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A method for building a robust strategy map using mathematical programming considering different scenarios

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ABSTRACT

Strategy maps have drawn serious attention from companies in recent years due to their effective performance in organizations' success. Different approaches have been taken to build these maps in the related literature. A strategy map is focused on the cause-and-effect relationship between lag and lead objectives. On the other hand, most methods used for this purpose work based on past performance and do not pay attention to the future. In this paper, a method is presented to build a scenario-based strategy map, trying to consider all the future conditions and choose the most stable strategic objectives (goals) based on the outcome of all situations and analyse the relationships between them. The purpose of this work is to present a hybrid and at the same time practical and simple method of developing the company's strategy map in such a way that includes strategic objectives and their relationships so that they are common in all possible future scenarios. This method considers different scenarios and strategic objectives concerning experts' points of view about the relationship importance between strategic objectives. In the proposed method, by using the paired comparisons technique and linear programming, in the first phase, the optimal strategy map is built for each scenario, and in the second phase using a heuristic method and expert judgments, the final strategy map is built, which is the result of all the maps of the first phase. The presented method tries to consider all future scenarios and builds a map that will be more valid in the future; it is called a robust strategy map. This method was used by the strategic planning department in a real case and the final strategy map built by the proposed method was outstanding and reliable so that it is simply constructed and understandable for all stakeholders. Furthermore, it explains the strategy of the organization well.

Keywords: *Strategy Map; Scenario Planning; Mathematical Programming Model; Balanced Scorecard*

INTRODUCTION

In today's world, many organizations and businesses are focusing on issues such as strategic decision-making and planning to address complex environmental issues[1]. Successful companies have realized the need to focus on strategic management, but sometimes strategic management only focuses on a specific part, which does not allow the strategic or operational plan to be achieved or fail in practice. One of the reasons for this failure is the lack of a comprehensive view of the pre-operational stages of strategic plans. The strategy map as a main component of the balanced scorecard (BSC) is a suitable tool for this challenge, which defines the strategic objectives of different dimensions of the company and by communicating them, identifies the paths for the company to succeed in implementing strategies[2].

The strategy map is a comprehensive tool for the correct attitude and the exact direction of the organization's progress toward its vision. If the organization can properly design and implement a strategy map, the implementation of the strategies will be significantly improved. The main objectives of a strategy map are to facilitate the transfer of strategy to operational conditions and to understand what each person's duty is to the overall goals of the organization [3]. If a strategy map is created through a collaborative process, the unity and commitment to implementing the

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strategy can increase. Through strategy maps, one can imagine how different parts of the organization directly or indirectly contribute to the overall performance of the organization. If a balanced scorecard framework is taken into account in a strategy map to describe the strategy's logic, it enables the organization to succeed both from the perspective of its customers and stakeholders. In addition, strategic objectives from four balanced scorecard perspectives are linked together in a chain of cause-and-effect relationships [4]. Most methods for building a strategy map focus on the current situation of the business and do not attention to the upcoming uncertain event in the future. A strategy map without considering the uncertainty of the world is of no credit, especially in the current unstable situation. In this paper, a method is presented to build a strategy map that points to this gap and considers different situations based on scenario planning. Hence, the proposed method in this paper tends to consider different situations in the future. Therefore, in the beginning, a preliminary strategy map is prepared for each scenario. For this purpose, the pairwise comparisons technique is applied and its results are used as input parameters of linear programming. In fact, in the first phase, the strategy map of each scenario is built, including strategic objectives and important cause-and-effect relationships. In the initial map of each scenario, assumed that each low-level goal has a relationship with all its high-level goals in the balanced scorecard. Then, in the second phase, based on the heuristic method and the judgment of experts, the final strategy map of each scenario is made. The contribution of the proposed method is the ability to consider the relationship between the low-level goals of the balanced scorecard aspects (growth and learning aspect) on the high-level goals of the balanced scorecard (financial aspect), without considering predecessor and successor strictly constraint between aspects. It has also tried to use the advantages of exact and heuristic methods to present a strategy map that is valid in possible futures.

The 2nd section consists of related work to strategy maps by researchers. The proposed method is represented in section three. In the 4th one, this method is applied to a real case study. Finally, the conclusion is presented in section five.

LITERATURE REVIEW

Despite that design and use of strategy maps have advantages, some researchers have also expressed their weaknesses. For example, they argue causal relationships of BSC show a one-way linear approach often with a learning and growth aspect, and they move toward financial results while they should also show non-linear and two-way links[5] [6, 7]. From a statistical point of view, testing the relationship between elements of a strategy map can increase its quality. Ittner and Larcker show that less than 30 percent of the companies surveyed create causal models for testing relationships[8]. However, the idea of calculating cause-and-effect relationships may be misleading, because the performance index or data of strategic objectives may lead to a positive or negative correlation without necessarily causation. Norreklit [9] points out that strategy maps do not distinguish between logical and causal links. Even if it only focuses on statistical analysis, there is not enough historical data to determine a reliable coefficient. Typically, in many organizations, there is a difference in the frequency of accumulated amounts and the range in which values vary over a period.

Although statistical relationships are related to strategy maps, experience has shown that the design of strategy maps is rarely scientific. Often, strategy maps are the result of a collective view of managers identifying business goals and how to achieve them. This mapping approach is not necessarily a mistake. However, a statistical strategy map may be seen as a black box that does not provide an understanding of strong causative relationships. If managers were not part of the mapping process, they could get away from the use and outcome of their strategy maps, especially if their reasons were not in their favor. Ownership is needed but building a strategy map must be done in a collaborative process. There is significant attention that the dependence on the causal model shown in the strategy map may not be enough to reflect the evolution of the strategy over time [10]. Relying on a long-term statistical strategy map is equivalent to assuming that the organization and strategy will remain the same, and competitors will continue to behave in the same way. In addition, if strategy maps are supposed to be able to predict, then it would be possible to question the validity of the analysis of past data to predict future situations. Indeed, the validity of a strategy map based on past data may invalidate it. This means that although the development of a strategy map can help the organization to implement its strategy, it cannot enable the organization to face changes that can affect its strategy and ultimately its performance. Linking the design of strategy maps to future scenarios can help reduce this risk, as maps can be linked to the future, rather than simply displaying the current state of affairs. Using a method to imagine a possible future, such as scenario analysis, could solve these concerns and improve current communication and predictability of strategy maps[11]. The scenario is defined as a vision of what might happen in the future. It is not a prediction, but one of the possible future outcomes. Scenario analysis is a tool to regulate its understanding of future alternatives[12]. Similarly, scenario analysis does not mean exact terms about the future. Instead, it helps managers to not consider future performance as a single plan, but as a set of options that they can choose and work to accomplish. In other words, scenarios can prepare an organization for what might happen in the future. Scenario analysis is a qualitative and orderly method to illustrate possible future situations [13]. Scenario planning is used to imagine the world's future prestigious positions and to consider how to take advantage of opportunities and prevent potential threats [14]. The scenario analysis seeks to resolve two common concerns in decision-making, excessive change prediction, and inadequate changes. To do this, participants in the development of scenarios are encouraged to distinguish between factors that are believed to be aware of it and elements that are unknown to them and indistinguishable from them. Scenario analysis is a different way of looking at the future for two main reasons. First of all, for organizations, creative thinking about the future is necessary to avoid unforeseen risks and the lack of readiness. Second, since the future is inherently uncertain, organizations must be prepared for possible future situations, not just those that are expected to occur[15].

Two or three scenarios are usually created. The first scenario can be an understanding of the current situation. The second scenario may describe a bright future, which can be due to good organization to deal with the disorder. The third scenario can describe a sadder view, for example, confronting a disorder that the organization is not prepared to deal with[12]. Generally, it can be argued that organizations can use scenario analysis with an official approach to designing strategy maps. Strategy maps are tools for anticipating because they seek to show how decisions can now affect future outcomes. Scenario analysis can extend the effectiveness of strategy maps. The common use of the two methods can be an important step in coping with multiple non-compliant versions of the truth, all of which identify the status of management information in many organizations[1]. Using scenario analysis in building strategy maps can add an uncertain perspective that a standard strategy map design has not considered it. Both scenario analysis and strategy map force executives to identify both the number of opportunities that may occur in the future and the key goals of the organization. When scenarios are built, the main task of managers is to design a strategy that is stable under the conditions specified in the assumed scenario [10]. The combination of strategy maps and scenario analysis has several advantages as follows[4]:

- Strategy maps and scenarios are effective tools for communicating the current and future strategy of an organization.
- Both tools are based on a comprehensive view of the organization and its environment, and how it is interlinked between key activities and processes.
- The internal focus of strategy maps by analysis of the scenario on environmental factors is considerable.
- Both tools require the participation of several interest groups. This can increase the credibility and firmness of the organization's strategy.
- Ultimately, probabilities, uncertainties, trends, and opportunities that are rarely anticipated can be identified, evaluated, and entered into strategy maps through scenario analysis.

Buytendijk, et al. [11] presented a new approach to designing a scenario-based strategy map. In the following, four steps proposed by them to create a scenario-based strategy map are represented. It is assumed that the organization currently has a strategy map.

1. Consider the strategy map and identify strategic objectives that describe the assumptions of the business model.

2. Create multiple scenarios, for example, using the analysis of political, economic, social, technological, environmental, and legal elements. Identify the new success factors or important changes in each of these scenarios.
3. Create a strategy map for each of these scenarios.
4. Integrate goals across multiple scenarios.

Rezaee, et al. [16] presented an intelligent strategy map to evaluate improvement projects in the auto industry using the fuzzy cognitive map and slack-based efficiency model. Verna, et al. [17] worked on quality inspections in manufacturing processes and proposed a general framework for inspection planning by defect prediction models and inspection strategy maps. Jahromi (2021)[18] proposed a novel multi-objective mathematical model for selecting strategic objectives from identified potential strategic objectives and selecting the important relationships between them. This paper presented a goal programming approach to model-building strategy maps and contained three goals: goals related to the relative importance of strategic objectives (G1), number of casual relationships (G2), and relative importance of relationships (G3). The more the goal is among the more scenarios, the more important and the probability that the goals will be achieved in a changing environment is higher. To work on this collaborative analysis, strategic objectives must be clear. This means that high-level dominant goals such as maintaining profitability do not provide practical guidance.

Currently, some approaches provide a strategy map combining the analytical hierarchy process(AHP), analytical network process(ANP), decision-making trial and evaluation laboratory (DEMATEL), Balanced Score Cards (BSC), and so on with a mathematical optimization model[19] [20],[21],[22, 23]. Moraga et al. presented a method to build a strategy map focused on identifying causal relationships. They present a methodology to improve the identification of causal relationships of an existing strategy map of a company, using a multi-decision criteria method [24]. In another study, a fuzzy cognitive map for the Sustainable Development Goals was constructed so that the Causal-effect links among them were identified and mapped[25]. Taghizadeh, Torabi, and Rajabzadeh [26] developed a decision-making model investigating the outsourcing of complex product systems using SEM and ISM methods. Al-Mawali[27] integrated the sustainability balanced scorecard (SBSC) framework with DEMATEL for proposing a model and identifying the cause-and-effect relationships between the five perspectives of SBSC and then 23 performance indicators within the SBSC framework in a strategy map. Goodspeed et al.[28] urged that Data-driven scenario planning can be effective in resource-limited contexts. Mohammadi[29] showed that strategic foresight is effective in creating dynamic capabilities. In the proposed method in this paper, a strategy map is assumed with some determined strategic objectives and all potential relationships between them. The strategy map is proposed with the least possible causal relationships while maintaining relationships among the most important goals considering different scenarios. Notably, the robustness of the presented strategy map in this paper is dependent on its adaptability and validity in different futures.

THE PROPOSED APPROACH

As mentioned earlier, in this paper, a hybrid-scenario-based method is presented that uses mathematical programming and pairwise comparisons based on the AHP technique for building a strategy map. While considering different scenarios in the future named robust strategy map, it has the most common features in future scenarios. The proposed method has two phases containing four steps. In the first phase, the optimal strategy map of each scenario is built as a preliminary strategy map. The second phase produces a conclusive strategy map based on the final strategy maps derived from the first one. According to different scenarios and corresponding to each one, in the first step, a preliminary strategy map is designed. In the second step, experts determine the relative importance of goals and the relationships between them. Employing a linear mathematical programming model, in the third step, the final map is determined for each scenario. The linear mathematical programming model is used to maximize the relative importance between selected goals and minimize the number of relationships. In the fourth step, the conclusive strategy map (i.e., robust strategy map) is developed. It incorporates all the common strategic objectives and semi-common goals. Based on the output of the mathematical model and taking into account the opinions of the experts, the final strategy map is provided in the proposed method. While maintaining simplicity and considering different scenarios, the outcome of the precise design of this method comprises a combination of mathematical linear programming with decision-making based on pairwise comparisons.

Linear mathematical programming approaches used in this model pursue the following objectives:

- Maximizing relative importance between goals.
- Minimizing the number of relationships between goals.

In addition, the following assumptions are considered:

- There is more than one initial strategy map. The number of these maps equals the number of determined scenarios and different scenarios with the same strategy map are considered as a single scenario.
- In each strategy map, the importance of relationships is determined by the experts and the model does not play a role.
- The existence of causal relationships between goals at one level and all higher levels is possible.
- The effect of goals is from lower (growth and learning aspects) to higher levels (financial aspects), and at each specific level, it is possible to consider the two-way relationship between goals.

One of the advantages of this method compared with other related research is that based on the BSC logic about lag and led nature between goals, the relation between goals is not limited to two consecutive levels. The relationship between goals at all levels, including a specific level with itself, is considered.

As mentioned earlier, the proposed hybrid method that included mathematical programming and experts' viewpoints has four steps described below. The symbols used in the mathematical programming of the model are shown in Table 1.

Table 1. The symbols and notations used in the mathematical model

Notations	
I	Collection of nodes (goals) in a strategy map.
J_n	Nodes at *n*th level, $n = 1, \dots, 4$.
$l_{ij}^{n,m}$	The importance between nodes $i \in J_n$ *and* $j \in J_m$ so that $m \geq n$ according to Saaty paired comparison.
f_i^n	Importance of node $i \in J_n$ at its level.
$k_{ij}^{n,m}$	Relative importance between $j \in J_m$ node $i \in J_n$ at the *n*th level so that $m \geq n$.
C	The total relationships between all goals.
θ	The weight of the goals as a control parameter
Decision variables	
$R_{ij}^{n,m}$	Equal to 1 if there is a relation between $i \in J_n$ and $j \in J_m$, otherwise, it is zero, as an independent variable.
t_n^+	The number of relationships between the goals of the *n*th level and the levels of $m \geq n$, as a dependent variable.
t_n^-	The difference between 1 and the sum of the relative importance of the selected relationships between the goals of level *n* and level, $m \geq n$, as a dependent variable.

FIRST STEP

First, preliminary strategy maps are prepared based on different scenarios. This map includes goals and causal relationships that by default all goals are related to all levels from lower to higher considering the principle of BSC so that there are led and lag relations between goals from the learning and growth aspect to goals of the financial aspect. It is noteworthy that the goals appear not necessarily the same in different scenarios.

SECOND STEP

In this step, the importance of the relationship between goals is determined by the experts and described in the following procedure. To obtain the importance of relationships, the paired comparison method is used [30]. Based on the Analytical Hierarchy Process (AHP) logic, presented by Saaty, the summation of goals' importance in each aspect (Eq. 1) and the importance of goals in each higher aspect (m≥n) of BSC is equal to one (Eq. 2).

$$\sum_{i\in J_n} f_i^n = 1, \quad \forall n \tag{1}$$

$$\sum_{j\in J_{m,m\geq n}} l_{ij}^{n,m} = 1, \quad \forall n, i \in J_n \tag{2}$$

In this case, the relative importance between the node $i \in J_n$ at the nth level and node $j \in J_m$ which is $m \geq n$, is shown with $k_{ij}^{n,m}$ as Eq. 3. Moreover, the summation of the relative importance of relationships of each aspect is equal to one according to Eq. 4.

$$k_{ij}^{n,m} = l_{ij}^{n,m} \times f_i^n, \qquad \forall n, i \in J_n, j \in J_{m,m\geq n} \tag{3}$$

$$\sum_{i\in J_n} \sum_{j\in J_{m,m\geq n}} k_{ij}^{n,m} = \sum_{i\in J_n} \sum_{j\in J_{m,m\geq n}} l_{ij}^{n,m} f_i^n = \sum_{i\in J_n} f_i^n \sum_{j\in J_{m,m\geq n}} l_{ij}^{n,m} = 1, \quad \forall n \tag{4}$$

THIRD STEP

In this step, a linear programming model is presented to minimize the number of relationships and maximize the relative importance between goals in the strategy map for each scenario. It is worth noting this model resembles the model presented by Quezada and López-Ospina[6]. However, there is a possibility of a relationship between the goals of non-successive aspects of BSC. The binary linear programming model is as follows.

$$min\, z = \theta \times \frac{\sum_n t_n^+}{C} + (1-\theta) \times \sum_n t_n^- \tag{5}$$

Subject to:

$$t_n^+ = \sum_{i\in J_n} \sum_{j\in J_{m\geq n}} R_{ij}^{n,m}, \quad \forall n \tag{6}$$

$$t_n^- = 1 - \sum_{i\in J_n} \sum_{j\in J_{m\geq n}} k_{ij}^{n,m} R_{ij}^{n,m}, \quad \forall n \tag{7}$$

$$\sum_{i\in J_n} \sum_{j\in J_{m\geq n}} R_{ij}^{n,m} \geq 1, \tag{8}$$

$$R_{ij}^{n,m} \in \{0,\ 1\}$$

Equation (5) represents minimizing the number of relationships and maximizing relative importance of them, simultaneously. The number of relationships between $i \in J_n$ and $j \in J_m$ in the final map is calculated by equation (6) and the value corresponding to relative importance is calculated by equation (7).The maximum value of $\sum_{i\in J_n} \sum_{j\in J_{m\geq n}} k_{ij}^{n,m} R_{ij}^{n,m}$ is equal to one if all goals and relationships be selected and maximizing it is equal to minimizing t_n^-. Obviously, t_n^- have a value between zero and one, but this is not true for t_n^+. The maximum value of t_n^+ is equal to the number of relationships between the goals of levels n and m ($m \geq n$). Thus, $\sum_n t_n^+ / C$ is a scale between zero and one and can be summed up with t_n^-. Equation (8) states that each node must have a relationship at least by one of the goals at its higher level, except for end-level nodes (i.e., n=4) according to BSC. It is noticeable that the mathematical programming model unlike previous ones considers the possibility of a relationship between a goal at the higher level with the goals at the lower level.

FOURTH STEP

The final strategy map includes fully common goals and semi-common goals. So that fully common goals existed in all scenarios and semi-common goals existed at least in fifty percent of scenarios. Ultimately, goals that existed in one scenario are not considered in the final strategy map. The relationship between the two goals in the final map follows the following logic:

A. If two goals, at least in one of the early maps, are related, they will also be related to the final map.

B. If two goals do not have casual relations on the same map, the declaration of the relationship between them requires the decision of the experts.

SIMULATION, DISCUSSION, AND NUMERICAL RESULTS

In this section, the effectiveness of the proposed method is examined by applying it to a real case. This real case study is solved by the GAMS program on a computer with a 2.10GHz CPU and 4.00 GB RAM. Considering three scenarios, here, a strategy map is developed for each scenario aimed at building a final strategy map. These scenarios belong to a company kept unknown due to some confidential considerations. This information has been received from the strategic planning department of the company. Eighteen strategic objectives are considered by the company's experts (see Table 2). The first and second scenarios are related to optimistic and pessimistic situations, respectively and the third scenario points to the current situation (i.e., most likely). In Figures 1-3, the initial strategy maps for these three scenarios are respectively depicted.

Table 2. Strategic objectives

BSC levels	Strategic Objective (Goal)
Financial	Improving financial sustainability (O1)
	Increasing return on capital(O2)
	Increasing in profit(O3)
	Increasing financial efficiency (O4)
Customer	Reduction in costs(O5)
	Improving pricing(O6)
	Customer loyalty(O7)
	Value proposition(O8)
	Customer satisfaction(O9)
Internal processes	After sales services(O10)
	Increasing capacity(O11)
	Improving supply chain(O12)
	Improving production process(O13)
Learning and growth	Improving Logistic(O14)
	Improving Safety(O15)
	Job Satisfaction (O16)
	Job Development(O17)
	Job Rotation(O18)

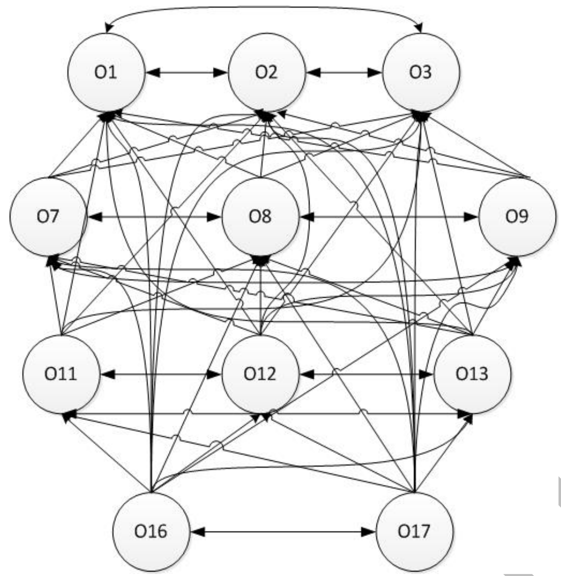

Figure 1. First scenario's strategy map

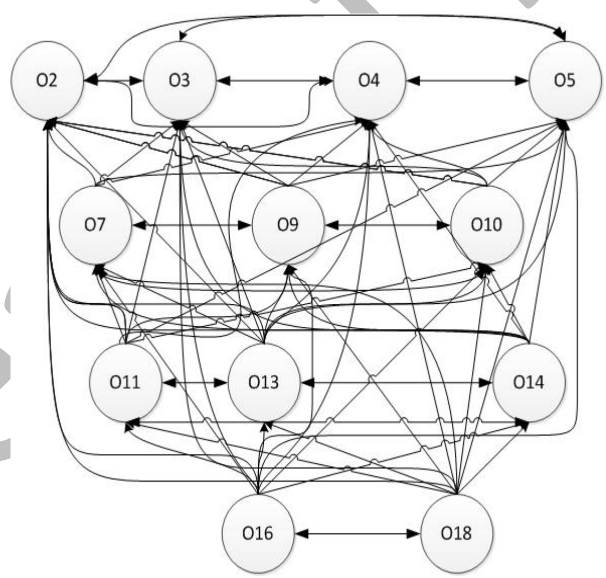

Figure 2. Second scenario's strategy map

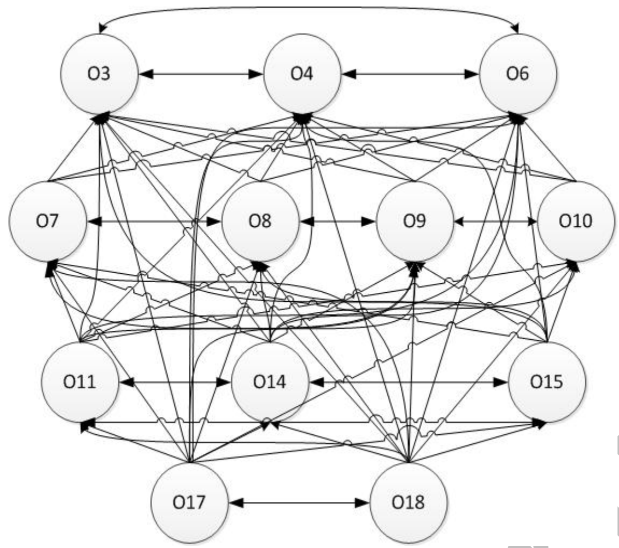

Figure 3. Third scenario's strategy map

The mathematical optimization introduced in the previous section is applied to this case. In this example, the control value is set to fifty percent (i.e., □ = 0.5). The details of choosing goals for the final strategy map incorporating fully common goals and semi-common ones are presented in Table 3 based on the expert's view. Common goals exist in all scenarios and semi-common ones must be mutually found in two scenarios. In Table 3, all strategic objectives and their status in each scenario (i.e., existed or not existed) in addition to assessing and decisions about them (i.e., reject, strategic choice, or common objectives) are mentioned. In Figures 4-6, the final strategy maps for the first, second, and third scenarios are respectively shown.

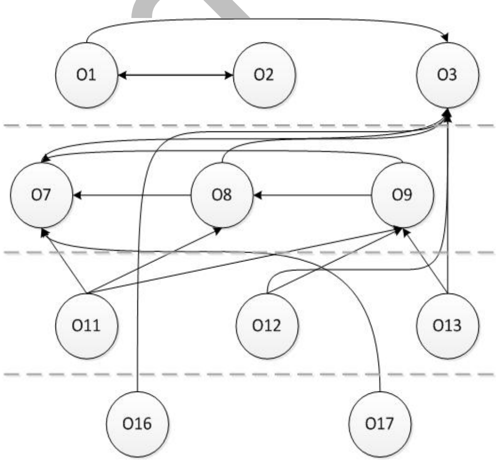

Figure 4. The final strategy map for the first scenario

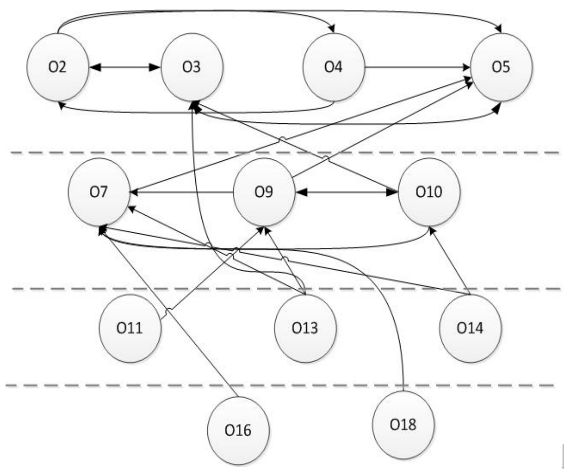

Figure 5. The final strategy map for the second scenario

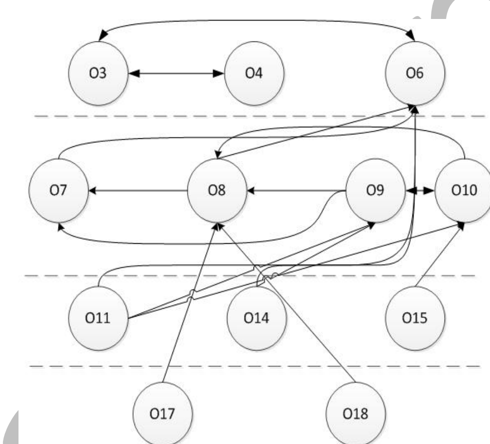

Figure 6. The final strategy map for the third scenario

Table 3. Decision-making results for strategic objectives

Levels	Strategic objectives	First scenario	Second Scenario	Third Scenario	Assess and decision
Financial	Improving financial sustainability (O1)	✓	✗	✗	Reject
	Increasing return on capital(O2)	✓	✓	✗	strategic choice
	Increasing in profit(O3)	✓	✓	✓	common goals
	Increasing financial efficiency(O4)	✗	✓	✓	strategic choice
	reduction in costs(O5)	✗	✓	✗	Reject
	Improving pricing(O6)	✗	✗	✓	Reject
Customer	Customer loyalty(O7)	✓	✓	✓	common goals
	Value proposition(O8)	✓	✗	✓	strategic choice
	Customer satisfaction(O9)	✓	✓	✓	common goals
	After sales services(O10)	✗	✓	✓	strategic choice
Internal processes	Increasing capacity(O11)	✓	✓	✓	common goals
	Improving supply chain(O12)	✓	✗	✗	Reject
	Improving production process(O13)	✓	✓	✗	strategic choice
	Improving Logistic(O14)	✗	✓	✓	strategic choice
	Improving Safety(O15)	✗	✗	✓	Reject
Learning and growth	Job Satisfaction (O16)	✓	✓	✗	strategic choice
	Job Development(O17)	✓	✗	✓	strategic choice
	Job Rotation(O18)	✗	✓	✓	strategic choice

In Figure 7, the final strategy map is shown based on three scenarios including fully common goals and semi-common ones. This robust map is based on three scenarios and is expected to be more reliable. Furthermore, relationships between them are based on their existence in the final strategy map in each scenario. If there is a relation between two objectives in the final strategy map of each scenario, this relation will exist in the final strategy map. As it turns out, this strategy map is based on different scenarios and is therefore expected to be more reliable under different situations. In the final strategy map of the mentioned company, there are thirteen strategic objectives out of eighteen identified primary strategic objectives based on the proposed method (Fig 7).

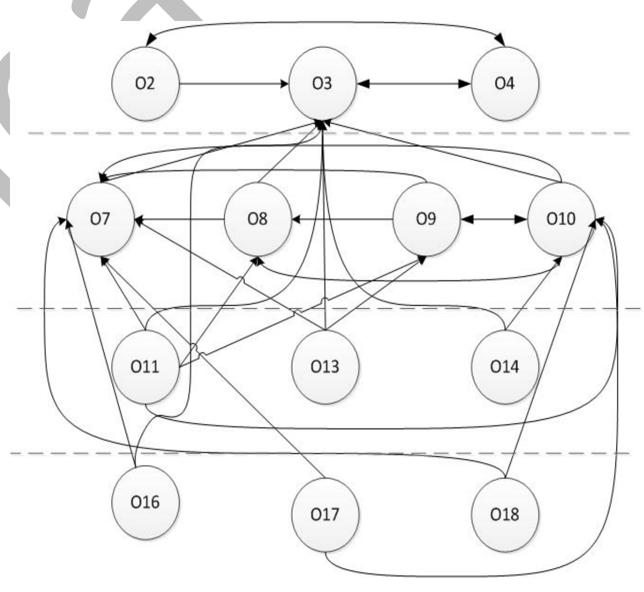

Figure 7. Final strategy map based on three scenarios

CONCLUSION

One of the purposes of making a strategy map is to solve the problem of most organizations in transferring and translating the strategy into daily work for their internal stakeholders. On the other hand, and in turn, making a suitable map is one of the challenges of organizations. This paper aims at providing a simple yet practical and logical method for making a strategy map. Thus, exact and heuristic methods and expert judgment have been used in a combined, realistic, and comprehensive manner. Due to the unstable environmental conditions in which organizations operate and compete, this method estimates various future scenarios. First, it builds the strategy map of each scenario optimally, and second, tries to create a conclusive strategy map for a company using the heuristic method and experts' judgment. This approach is the common point of all identified scenarios.

This paper focuses on developing a method that emphasizes maintaining strong relationships while keeping the final strategy map simple. As a consequence, maximizing the relative importance between goals and minimizing the number of relationships among them are included in the objective function of mathematical programming in the first phase. Among the advantages of this paper, is using a simple heuristic method in the second phase of this method. In other words. a combination of exact and heuristic methods has been used to solve one of the challenging problems of companies. In summary, the contribution of the present paper is to develop a method with the following advantages:

- It is an interactive method.
- It contains a combination of exact and heuristic methods.
- It can be easily implemented.
- There is no constraint in determining cause-and-effect relationships between goals at different aspects.
- It is possible to consider different scenarios and there is no limit in determining future scenarios.
- The conclusive map is presented based on considering the commonality of all possible future states.
- The conclusive strategy map is simple, concise, and useful.

To mention managerial implication, the presented method was implemented in a commercial company with the cooperation of all stakeholders. The resulting strategy map has met desired demands, according to the acknowledgment of all stakeholders. Further research can be done by utilizing heuristic alternative methods, or the optimization techniques such as GOT, ALO, EHO, etc. instead of the mathematical model.

NOMENCLATURE

$\boldsymbol{I}$	Collection of nodes (goals) in a strategy map.
J_n	Nodes at *n*th level, $\boldsymbol{n = 1}$, … , $\boldsymbol{4}$.
$l_{ij}^{n,m}$	The importance between nodes $\boldsymbol{i \in J_n}$ ***and*** $\boldsymbol{j \in J_m}$ **so that** $\boldsymbol{m \geq n}$ according to Saaty paired comparison.
f_i^n	Importance of node $\boldsymbol{i \in J_n}$ at its level.
$k_{ij}^{n,m}$	Relative importance between $\boldsymbol{j \in J_m}$ node $\boldsymbol{i \in J_n}$ at the *n*th level so that $\boldsymbol{m \geq n}$.
C	The total relationships between all goals.
θ	The weight of the goals as a control parameter
$R_{ij}^{n.m}$	Equal to 1 if there is a relation between $\boldsymbol{i \in J_n}$ and $\boldsymbol{j \in J_m}$, otherwise, it is zero, as an independent variable.
t_n^+	The number of relationships between the goals of the *n*th level and the levels of $\boldsymbol{m \geq n}$, as a dependent variable.
t_n^-	The difference between 1 and the sum of the relative importance of the selected relationships between the goals of level *n* and level, $\boldsymbol{m \geq n}$, as a dependent variable.
Subscripts	
n & m	Level
I & J	Node
Acronym	
BSC	Balanced Scorecard

AHP	Analytical Hierarchy Process
ANP	Analytical Network Process
DEMATEL	Decision-making Trial and Evaluation Laboratory
SBSC	Sustainability balanced scorecard
GAMS	General algebraic modeling system
CPU	Central processing unit
RAM	Random-access memory
GOT	GLOBAL OPTIMAL TECHNOLOGY
ALO	Ant Lion Optimizer
ELO	Elephant Herding Optimization

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