Kybernetes

Proposing a basic methodology for developing balanced scorecard by system dynamics approach

Seyed Behnam Khakbaz Nastaran Hajiheydari

Proposing a basic methodology for developing balanced scorecard by system dynamics approach

Seyed Behnam Khakbaz and Nastaran Hajiheydari
Faculty of Management, University of Tehran, Tehran, Iran

Abstract

Purpose – Successful future has inspired organizations to measure long-term and non-financial measurements and key performance indicators (KPIs). Kaplan and Norton proposed balanced scorecard (BSC) for this issue and have extended it to one of the most preferred strategic management system's tools. However, available planning tools like BSC have some limitations, like dependency to the developer, weakness in showing time delays, and also mathematical relationships between lead and lag indicators. In this paper, the authors would present a new methodology for developing BSCs, which would be able to overcome these limitations. Therefore, the purpose of this paper is to develop an integrated framework for developing BSC with system dynamics approach (a dynamic BSC (DBSC)) which has lower limitation in compare with traditional BSC. The other purpose of this paper is developing a DBSC for an Iranian public transportation company.

Design/methodology/approach – Based on this purpose, related literature was thoroughly reviewed and the proposed methodology designed using the system dynamics and BSC concepts. This methodology is a composition of original BSC development methodology and system dynamics principles. An assumed organization has been used for showing methodology's capability and procedure. Furthermore, a case study has been accomplished in this paper. This case study is a DBSC which has been developed for an Iranian public transportation company. The purpose of this case study is to ensure about proposed methodology implication in action.

Findings – The authors proposed a methodology which can be applied for developing BSCs. This methodology consists of six different steps which are: developing a system for organization, selecting stakeholders' most important objectives and target, identifying organization's objectives and their KPIs for different BSC aspects, developing strategy map, targeting, and selecting initiatives. In the proceeding of this paper, the proposed methodology and its steps would be explained in detail.

Originality/value – The system dynamic approach has precedents in business studies; however, this research makes this approach operational in BSC designing and analysis. BSCs, which developed by this methodology can show time delays between an organization's objectives, its KPIs' relationship and also planning for it. Selecting achievable and rational vision and objectives' targets, change management, scenario planning and policy analysis are other values which can be achieved by DBSC deployment which need further researches. In summary, this research has shown an integrated framework for developing DBSC and then applies it to an Iranian public transportation company. Therefore, another contribution of this paper is the application of this method for an Iranian public transportation company.

Keywords Balanced scorecard, System dynamics, BSC developing methodology, Developing BSC, Dynamic balanced scorecard

Paper type Research paper

Introduction

In the competitive economy of the day, companies have to achieve their financial targets; moreover, they must have loyal customers, introduce new innovative products, improve employee skills, and also invest on their infrastructures. Financial measures may only tell a fraction of a company's behavior. Therefore, the financial accounting tools must be expanded to incorporate the company's intangible and intellectual assets that satisfy customers and employees (Kaplan and Atkinson, 1998). Kaplan and Norton (1992)

Kybernetes
Vol. 44 No. 6/7, 2015
pp. 1049-1066

0368-492X
DOI 10.1108/K-12-2014-0287

proposed a tool for managing organizations and assessing their performance; which is named balanced scorecard (BSC). They developed BSC and transformed it to a strategic management system (the BSC literature would be described later in this paper). However, BSC has some limitations. BSC is completely dependent on the developer and different BSC developers create different BSCs for the same organization. Moreover, mathematical, non-linear relationships, and also the time delays between the objectives and key performance indicators (KPIs) are still unknown. Furthermore, targeting for objectives and initiatives settings are so primitive and essential. By employing systems thinking, entrepreneurs can establish accountability mechanisms, ensure equity for all stakeholders, and facilitate system sustainability (Dzombak *et al.*, 2013). Therefore, we have applied system dynamics for developing BSC to overcome these limitations and gained respectable results. Generally, BSCs and their complementary tool, strategy maps, have some limitations which described in the proceeds of this section.

Hudson *et al.* (2001) have pointed out BSC has not a mechanism for defining relevance measures, and as a result relevance objectives. This would results in different BSC for a company with a special vision, which have comprised of developer. Applying system dynamics for developing BSC and designing a standard mechanism would be concluded in a unique BSC for a unique company with a unique vision.

One of the most significant issues for a BSC is its developer. Some of organization's influence on its environment and feedback of environment to organization is not considered by developers. These feedbacks reduced managers' authority and they must be considered (Grant, 2013). Therefore, selecting borders of analysis for developing BSC is a debating issue for its developer. Borders of analysis for developing BSC depend on developers, most of whom consider internal factors. Neely *et al.* (2002) have criticized BSC for not considering important interest groups, such as suppliers. Furthermore, Mooraj *et al.* (1999) have argued that BSC does not consider the company's extended value chain. For developing a system, limitations must be considered. Selecting an appropriate border, results in considering different interest groups. In this paper's proposed methodology for developing BSC, borders are beyond internal environment and would consider almost all important interest groups.

Some researchers criticize BSC for its weakness in describing interrelationships between measures (Lawrie and Cobbold, 2004). As a result, relationships between objectives are not clear and targeting for them is depending on developer. BSC cannot properly describe causality between objectives as mentioned by Nørreklit (2000). In addition, she has mentioned that causal connections between objects are not as shown in strategy maps, and also, has noted that BSC is a static model and would not consider time factors (Nørreklit, 2000). This weakness can cause some problems for the organization to deploy this method in action. Kaplan and Norton (2004) have eliminated some problems, aroused from the gap between measures and objectives, by strategy maps. But some problems still remain. For example, without considering time delays between measures, organization's decision-making process would have lots of complexities. Causal loops and system thinking are tools, which can be applied for solving problems like time delay consideration. Kunc (2008) has applied system thinking in developing causal loops for BSC, and he has achieved considerable results. Moreover, Capelo and Dias (2009) have shown the capability of mental models for assisting to managers' business learning. Barnabe and Busco (2012) have added some discussions to Kunc's research works. They have identified system dynamics contributions to the BSC. As it can be seen in Kunc's research works, they have proposed applying causal loops and linkages. Furthermore, they have offered using

loop's polarity and variable formalizing for a better representation of causal loops. Also, causal loops can explicitly describe feedbacks in the organization's strategy map. Mental model and using organization's knowledge for strategic planning by BSC is another advantage of system dynamics approach to BSC (Barnabe and Busco, 2012). This problem could be solved with system dynamics abilities for describing causality between objectives. In addition time consideration is one of the other capabilities of system dynamics, which can be applied for developing better targets.

Another BSC weakness is its limitations for time delays interpretation (Dzombak *et al.*, 2013). Well-known BSC developing approaches are taken into account in differentiating between lagging and leading indicators and have no explicit representation or formalization for time delays. This problem would be solved by using system dynamics modeling, which is mathematically formalized in computer models according to their typology. Furthermore, non-linearity would be analyzed when an organization has applied system dynamics for its BSC. Moreover, organizations, which have benefited from system dynamics, can analyze their strategic scenarios and choose the best scenario by system dynamics mathematical model (Barnabe and Busco, 2012). In addition, Morecroft believes in system dynamics ability for a better linkage between strategy and operations in organizations. He has also recommended policy analysis with system dynamics; which can be applied for identifying resources and operational flows in the organization (Morecroft, 2007). Furthermore, Bianchi and Montemaggiore have applied system dynamics for developing BSC. They have used their dynamic BSC (DBSC) for measuring and controlling a city water company (Bianchi and Montemaggiore, 2008).

In 2008, Nielsen and Nielsen have constructed a dynamic model, inspired by a case study based on an international company. Theoretically, they have described one of the main difficulties of BSC, which is to foresee the time lag dimension of different types of indicators and their combined dynamic effects. Therefore, they have applied system dynamics for an international company's BSC and analyzed three different strategic policies for the company. These policies have been compared by their effects on a main target (return on capital). Their results have shown that a minimal change in one of the base variables (skills, customer base, or work in process) may have a major influence on profit and other indicators and its prediction might be impossible without using a dynamic model (Nielsen and Nielsen, 2008).

One of the most comprehensive studies on applying system dynamics in strategic management system has been presented by Barnabe (2011). He aimed to focus on the development of a "dynamic Balanced Scorecard" and demonstrated that matching the traditional BSC architecture with system dynamics principles offers a better support for strategic management decisions. Therefore, he developed a comprehensive dynamic model for a company and then applied flight simulator to it. He suggested that this dynamic BSC has overcame some limitations of the original BSC and also helped companies on applying BSC architecture and system dynamics principles simultaneously (Barnabe, 2011). Furthermore, Bianchi and Montemaggiore (2008) have developed a DBSC. They apply system dynamics in the concepts of BSC and developed a DBSC. Their method for developing DBSC is somewhat similar to DBSC which has been proposed by Barnabe (2011) (Bianchi and Montemaggiore, 2008).

These researches have inspired us in developing the proposed methodology. Kunc's research has shown the ability of causal loops for demonstrating strategy maps, which have been applied in our research work for developing strategy maps. The research papers by Barnabe and Busco (2012) show the highest capability of system dynamics

in strategic management system, and have been applied in our methodology. Morecroft has mentioned that a dynamic model can be used for linking strategic and operational approaches, and we used his results after changing some targets and setting initiatives for BSC. Capelo and Dias have shown mental models abilities for the learning of managers which would apply in our composition methodology. Furthermore, they have shown the system dynamics ability for identifying and selecting KPIs which is one of the steps of our proposed method. Nielsen and Nielsen have introduced good aspects of applying system dynamics for BSC. Selecting most important objective of the organization and analyzing different policies for organization's success are the lessons to learn from them. These lessons with some modification are applied in the second, fifth, and sixth steps of our methodology, which are described later in this paper. Also, Barnabe (2011) and Bianchi and Montemaggiore (2008) have introduced DBSC, which is the synthesis tool for strategic management system. This tool is a system dynamics model based on BSC concepts. However, we use the capabilities of system dynamics and after improving some aspects and adding new features. The DBSC of this paper, developed with a system dynamics approach which has dynamics features; therefore it could be applied for designing and analysis of policies for the company.

The framework which has proposed in this paper is the contribution of this paper which would apply for an assumed and real case. For this, in the next two subsections of this section, BSC and system dynamics concepts would be presented. Then the proposed framework would be presented and then applied for an assumed case. In this case, the methodological procedure of framework would be illustrated. Afterwards, our proposed method (case study) would present. Subsequently the results of applying this methodology in an Iranian public transportation would be shown and at the end the conclusion of this paper would be presented.

System dynamics

Forrester (1958) applied system dynamics in different applications for the first time. Since then, system dynamics has been developed and used in several problems like engineering, strategy and policy analysis, environmental issues, etc., the unanticipated impact of low-cost housing programs which results in increasing unemployment (Forrester, 1969). System dynamics, related to systems thinking, is defined as the principle and technique of feedback control systems for modeling, analyzing, and understanding the dynamic behavior of complex systems (Barnabe, 2011). While the best known models are linear with beginning and ending points, system dynamics sees the world as it is, with non-linear and interacting parts that influence and feedback to one another. It uses basic concepts like causal loops (a causal loop diagram could be applied for defining relationships between variables. The diagram consists of a set of nodes and edges which shown variables and their relationships) and stock and flows diagrams ("stocks" are levels of quantities that change overtime and need to be tracked and "flows" are the rates of changes). System dynamics modeling is a tool to address the complexity and incorporates feedback loops in systems, and the results of system dynamics models have shown to be valuable in identifying factors that affect outcomes of processes, programs, and decisions (Sterman, 2001).

Sterman in his widely recognized book, *Business Dynamics: System Thinking and Modeling for a Complex World* claims that "formalizing qualitative models and testing them via simulation often leads to radical changes in the way we understand reality." Simulation speeds up and strengthens learning feedbacks. Discrepancies between formal and mental models result in improvements in both, which includes changes in basic assumptions such

as model boundary, time horizon, and dynamic hypotheses (Sterman, 2000). Moreover, mental models are integral in order to focus on the openness needed to unearth the shortcomings in perceptions (Senge, 1990). Long-term side effects of decisions could be analyzed by complex systems and apply for designing better strategies (Sterman, 2000). Systems become increasingly complex and this leads to a more difficult process of conceptual design for their behavioral model. Therefore, the concept of using "Micro-world" is developed to analyze some of the pre-defined variables in order to understand system behavior. Creation, modification, and manipulation of "Micro-world" increase our knowledge about the systems we live in, work or stop working with (Woodside, 2006).

Nevertheless, building a model is not an easy task. It implies an iterative process, in which the model could be rebuilt several times. There is no best recipe for developing a successful model and no optimal procedure that could guarantee a useful model, although a few main steps should be included in any modeling process (Barnabe, 2011):

(1) articulate the problem that needs to be addressed;

(2) formulate a dynamic hypothesis or theory about the causes of the problem;

(3) build a simulation model to test the dynamic hypothesis;

(4) test the model; and

(5) design and evaluate policies.

BSC

Organizations have used tools and systems consisting of a mix of financial and non-financial measures to track progress for quite some time. BSC is one of these tools, which has been proposed by Kaplan and Norton in the early 1990s. The BSC includes four different perspectives: the financial perspective, the customer perspective, the internal perspective, and the learning and growth perspective. The BSC was developed to address the shortcomings of traditional management accounting by including three new perspectives in addition to the financial perspective: a customer, an internal process and a learning, and growth perspective (Kaplan and Norton, 1992). Kaplan and Norton paper was a popular success, and was quickly followed by a second in 1993. In this second paper, they have shown BSC in practice (Kaplan and Norton, 1993). In 1996, they published a book *Balanced Scorecard: Translating Strategy into Action*; which presents their ideas about assessing organization's long-term success. They have demonstrated that one of the most important objectives of BSC is the feedback related to learning and improvements for employees, the communication, information, and learning for executives (Kaplan and Norton, 1996a). Moreover, in the same year, they have published another article about applying BSC as a strategic management system (Kaplan and Norton, 1996b). Kaplan and Norton have introduced the strategic maps, which links the key performance measures together in a causal chain. They specify how to translate strategy into tangible and operational terms. The strategy is defined through specific objectives that can be linked in cause-and-effect relationships across the four perspectives (Kaplan and Norton, 2004). Kaplan and Norton (2006) described the alignment process of all organizational strategic business units to the strategy and, thereby, introduced an enterprise strategy map and a BSC that clarified corporate priorities.

In *Execution Premium*, Kaplan and Norton proposed a strategic management system with BSC; which can be seen in Figure 1. The steps of this cycle are described later in this paper. We would apply this cycle for developing our dynamic strategic management system.

Figure 1.
Kaplan and Norton's strategic management system

Source: Kaplan and Norton (2008)

The six steps of Kaplan and Norton's strategic management system are:

(1) Develop the strategy: developing the strategy uses an array of strategy tools such as mission, values, and vision statements; external competitive, economic, and environmental analyses.

(2) Translate the strategy: organizations must be willing to develop strategic objectives, measures, targets, initiatives, and budgets that will ultimately guide action and resource allocation. Translating the strategy uses strategy maps and BSCs, along with targets and strategic initiatives.

(3) Align the organization: organizations align with the strategy by cascading strategy maps and BSCs to all organizational units, by aligning employees through a formal communication process, and by linking employees' personal objectives and incentives to strategic objectives.

(4) Plan operations: organizations must link long-term strategy with day-to-day operations, align strategy with operating plans and budgets while focussing on those process improvements that are most critical to the strategy.

(5) Monitor and learn: organizations must be committed to monitoring performance results once a strategy has been developed, planned, and implemented, enabling them to determine if the strategy is being properly executed.

(6) Test and adapt: organizations must also test fundamental strategic assumptions to determine if they have certainly found the right strategy. Then launching a new cycle of integrated strategy planning and operational execution.

Pluralization

In the following paragraphs, we would introduce our methodology for developing BSC with system dynamics approach. In this section, an assumed organization would be used for showing methodology's capabilities. Afterwards results of applying this methodology for developing a DBSC for an Iranian public transportation company would show. And finally, we would demonstrate methodology's contributions and capabilities, advantages, and future research frontiers.

Proposed method

As we know, developing BSC is highly dependent on its developer. In this section, we demonstrate a new BSC developing methodology, which leads to standard BSCs. Furthermore, this methodology can improve BSC. Like strategy maps, BSCs and its complementary tools have some limitations like:

(1) Objective selection is dependent on analysis of developer and if developers use subjective predispositions in designing BSC, their results would differ.

(2) The relationship between objectives in strategy maps is also dependent on developer perspective. This can be results in unrealistic causal relationships because of developer's point of view and his/her bounded rationality.

(3) Determining static targets for objectives results in imperfect strategic management in organizations.

(4) Since the relationships between the objectives are not quantitative, sensitivity analysis[1] cannot be done, and therefore, managers have some difficulties for selecting appropriate initiatives and policies.

These limitations have guided us to a new methodology. This new methodology is a combination of system dynamics and strategic management system. Combining five steps for developing a system dynamics model with first two step of developing BSC, lead us to this paper's proposed methodology. Procedures of this methodology consist of the following six steps:

(1) Selecting vision: this step is based on the first step of Kaplan and Norton's (2008) strategic management system.

(2) Modeling a system for organization: this step is a system dynamics step for developing a system for an organization. This step has proposed by lots of researchers which have applied system dynamics for analyzing policies like Nielsen and Nielsen (2008) and Barnabe (2011).

(3) Identifying organization's objectives and their KPIs for different BSC aspects (Financial, Customers, Internal Process and Learning and Growth): this is a compound step which is composed of the first and second steps of Kaplan and Norton's strategic management system with system dynamics sensitivity analysis. This step is similar to selecting KPI with system dynamics which has demonstrated by Capelo and Dias (2009).

(4) Developing strategy map: this step is also a compound step, composed of the second step of Kaplan and Norton's strategic management system and causality loops of system dynamics. This step is applied by lots of researchers which have applied system dynamics for analyzing policies like Kunc (2008) and Barnabe (2011).

(5) Targeting: this step is a system dynamics step, in which the target of objectives would be selected. This step is somewhat a novel step. However, research of Bianchi and Montemaggiore (2008) is similar to this step.

(6) Selecting initiatives and policies: this step is a facilitator for Kaplan and Norton's management system, in which generality of initiatives and policies for rotating the cycle would be analyzed. This step is a novel step in the proposed method in this paper.

Steps 5 and 6 are iterative steps and iterate in anticipation of complete accordance. After these steps, steps 3-6 of Kaplan and Norton's strategic management system must be applied and the cycle of BSC must be completed. These steps assist our proposed methodology for developing DBSC which concluded to a dynamic management system (a DBSC cycle like BSC cycle). The methodology has been shown in Figure 2. The novelty of this methodology is its integration framework, which could be applied for developing DBSC.

In the following paragraphs, we have explained the steps that have been followed by an example. This example is a simplification of a production organization which sells directly to consumers. This organization produces agricultural machines. This example is only for better methodology instruction and simplification would be applied in the proceeds of this paper. We will refer to this organization, as "A."

Step 1: selecting vision

This step is highly dependent on organization's stakeholders; also, it can form the organization's BSC and strategy map. Each organization has its unique vision. For example, one company has a target for creating the most possible revenue and another has the target for uprising its brand. Therefore, this step has been placed in the methodology for consideration of organizations differences.

A's vision is to be achieving higher profit margin from about 6 to 18 percent.

Step 2: modeling a system for organization

Developing a system is a base for the proposed methodology. In this step, we develop a complete system for the organization (e.g. A). In developing this methodology,

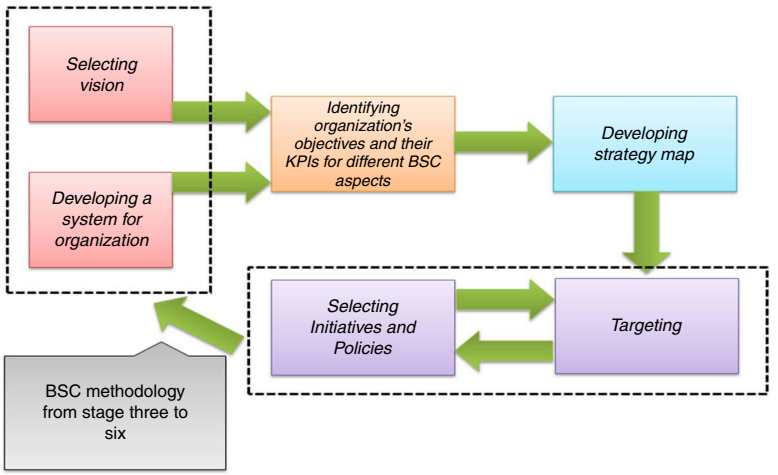

Figure 2.
The procedure of the proposed methodology

environmental and internal aspects of the organization must be considered. This can be done by methods like Political, economic, social, technological, environmental, and legal (PESTEL) analysis (Yüksel, 2012) for macro environment and Porter five force[2] analysis (Porter, 2008) for micro environment. In addition, value chain (Porter, 1985) and McKinsey 7S framework (Waterman *et al.*, 1980) could be applied for organization's internal analysis. Therefore, important factors have been identified for the organization and its environment. These factors must be applied for developing a qualitative system for the organization.

Afterwards, the system must be transformed to a quantitative dynamic system. Therefore, variables are created directly or indirectly from factors. If a factor needs to be better explained, then some variables would be created indirectly from it, otherwise, the variable is made directly. In summary, a system dynamics model is developed for the organization, as explained in the system dynamics literature. For example, Figure 3 demonstrates a quantitative dynamic model for "A." In this figure, for simplicity we have considered a part of organization's internal analysis, and assumed that A is in an isolated environment and the "word of mouth" is the only effects of environment on it, which can affect the customer gain rate. This dynamic model would be used later in this paper.

In this model, we can see A's manager can change: the employees' abilities by training, production line by structure investments (cost), quality of products by Research and development (R&D), marketing by price and marketing costs (marketing campaigns like promotion, advertisement, events, and so on), combination and number of employees also employees' salaries. In conclusion, these are the lead factors[3] in an organization and managers can change them by initiatives or policies, for organization's success.

Step 3: identifying organization's objectives and their KPIs for different BSC aspects

This step is the most important step in our methodology. In this step, developer must change the independent variables (lead variables) and study other dependent variables (lag variables); especially organization's primary target or vision. Most sensitive[4] variables must be identified and used for creating objectives from them, then allotted to one of the four BSC aspects. These most sensitive variables are objective's components for a company[5]; which must be monitored by BSC. On the other hand, these components are KPIs of the organization's objectives. In summary, this step helps identify the organization's objectives for developing its BSC. As an example, in Figure 3 we have simulated a model for A. The most sensitive variables are:

(1) price;
(2) marketing cost (like promotion cost);
(3) R&D cost;
(4) training cost;
(5) orders;
(6) customer rate;
(7) revenue;
(8) cost;
(9) structure cost; and
(10) production cost.

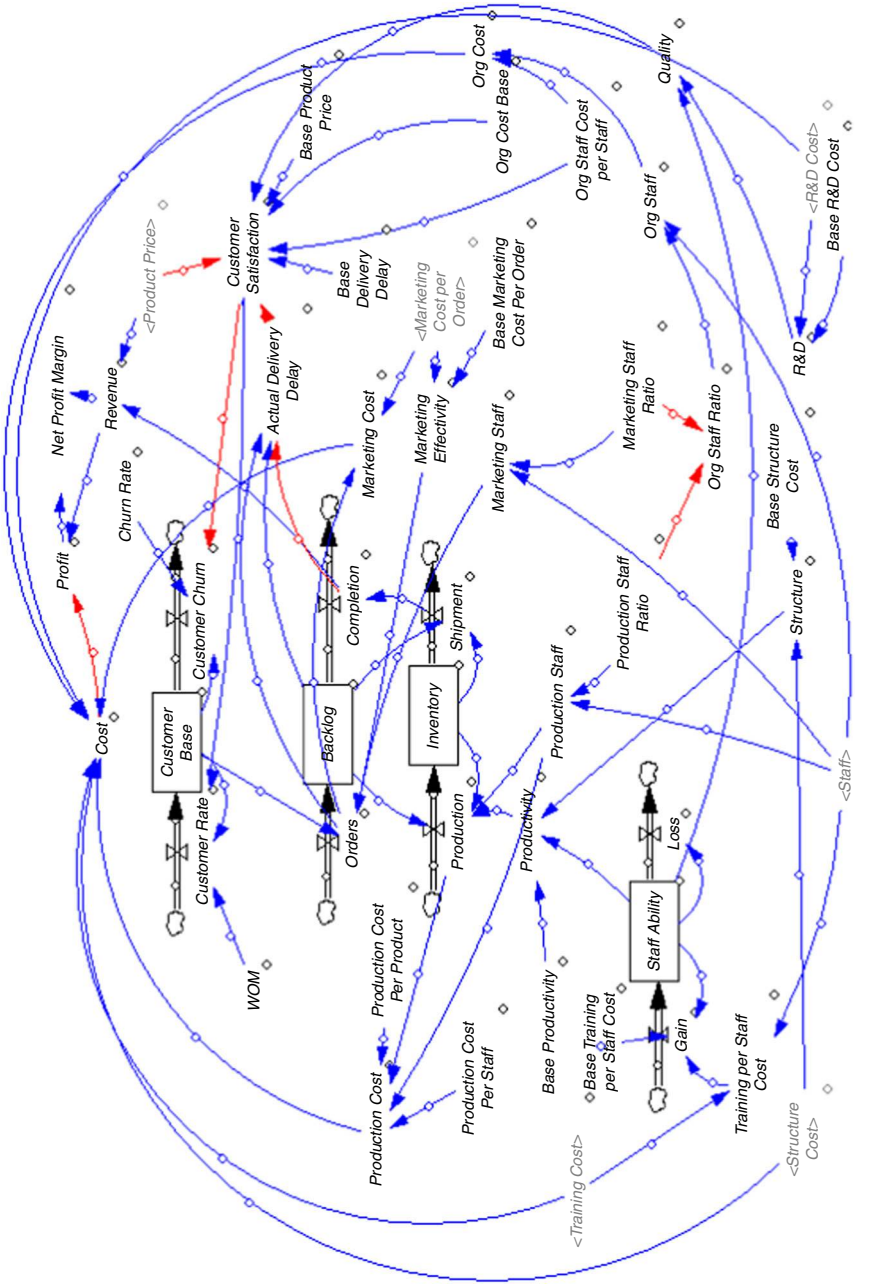

Figure 3.
A's stocks and flows diagram

These variables have been applied for creating A's objectives. Furthermore, they are the KPIs of the objectives too. A's objectives and their corresponding KPI(s) and BSC aspects are shown in Table III (complete BSC).

Step 4: developing the strategy map

System thinking and causal relationship between the variables in a system dynamics model would be applied for developing strategy maps. As mentioned in the introduction, this procedure has been performed by studying cause-and-effect relationship in system dynamics model. It must be noted that for creating comprehensible strategy map, some of causal relationships must be excluded from original system. For example, A has a strategy map, as shown in Figure 6 (for real case study). The relationships between objectives in this figure are concluded from mental model (has not been shown in this paper) and stock and flow model (Figure 3) dynamic models for this organization.

Steps 5 and 6: targeting and selecting initiative and policies

Targeting and selecting initiatives are iterative steps in this methodology. In the targeting step, BSC developer would analyze changeable variables and their effects on the most important objective(s) or vision of the organization. Therefore, the developer must consider planning limitations like budgeting boundaries (strategy budget or STRATEX usually must be lower than 10 percent of the total budgets of the organization), time limitation, etc.

These two steps are aimed to create a system dynamics game and change the leading variables until the most important objective(s) of organization has (have) been satisfied. When the most important objectives, targets, and also initiative limitations are modified using the values of the KPIs, they would be the targets for the objectives of the organization. Otherwise, limitations and boundaries adjust their values until all of them and also organization's most important objective(s) are satisfied. For example, "A" can achieve its vision by Table I initiatives. In this table, time and cost of initiatives (project or action) are shown, while the detail could not be covered in this paper. Figure 4 illustrates the effects of initiatives on Net Profit Margin. Furthermore, we have identified the target for each of A's KPIs. This can be seen in Table II (Table III).

Initiative	Value	Time (number of month in plan)
Uprising training cost	10 percent	1st month
Uprising marketing cost	0.5 percent each month	From the 1st month
Uprising training cost	0.3 percent each month	From the 6th month
Uprising R&D cost	10 percent	6th month
Uprising R&D cost	0.3 percent each month	From the 12th month
Holding an exhibition (uprising marketing cost)	7 percent	28th month
Uprising price	5 percent	30th month
Uprising price	3 percent every 6 months	From the 46th month
Holding an exhibition (uprising marketing cost)	7 percent	50th month
Investment on production facility	5,000	From the 50th to 60th month

Table I. A's initiatives and policies

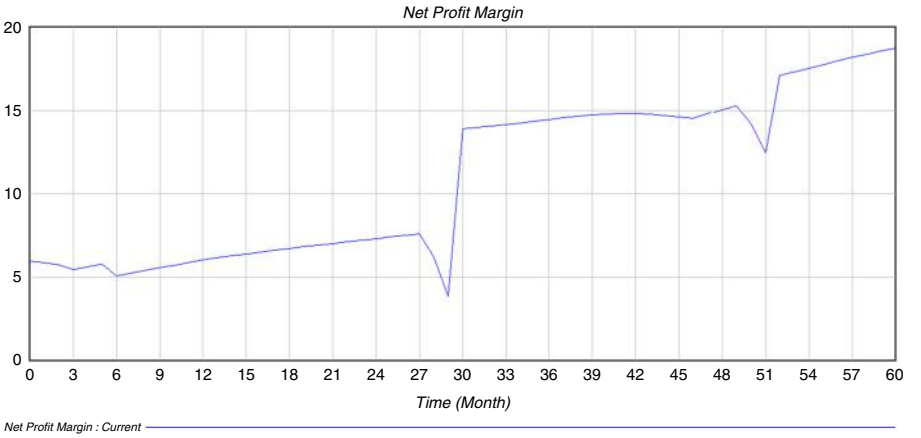

Figure 4.
A's Net Profit Margin behavior during 60 months of planning

KPI	Base year	First year	Second year	Third year	Fourth year	Fifth year
Net profit margin	5.96	6.04	7.31	14.43	15.03	18.73
Revenue	10.9	113.88	119.96	141.1	143.38	153.38
Cost	102.5	107	111.2	120.75	121.83	124.65
Customer rate	33	33	33	33	29	26
Orders	218	230	242	271	271	271
Price	0.5	0.5	0.5	0.525	0.53	0.56
Marketing cost	10.9	12.12	13.49	16.86	17.56	19.49
Production cost	264	261	258	252	252	251
Training cost	1	1.12	1.15	1.19	1.23	1.26
R&D cost	10	11	11.36	11.72	12.08	12.44
Structure cost	20	20	20	20	20	25

Table II.
A's KPIs target

Case study

Case study is a research strategy which applies with different methods. One of its important abilities is in simulation. In simulation, data should manipulate in a controlled environment (Groat and Wang, 2002). Case could be selected purposefully or analytically (Stake, 1995). Case study is applied when the case is (Yin, 2009): complex, must be investigated in its context and also contemporary.

This paper's case is a new and contemporary case (developing DBSC for an Iranian transportation company). Furthermore, strategy cases must be considered in their context and therefore are complex. Consequently, we must apply case study research strategy. Yin (2009) has proposed three basic Steps for case study researches which are:

(1) defining the case (in the introduction, the case has been defined);

(2) choosing between single or multiple case study (we select a single case study); and

(3) theory development which consists of selecting case (we have selected Mashhad Urban Train, purposefully), developing data collection protocol (as mentioned in system dynamics literature with its standards), collecting data (with interviews), and then analyzing data (with proposed methodology in this paper).

Corresponding BSC aspect	Objective	Corresponding KPI	Base value	Target value	Initiative
Financial	Increasing net profit margin	Net profit margin	5.96	18.73	
	Increasing income	Revenue	10.9	153.38	
	Decreasing cost	Cost	102.5	124.65	
Customer	Customer stabilization	Customer rate	33	26	
	Increase customer orders	Orders	218	271	
Internal process	Optimizing marketing mix policies	Price	0.5	0.56	Uprising product price by 5 percent in the 30th month Uprising product price by 3 percent every six months from the 46th month
		Marketing cost	10.9	19.49	Uprising marketing cost by 0.5 percent each month from the first month Holding an exhibition (uprising marketing cost) by 7 percent of total marketing cost in 28th month Holding an exhibition (uprising marketing cost) by 7 percent of total marketing cost in the 50th month
	Improving production process efficiency	Production cost	264	251	
Learning and growth	Improve knowledge of employers	Training cost	1	1.26	Uprising training cost by 10 percent in first month Uprising training cost by 0.3 percent each month from 6th month
	Investment on product's quality	R&D cost	10	12.44	Uprising R&D cost by 10 percent in the 6th month Uprising R&D cost by 0.3 percent each month from the 12th month
	Investment on production facility	Structure cost	20	25	Investment on production facility by 5,000, from the 50th to 60th month

Table III.
Complete BSC for A

In the next section, the results of our case study would demonstrate. This could give you an idea about the ability of our proposed methodology for developing DBSC in a real case.

Iranian public transportation case study

This case study is the most important section of this paper. We would illustrate the capability of our proposed method in a real case. However, only some results of the case could be shown in this paper. The case is about Mashhad Urban Train (an Iranian public transportation company which is based in Mashhad; one of the most important cities in Iran). Its vision is "to be the most reliable transportation system in Iran which is on time and safe and be an independent public transportation company which plays an important role in development of city."

Analyzing strategic decisions and developing BSC for managing is one of the most growing issues in Iranian organizations, and our case is not exempt. This organization

is active in public transportation and envisioned for an ideal future. However selecting strategic decisions and also assessing their success is a debating issue for its managers. Therefore they applied BSC for their issue. As we mentioned in previous sections, BSC has some limitations which could damage this organization's strategic decisions. As a result, we proposed our methodology, analyzed their organization and its environment, and develop a DBSC for them. However, because of privacy for this organization, we should only demonstrate results of applying our methodology for this organization. For that reason, its causal system is demonstrated in Figure 5, its strategy map is shown in Figure 6 and its DBSC is depicted in Table IV. It must be noted that, the results of this study are considered by managers of the case.

Conclusion

During the last two decades, the necessity for developing and implementing multidimensional performance measurement systems and strategic management systems has become clear in management science. Long-term success is a critical issue for modern organizations. They have understood successful long-term performance, not necessarily related to financial performance. Therefore, Kaplan and Norton proposed BSC to respond to this critical need. In addition, they have improved BSC as a strategic management tool. However, BSC has some limitations. Dependency of an organization's BSC to its developer, vague relationships between objectives, weakness of targeting, and setting initiatives are some weaknesses of the original methodology in developing BSCs. Therefore, we proposed a new methodology for developing BSCs with system dynamics, to overcome these limitations. This methodology consists of six

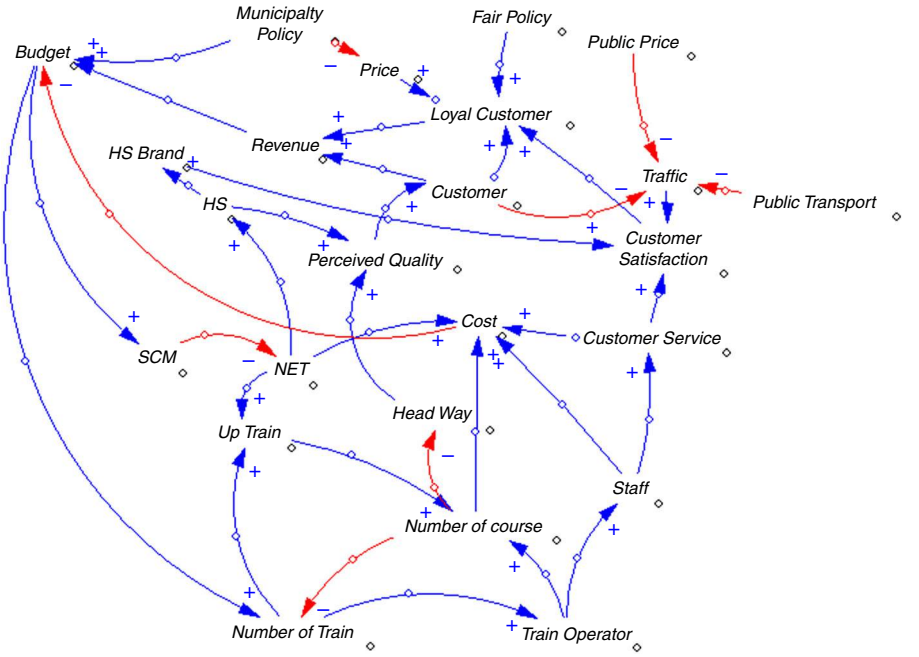

Figure 5.
Causal diagram for this paper's case study

Notes: NET, maintenance and repair; HS, Health and Safety; SCM, Supply Chain Management; Head Way, time between two train departure

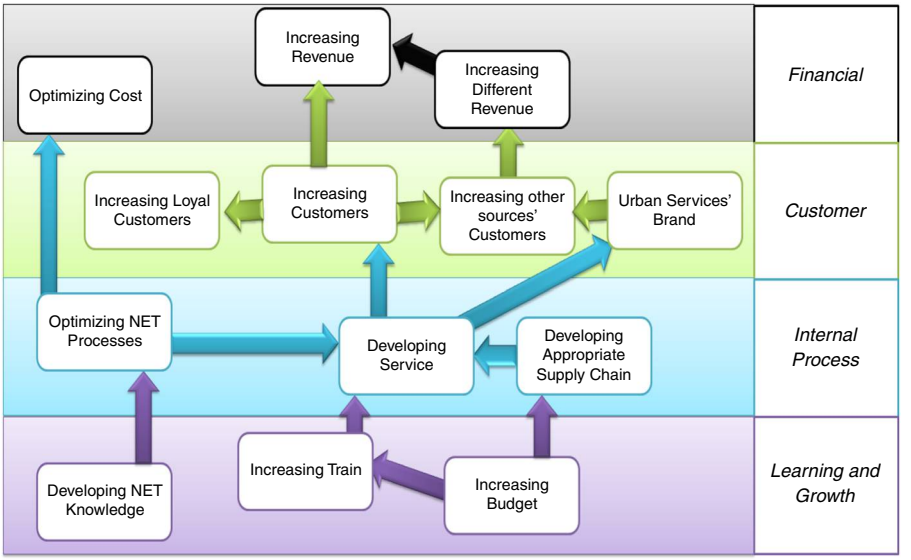

Figure 6. Strategy map for this paper's case study

KPI/KRI	Objective	Perspective
Revenue	Increasing revenue	Financial
Cost	Optimizing cost	
Revenue from other sources	Increasing different revenue	
Number of customers	Increasing customers	Customers
Number of other sources' customers	Increasing other sources' customers	
Customer satisfaction	Urban services' brand	
Customer trust		
Number of loyal customers (with at least five trip)	Increasing loyal customers	
N/T cost	Optimizing NET processes	Internal process
Number of employed train		
NET cost		
Average of delays for supplying	Developing appropriate supply chain	
HSE index	Developing service	
Head way		
% budget increase	Increasing budget	Learning and growth
Number of train	Increasing train	
H/P education	Developing NET knowledge	
Number of submit documents		

Table IV. Dynamic balanced scorecard for this paper's case study

steps: developing a system for organization, selecting stakeholders' most important objectives and their target (vision), identifying organization's objectives and their KPIs for different BSC aspects (Financial, Customers, Internal Process and Learning and Growth), developing strategy map, targeting, and selecting Initiatives. This methodology could extend BSC capabilities and reduced its limits. Some of BSC's limits which this methodology could eliminate them have been mentioned in this

paragraph. In addition, this paper's proposed methodology has been described with a presumed exemplary organization in previous sections of this paper and its results have been shown for an Iranian public transportation company.

In brief, the proposed methodology, contributed in science for composing system dynamics concepts, capabilities, and methodology with strategic management system which has been proposed by Kaplan and Norton. This results in proposing a methodology for developing a dynamic strategic management system. Besides, it can be used for several applications, in addition to developing BSCs; which can be a subject of further research works. The organization's vision would be analyzed by the BSCs, which have been developed by this methodology and a rational achievable vision could be selected. Moreover, managers of the organizations, who have applied these BSCs, can analyze their strategies and policies and select the one, which is the most appropriate for governing their organizations. Additionally, change management can be applied with these BSCs for planning changes by strategic objectives' targeting. These applications could be applied in organizations for strategic planning (vision) so that better strategic policies compare with previous methods could be made.

Notes

1. Sensitivity analysis is the study of how the uncertainty in the output of a mathematical model or system (numerical or otherwise) can be apportioned to different sources of uncertainty in its inputs (Saltelli *et al.*, 2008).
2. Threat of new entrants, threat of substitute products or services, bargaining power of customers or buyers, bargaining power of suppliers, and intensity of competitive rivalry.
3. A lead factor can modify lag factors (like financial factors) and could be changed by company and its managers.
4. When independent or leading variables change, some of dependent or lagging variables change more rapidly, compared with the others, therefore they are sensitive variables. Moreover some of leading variables respectably change the whole system; subsequently they are also sensitive variables.
5. Because these variables could change more respectable than the other variables, therefore they must controlled, which controlling them, results in controlling the whole system's health.

References

Barnabe, F. (2011), "A 'system dynamics-based balanced scorecard' to support strategic decision making insights from a case study", *International Journal of Productivity and Performance Management*, Vol. 60 No. 5, pp. 446-473.

Barnabe, F. and Busco, C. (2012), "The causal relationships between performance drivers and outcomes reinforcing balanced scorecards' implementation through system dynamics models", *Journal of Accounting & Organizational Change*, Vol. 8 No. 4, pp. 528-538.

Bianchi, C. and Montemaggiore, G.B. (2008), "Enhancing strategy design and planning in public utilities through 'dynamic' balanced scorecards: insights from a project in a city water company", *System Dynamics Review*, Vol. 24 No. 2, pp. 175-213.

Capelo, C. and Dias, J.F. (2009), "A system dynamics-based simulation experiment for testing mental model and performance effects of using the balanced scorecard", *System Dynamics Review*, Vol. 25 No. 1, pp. 1-34.

Dzombak, R., Mehta, C., Mehta, K. and Bilen, S.G. (2013), "The relevance of systems thinking in the quest for multifinal social enterprises", *Systemic Practice and Action Research*, Vol. 27 No. 6, pp. 593-606.

Forrester, J.W. (1958), "Industrial dynamics: a major breakthrough for decision makers", *Harvard Business Review*, Vol. 36 No. 4, pp. 37-66.

Forrester, J.W. (1969), *Urban dynamics*, Pegasus Communications, Waltham.

Grant, R.M. (2013), *Contemporary Strategy Analysis*, Wiley, Barcelona.

Groat, L. and Wang, D. (2002), *Architectural Research Methods*, John Wiley & Sons, New York, NY.

Hudson, M., mart, A. and Bourne, M. (2001), "Theory and practice in SME performance measurement systems", *International Journal of Operations and Production Management*, Vol. 21 No. 8, pp. 1096-1115.

Kaplan, R. and Atkinson, A. (1998), *Advanced Management Accounting*, Prentice Hall Internationa, Englewood Cliffs, NJ.

Kaplan, R. and Norton, D. (1992), "The balanced scorecard – measures that drive performance", *Harvard Business Review*, Vol. 70 No. 1, pp. 71-79.

Kaplan, R. and Norton, D. (1993), "Putting the balanced scorecard to work", *Harvard Business Review*, Vol. 71 No. 5, pp. 2-16.

Kaplan, R. and Norton, D. (1996a), *Balanced Scorecard: Translating Strategy into Action*, Harvard Business School Press, Boston, MA.

Kaplan, R. and Norton, D. (1996b), "Using the balanced scorecard as a strategic management system", *Harvard Business Review*, Vol. 74 No. 1, pp. 75-85.

Kaplan, R. and Norton, D. (2004), *Strategy Maps: Converting Intangible Assets into Tangible Outcomes*, Harvard Business School Press, Boston, MA.

Kaplan, R. and Norton, D. (2006), *Alignment*, Harvard Business School Press, Boston, MA.

Kaplan, R. and Norton, D. (2008), *The Execution Premium. Linking Strategy to Operations for Competitive Advantage*, Harvard Business Press, Boston, MA.

Kunc, M. (2008), "Using systems thinking to enhance strategy maps", *Management Decision*, Vol. 46 No. 5, pp. 761-778.

Lawrie, G. and Cobbold, I. (2004), "Third-generation balanced scorecard: evolution of an effective strategic control tool", *International Journal of Productivity and Performance Management*, Vol. 53 No. 7, pp. 611-623.

Mooraj, S., Oyon, D. and Hostettler, D. (1999), "The balanced scorecard: a necessary good or an unnecessary evil?", *European Management Journal*, Vol. 17 No. 5, pp. 481-491.

Morecroft, J. (2007), *Strategic Modelling and Business Dynamics*, Wiley, Chichester.

Neely, A., Adams, C. and Kennerley, M. (2002), *The Performance Prism: The Scorecard for Measuring and Managing Business Success*, Financial Times Prentice Hall, London.

Nielsen, S. and Nielsen, E.H. (2008), "System dynamics modelling for a balanced scorecard computing the influence of skills, customers, and work in process on the return on capital employed", *Management Research News*, Vol. 31 No. 3, pp. 169-188.

Nørreklit, H. (2000), "The balance on the balanced scorecard- a critical analysis of some of its assumptions", *Management Accounting Research*, Vol. 11 No. 1, pp. 65-88.

Porter, M.E. (1985), *Competitive Advantage: Creating and Sustaining Superior Performance*, Simon and Schuster, New York, NY.

Porter, M.E. (2008), "The five competitive forces that shape strategy", *Harvard Business Review*, Vol. 86 No. 1, pp. 86-104.

Saltelli, A., Ratto, M., Andres, T., Campolongo, F., Cariboni, J., Gatelli, D., Saisana, M. and Tarantola, S. (2008), *Global Sensitivity Analysis: The Primer*, John Wiley & Sons, Chichester.

Senge, P. (1990), *The Fifth Discipline: The Art and Practice of the Learning Organization*, Doubleday/Currency, London.

Stake, R. (1995), *The Art of case study Research*, Sage, Thousand Oaks, CA, New London, CT.

Sterman, J.D. (2000), *Business Dynamics. Systems Thinking and Modeling for a Complex World*, Irwin McGraw-Hill, Boston, MA.

Sterman, J.D. (2001), "System dynamics modeling: tools for learning in a complex world", *California Management Review*, Vol. 43 No. 4, pp. 8-25.

Waterman, R.H.J., Peters, T.J. and Phillips, J.R. (1980), "Structure is not organization", *Business Horizons*, Vol. 23 No. 3, pp. 14-26.

Woodside, A. (2006), "Advancing systems thinking and building microworlds in business and industrial marketing", *Journal of Business and Industrial Marketing*, Vol. 21 No. 1, pp. 24-29.

Yin, R.K. (2009), *Case Study Research*, 4th ed., Sage, Thousand Oaks, CA.

Yüksel, İ. (2012), "Developing a multi-criteria decision making model for PESTEL analysis", *International Journal of Business and Management*, Vol. 7 No. 24, pp. 52-66.

Corresponding author
Seyed Behnam Khakbaz can be contacted at: khakbazbehnam@yahoo.com