$	Internationalization
I4-1	$w_{19} = 0.000000$	x_{19}	$E_{19} = 0.0$	Cultural encouragement
I5-1	$w_{20} = 0.036370$	x_{20}	$E_{20} = 26.0$	Internationalization
I6-1	$w_{21} = 0.333389$	x_{21}	$E_{21} = 12.6$	Internationalization
I6-2	$w_{22} = 0.047146$	x_{22}	$E_{22} = 3.2$	Internationalization
I6-3	$w_{23} = 0.000000$	x_{23}	$E_{23} = 7.1$	Expert development

Table IX. Budgets of strategic management projects

results that were chosen. These projects, including x_1a and x_{15}, serve WIL, whereas x_4 supports the industrial linkage focus.

From the suggested managerial approach, all of the strategic budgets in this study should be expended at \$101,700, which is less than the traditionally estimated budget of \$42,400 ($d_1^- = 42.4$). Moreover, the suggested expenditures of the three major categorized projects including WIL, internationalization, and industrial linkage projects were \$10,600, \$82,000, and \$91,000, respectively, underconsuming by \$10,310, \$13,590, and \$9,480 ($d_2^- = 10.31$, $d_3^- = 13.59$, and $d_4^- = 9.48$), respectively.

In conclusion, the computation of the weights of strategic KPIs from ANP following the ZOGP calculation suggests that some strategic activities should be executed, and the traditionally provided budget could be reduced and also allocated only to projects critically serving the organizational strategies.

5. Discussion

As previously indicated, BSC is a comprehensive strategic method that theoretically supports an organization to develop a strategic management approach. Nevertheless, regarding its countless applications, there are two critical deficiencies in the BSC basis that negatively cause managements to carry out unscientific or intuitive decision making. The first problem is the vague contributions and priorities of BSC's elements, and the latter is the incomprehensive consideration of resource allocation. Furthermore, these problematic characteristics are interrelated. If managements could not realize the priorities of strategic objectives or KPIs, they must make intuitive decisions for allocating the limited resources of organizations. In the past decades, the first

Table X. ZOGP formulation of case study

ZOGP formulation	Goals
Minimize Z=	
$P1(d_1^+ + d_2^+ + d_3^+ + d_4^+)$	Satisfy all obligatory goals
$P2(\sum_{i=0}^{23}(w_i d_j^-))$	Select the highest weightages of the strategic projects directly responding to a relative KPI
$P3(d_{28}^- + d_{28}^+)$	Use \$10,455 for selected WIL projects
$P4(d_{29}^- + d_{29}^+)$	Use \$82,300 for selected internationalization projects
$P5(d_{30}^- + d_{30}^+)$	Use \$9,290 for selected industrial linkage projects
Subject to:	
$\sum_{i=0}^{23}(E_i x_i) + d_1^- - d_1^+ = 144.1$	Avoid surpassing maximum expense on all strategic budgets
$4.7x_1 + 4.4x_2 + 2.9x_{10} + 4.4x_{11} + 1.5x_{12} + 5.9x_{15} + d_2^- - d_2^+ = 20.91$	Avoid surpassing maximum expense on all WIL projects
$9.4x_5 + 13.2x_6 + 2.9x_7 + 14.7x_8 + 24.7x_9 + 0.0x_{13} + 1.8x_{18} + 26.0x_{20} + 12.6x_{21} + 3.2x_{22} + d_3^- - d_3^+ = 95.59$	Avoid surpassing maximum expense on all internationalization projects
$0.0x_3 + 9.1x_4 + 8.8x_{14} + 2.9x_{16} + d_4^- - d_4^+ = 18.58$	Avoid surpassing maximum expense on all industrial linkage projects
$x_i + d_j^- = 1$	Select project x_i where i=1 to 23, and $j = i+4$
$4.7x_1 + 4.4x_2 + 2.9x_{10} + 4.4x_{11} + 1.5x_{12} + 5.9x_{15} + d_{28}^- - d_{28}^+ = 10.46$	Avoid surpassing or underusing expected expense on all WIL projects
$9.4x_5 + 13.2x_6 + 2.9x_7 + 14.7x_8 + 24.7x_9 + 0.0x_{13} + 1.8x_{18} + 26.0x_{20} + 12.6x_{21} + 3.2x_{22} + d_{29}^- - d_{29}^+ = 82.00$	Avoid surpassing or underusing expected expense on all internationalization projects
$0.0x_3 + 9.1x_4 + 8.8x_{14} + 2.9x_{16} + d_{30}^- - d_{30}^+ = 9.29$	Avoid surpassing or underusing expected expense on all industrial linkage projects
$x_i = 0$ or 1, *where* i=1 to 23	

deficiency of BSC was significantly improved by the MCDM methods; nevertheless, the remaining difficulty related to resource allocation is still neglected and unsolved.

Therefore, this study aims to improve the critical existing gap of BSC by integrating the decision sciences methods ANP and ZOGP. Based on the proposed model and the calculated results of this study, the developed method could suggest a more efficient investment in strategic management than the original BSC and several other improved methods. First, the proposed method, the application of BSC and ANP, could provide the priorities as well as the importance of strategic KPIs, which can be summarized as the significant elements of the BSC dimensions. Generally, the original BSC traditionally provides a strategy map representing the strategic elements and their causal relationships being tracked by an organization, but this visualized diagram still lacks the visibility of significance. This fundamental foible forces executives to follow the strategic elements under insufficient information, and to make an intuitive decision subsequently. Therefore, as presented in Figure 4, the contribution of the proposed method could ameliorate the flaw of the BSC approach as well as the strategy map. The improved BSC could illustrate the different significance of the BSC perspectives as well as the strategic KPIs; moreover, this improvement could also be adapted to improve the strategy map by visualizing the significance of both the BSC's perspectives and the indicators.

From Figure 4, it can be seen that only the eight indicators with specified importance were placed on the strategy map. The size of the loop represents the significance of the indicator. The greater the weight of the significance, the larger the dimension of the circle. The map demonstrates that the most critical KPIs in this case are I1-7, I6-1, and I1-8. These three indices, mainly focussing on the improvement of international curriculums as well as the related aspects, namely, those of lecturers and academic processes, had a significance of more than 85 percent of the total strategic KPIs' weights. The visualized map also illustrates that the strategic concentration of the institution only relies on two BSC dimensions, the internal process and the learning and

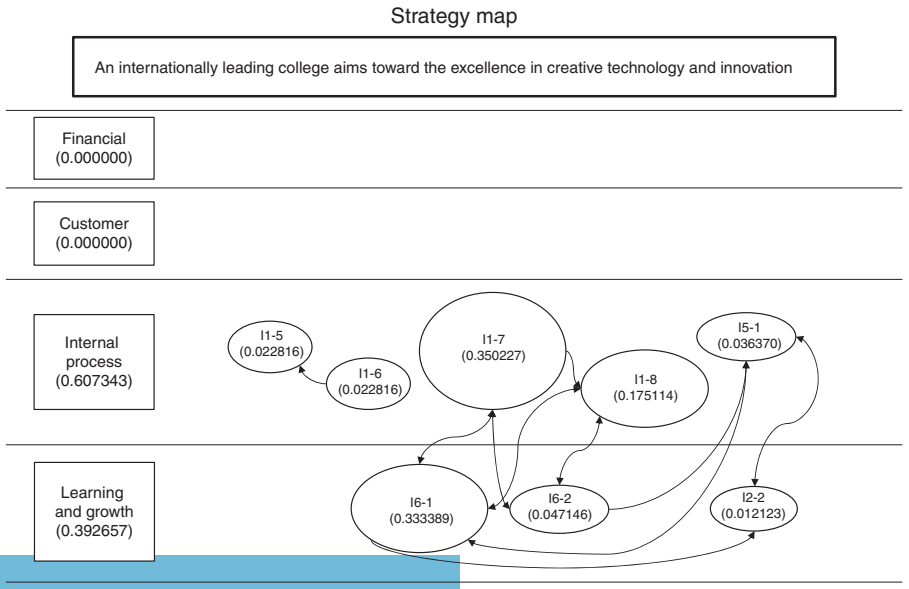

Figure 4. Improving the strategy map by identifying the weights of KPIs

growth perspective, whereas the financial and customer perspectives were excluded in the ANP calculation.

In this case, the financial perspective has been identified as not being a strategic concentration from the beginning as the academic institution receives some financial support from the government. This phenomenon generally occurs in non-profit academies as empirically found in past studies (Kettunen, 2005). On the other hand, all the indicators in the dimension of customer perspective were expunged from the strategy map during the application of ANP. The exclusion of customer focus indicators mainly stemmed from the identification of specifically narrow customers and lagging indicators of typically academic management so that when these KPIs were compared with other distinctive indices, they were less important and thereby excluded in the ANP calculation. Nevertheless, the application of non-profit organizations is quite dissimilar to the case of profit-seeking companies. In profit organizations, there could be several financial indicators and also more diverse customer indices; however, the proposed method is basically designed for coping with all of BSC's perspectives simultaneously. Therefore, generalizations of this integrative approach to profit companies are still plausible, but there would be more complications and the process would take more time. Furthermore, the obtained results, especially the priorities of BSC's perspectives as well as the emphasis on resource consumption, would be totally different.

From the mentioned results, it is evident that the integration of BSC and ANP could improve the basic weaknesses of the original BSC, especially the complexity faced by the decision maker when confronted with multiple indicators. The application could indicate the importance and priority of each KPI or even each BSC perspective, and that their significance levels were not balanced, as has been found in previous studies also (Wu *et al.*, 2009; Bentes *et al.*, 2012; Hsu *et al.*, 2011). Nevertheless, among these studies, the identified weights of the indicators and the perspectives were found to be totally different as they directly depend on the management concentration and direction of organizations. However, the diverse importance values discovered in this and other studies suggest that management should focus on high rank KPIs without the consideration of efficient resource allocation.

Therefore, in this study, another crucial contribution is a means to identify efficient strategic expenses under the limited resources of organizations by considering the calculated weights from the ANP application. As previously presented, the ZOGP was appropriately selected and applied after the weightage identification. Through the programming computation, only eleven of the 23 strategic projects were selected, and these projects could serve all the significant KPIs. Nevertheless, among these projects, there were three strategic projects that did not respond to any weighted KPIs, but when the resource usages of these projects were included with the eight critical projects, the overall expenses were still covered by the maximum provided budgets and were also close to the expected expenses. Hence, based on the ZOGP calculation, the organization could efficiently invest its limited resources better than with the traditional method, as presented in Table XI.

According to Table XI, the integration of BSC, ANP, and ZOGP could suggest lower strategic expenses and a smaller number of projects than the traditional management approach in all BSC dimensions, except for the financial perspective as there were no KPIs in this dimension. Moreover, the suggested results of the proposed method could also achieve the resource constraints of the organization by expending 101,900 USD, whereas the traditional management following the BSC approach spent 163,300 USD,

Perspective/strategic management	Traditional approach	Proposed method
Customer perspective		
Expenses ('000 USD)	45.8	9.1
No. of projects	6	1
Internal process perspective		
Expenses ('000 USD)	85.7	76.9
No. of projects	12	7
Learning and growth perspective		
Expenses ('000 USD)	31.8	15.9
No. of projects	5	3
All perspectives		
Overall expenses ('000 USD)	163.3	101.9
No. of all projects	23	11

Table XI. Comparisons of strategic management between traditional and improved methods

over the available resources of the organization at 144,100 USD. The resource allocation results indicated that the strategic management of the focussed institution should dedicate to only strategic activities related to IC management. The management concentrating only on IC is the nature of not-for-profit organizations as is generally the case in most academic institutions. Moreover, from the obtained outcomes, it is evident that the focussed institution could better realize the significance of IC as well as differences between financial and IC management via monetary units allocated to relative strategic activities.

Therefore, in this study, it was found that the hybrid of BSC and ANP could assist management in identifying the critical KPIs of strategic management, while the ZOGP, which has never been considered in the integration of BSC and ANP for optimally selecting the strategic projects of an organization, could also be applied to utilize the limited resources of an organization, as recognized in earlier ANP and ZOGP studies (Wey and Wu, 2007; Polat, 2010; Alias *et al.*, 2013). In conclusion, the new hybrid approach of integrating decision sciences methods to the BSC approach could yield a more comprehensive strategic management technique suggesting the priorities of the strategic elements and assigning resources to strategies that should be critically focussed, measured, and invested.

6. Conclusions

Today, organizational management does not rely on financial capital to the same extent that it did in the past. The financial management concentrating only on traditional indices such as ROA, NPV, IRR, etc. is indicated as not an efficient approach for competing in current business anymore. IC is now empirically identified as another critical managerial concern as it could deliver sustainable competitive advantages to the organization. Therefore, a strategic management technique that can comprehensively consider both financial and IC is critically required, and one highly recognized and applied method is BSC. BSC is a systematic tool that transforms the vision of an organization to practical strategic management. The method also concentrates on both tangible and intangible management through four major dimensions: the financial, customer, internal process, and learning and growth perspectives. Due to the several distinctive advantages of BSC, this strategic method

has been extensively adopted to commercial and academic requirements. Nevertheless, among the diverse applications, there were not only panegyrics but also criticisms. Several scholars identified the critical deficiencies of BSC, including dissimilarities between measurement units, incapacity to summarize the final quantitative result, complicated consideration of multiple strategic criteria, and, especially, the extent limitation of resource allocation consideration in strategic management. These fundamental problems lead to incomprehensive and inefficient strategic decision making by organizational executives. Nevertheless, excepting the deficiency of limited scope, the aforementioned weaknesses of BSC were resolved by the integration of MCDM methods; however, among these decision methods, there is only one appropriate method, the ANP, that capably accounts for the primary characteristic of BSC, that is, interrelationships among the strategic drivers. Therefore, due to its unique and fundamental capabilities, the ANP has been widely applied with BSC to address its deficiencies, especially the identification of priorities and weightages of BSC's perspectives, strategies, strategic objectives, and KPIs. Though most deficiencies of BSC could be improved by the integration of MCDM methods, especially ANP, the critical weakness related to resource allocation consideration has been still unsolved. At the same time, some scholars intently improved the deficiency of incomprehensive scope by encompassing organizational resources with BSC's outcomes; however, these approaches still omitted the typical constraint in real-life managerial situations which is restricted budgets and resources. Generally, enterprises administrating under limited budgets need to optimize their resource consumptions by selecting and executing only critical strategic activities. Several scholars empirically identified that assigning available resources to significant strategic projects is a critical managerial process that could bring competitive advantages to organizations. Nevertheless, because of the limitation of the scope of BSC, managements do not have a scientifically comprehensive approach for allocating available resources to critical strategic activities, so they are forced to make intuitive decisions on the concatenation of BSC's results with the limited resources of organizations. Nevertheless, the intuitive approach is still broadly identified as an unrefined, unreliable, and troubling concept, so several organizations are reluctant to apply this problematic management method.

Because of this reason, the remaining critical deficiency of BSC still requires further improvement that could enable the strategic method to include the resource allocation process relying on the decision sciences method. Therefore, to resolve the aforementioned difficulty, this research adopted the previously improved BSC, and further extended its scope by including a scientific consideration of the allocation of organizational resources. Furthermore, the intense literature reviews indicated that the integration of ANP weightages to ZOGP could convey critical strategic activities optimally utilizing the limited resources of an organization. Therefore, from the existing gap and novel improvement opportunity, this study aims to contribute a new hybrid BSC enabling the efficient allocation of the limited resources of an organization by integrating BSC, ANP, and ZOGP in order to optimize the resource usage of strategic management.

In this study, the mentioned improvement approach was developed, proposed, and then applied to a case study of the strategic management of an academic institution. Though the BSC approach was initially created for profit organizations, nowadays it is extensively applied in not-for-profit organizations also, including academic institutions, since competition in either profit or non-profit organizations has become more and more complicated and intense. Therefore, today, non-commercial organizations also

require the application of BSC similar to commercial enterprises. Moreover, non-profit firms also need proper strategic management methods that would allow them to efficiently allocate organizational resources in a strategically relevant approach because a comprehensive strategic method would be able to provide competitive advantages as well as a practical strategic management approach related to real-life managerial situations. Although the original BSC and the improved BSC have been widely studied in both profit and not-for-profit organizations, the application of a hybrid form of BSC and ANP has been rarely studied in the higher education domain. Moreover, critically, the outcomes of the improved BSC have never been continually applied to expansively and scientifically consider the optimal resource allocation of strategic management in any research area. Therefore, the main contribution of this study is the innovative improvement of BSC's critical deficiency that has not been resolved before.

In this study, the improvement approach was developed, proposed, and then applied to the case study of the strategic management of an academic institution to suggest an efficient resource allocation. Similar to most organizations, the focussed academy is managed under limited resources; moreover, its revenue is being dramatically declined even though it is a non-profit organization and mostly supported by the government. Therefore, in order to optimally utilize its available resources and to enhance its competitive advantages, the institution required a proper strategic method which comprehensively and scientifically considers the strategic investment and management, beyond the existing BSC forms; hence the proposed approach was applied to this case study.

The study was initially executed by following the systematic processes of original BSC. First, because the institution had already established strategic management including vision, missions, relative strategic objectives, and KPIs, the identified strategic KPIs were classified into the relative BSC perspectives. In this case, the college specified 23 key strategic indicators, but they were classified into only three major categories, including the customer, internal process, and learning and growth perspectives. All of the categorized indices were formulated to sequentially specify the relationships between each other by the top management of the organization via the questionnaire. Thereafter, the classified KPIs as well as their relationships were applied to construct both the strategy map and the KPI relationship matrix of the organization, which would be able to represent the network model of the study and could readily be applied for performing the ANP application. Nevertheless, before executing the ANP calculation, another questionnaire concentrating on the exploration of the influencing degree between the KPIs was created and sent to the authorized person once again. The survey form included three and eight major questions of pairwise comparisons for the BSC dimension level and the KPI level, respectively. The data were extracted from the completed questionnaire, which were subsequently inputted to the Super Decision software to verify the consistency of the data before performing the ANP calculation. Nevertheless, in this study, the first compared results were inconsistent. Following this, the most unreliable answers were described to the respondent and then reconsidered, and this time, the obtained results passed the consistency check. The adjusted and verified data were then used to calculate the priorities and also the weighted KPIs by the Super Decision software again. The obtained results indicate that only eight of the 23 KPIs were critical because of the weight identification. In this part, the integration of BSC and ANP provided the ranks and importance of KPIs for management, which is similar to several previous studies. Nevertheless, this study

newly adopted the obtained weightages of the strategic elements to further enhance the visibility of information to a strategy map, so the improved diagram could illustrate the significance of both BSC's perspectives and indicators. However, the improved BSC and the new strategy map still only provided the ranks and importance for the management decisions, which is barely different from the achievement of several previous studies. These computed results could support executives to make decisions in the resource allocation process, but the executives still had to rely mainly on the managements' intuitions and their diverse experiences. Therefore, to further improve the identification of the resource management approach, the decision sciences method, ZOGP, was integrated to the improved BSC in the main second part. In this section, the complicated GP model was initially created and then calculated by inclusively considering the computed weightages of the KPIs, constraints, and resource data of the organization. Through scientific calculation, only 11 of the 23 projects responding to KPIs and organizational strategies were selected; moreover, the suggested results could also propose less strategic expense than the traditional management approach. Therefore, this extended approach would contribute a new systematic method that eliminates the existing critical deficiency of BSC. The novel integration of BSC, ANP, and ZOGP provides expansive strategic management through a resource allocation activity that is more comprehensive than the original BSC and the previously improved BSC. Because of this improvement, management teams will not be forced to depend solely on their own intuitive decisions anymore. This new hybrid approach could innovatively transform the traditional way of all previous BSC forms. In conclusion, the proposed method was able to suggest efficient utilization of limited resources for sustainable strategic management by focussing on both financial and IC management.

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