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A dynamic balanced scorecard for identification internal process factor

Javad sofiyabadi[a*] and **Sakineh Noori Nasab**[b]

[a]*Department of Management, Firoozkooh Branch, Islamic Azad University, Firoozkooh, Iran*
[b]*Department of Management, Semnan Branch, Islamic Azad University, Semnan, Iran, P.O.B: 35145-175*

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A B S T R A C T

We present a dynamic balanced score card (BSC) to investigate the strategic internal process management factors. The proposed dynamic BSC emphasizes on internal processes aspect, and using VIKOR and Shannon Entropy, determinants the internal processes, process management and improvement and all important factors are ranked. The current study first introduces dynamic BSC and examines effective factors on the process. The proposed model focuses on internal processes perspective of BSC and determines importance degree of each factor is used using VIKOR decision-making techniques.

1. Introduction

In a systemic and dynamic perspective, an organization is composed of a set of complex and changing processes and by interaction and performance of these complex processes, we can access to strategic objectives. If the existing processes in organization are correctly identified and carefully managed, we can expect effective results. Many experts of business processes believe that the main cause of process related problem is failure in their management so as in some cases a process can be remarkably improved by installation of a management system or improvement of the existing one. Thus, at the time when a new process becomes operational, the key to guarantee its efficient implementation is in presence of a fitting system and the key of its effectiveness in correct management. In fact, by correct management of a process, objectives are realized and by control the strategic factors, the processes maintain the necessary effectiveness. In this sense, management can be defined as optimal use of resources to achieve the objectives. According to Kaplan and Norton (1996), management represents "Optimum use and employment of effective factors of resources and inputs in order to achieve process' objectives (expected outputs)". This type of management will

* Corresponding author. Tel: +98-919-4312179
E-mail addresses: j.sofiyabadi@Gmail.com (J. Sofiyabadi)

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result in increase of process and organization's effectiveness. BSC as one of the effective factors in process correct management, in place of measurement, emphasizes on business process design and then on its measurement, generally. Therefore, the measurement issue proposed in the topic processes facilitates management and hierarchy in processes and representation of the quadruplet structures in process with BSC. Use of BSC is one of the tools employed to advance objectives by pioneering organizations and it is considered an inseparable part of directed management process (Kaplan & Norton, 1996). BSC as a performance evaluation system, in addition to traditional financial evaluation, measures organization's performance by adding three other dimensions, i.e. customers, business internal processes, and learning and growth. In fact, this method with its wide range of capabilities with a more comprehensive view ways controls organization and its processes. BSC has been widely used and it represents capabilities of strategic approach in management and controls various aspects of industrial and service organizations. However, this method apart from plenty of advantages for organizations has some shortcomings as well. BSC, neither relatively nor absolutely provides estimation for the extent of landscape contribution nor even estimates relative importance of each indicator under a single landscape (Suomala & Kulmala, 2004). In addition, in BSC model, effect of each structure and its internal factors on each other is unknown. Therefore, we can use quantitative methods including statistics, mathematics, decision making quantitative models and operation research to resolve the shortcoming.

1.1. Capabilities of BSC in other research

As explained earlier, BSC has been investigated from many aspects and this is an indication to its potential capabilities. For example, it can be referred to recent researches on BSC (Krause, 2003, Oh et al., 2009, Tohidi et al., 2010; Chen et al., 2009; Chen et al., 2009; Yuan & Chiu, 2009; Yuan & Chiu, 2009; Asosheh et al., 2010; Asosheh et al., 2010; Zandi & Tavana, 2011; Hsu et al., 2011; Hsu et al.,2011; Grigoroudis, et al., 2011; Wu et al., 2009; Fernandes et al, 2006). In this research, with emphasis on BSC dynamic model, we extend it to process management and by VIKOR technique, effective factors in BSC internal processes, which are important elements of process management are ranked.

2. Literature review

2.1. Process management

During the past years, numerous concepts have been introduced for business processes and their respective performance. In general, "process oriented" concept emphasizes on transfer of concentration from functional characteristics to process characteristics. This concentration transfer has been emphasized by many researchers. In other words, it can be said that the whole organization should be regarded as a system of processes and these processes should be correctly managed (Hellstron & Eriksson, 2008). Process orientation comprises several dimensions including process design and documentation, support of process program, existence of process owners, process performance evaluation, organizational culture, use of IT, compatibility of organizational structure with process view, existence of suitable knowledge and process-based human resource systems, and official samples from coordination and integration of all projects inside process-oriented organizations (Kolbacher, 2010). Kalpik and Bernus (2006) believed that process is a set of actions or operations, which ends to one goal, or as a set of gradual changes, which lead to a particular result. In addition, Al-Modeming (2007) defines business processes as a set of related activities with definable inputs and during execution result in outputs which always create added value for customers. Given the above explanations on process concepts, it is obvious that processes are placed in the heart of all what organizations do for their survival and growth and for this reason improvement of organizations' efficiency and effectiveness necessarily involves process improvement and management (Dalmaris et al., 2007). Table 1 provides some definitions on business process management.

Table 1
Different definitions of business process management

Business process management as a structured method for analysis, improvement and control of processes. Process management enables organizations to standardize their business processes and to enhance their integrating capability (Mahmoodzadeh, 2009).
Process management is systematic method for constant organization, management and improvement organization's processes. Process management is managing and viewing organization as a system of multi-functional processes in place of vertical functions (Entröm, 2002).
Business process management using methods, techniques and software's for design, approval, control and analysis of operational processes including humans, organizations, programs and other informational sources (Van dar, 2007).
Business process management is a comprehensive and coordinated set of interrelated activities or tasks which altogether help achieving organizational strategic objectives of generating value for customers (Zandi & Tavana, 2011).
Business process management is a method which allows companies to adapt themselves more quickly with change of market and customers' requirements (Neubaner, 2009).

Although business process management is considered as part of industrial management techniques, but its meaning is quickly changing, which leads to numerous interpretations of process management in the course of time (Antonucci & Goeke, 2011). In this regard, recent studies on process management literature indicate that there is no common definition of process and process management concepts. One definition of process is: "a horizontal sequence of activities which transforms an input (a need) into an output (result) to meet customers or beneficiaries' needs". When these concepts enter the area of process management, two different movements are identified. The first movement is focused on management and improvement of distinct processes, which can be stated briefly as "a structured systematic method for continuous analysis and improvement, and the second movement comprises a more comprehensive view process management as part of the whole organization which according to definition is " and "a more comprehensive method for management of all business aspects and as a valuable view for adaptability with organizational effectiveness determination" (Palmberg, 2010).

2.2 Balanced Scorecard (BSC)

According to BSC, the successful companies for measurement of their performance do not rely on financial measures but measure their performance from three perspectives of customer, internal process, and learning and growth. Kaplan and Norton (2001) declared that for a perfect evaluation of organization's performance, this performance should be investigated from four angles or perspectives and these four aspects are presented in Fig. 1.

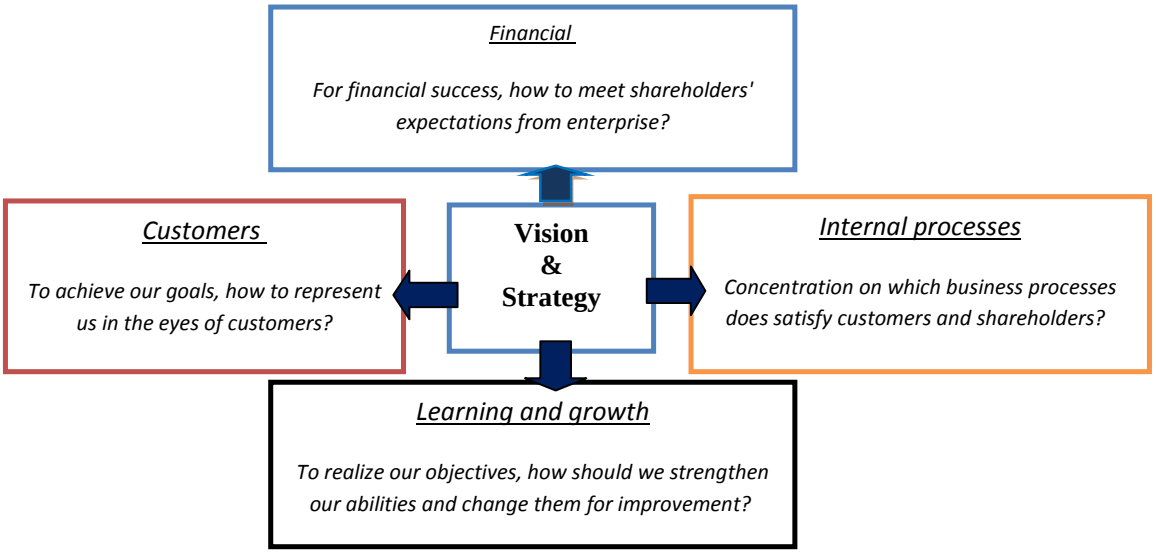

Fig. 1. Transformation of perspective and strategy into four aspects of BSC

If we want to explain four dimensions of BSC, we can refer to the following: "financial dimension", in this dimension, economic results obtained from implementation of strategies are measured. In fact, BSC is considered as an approach for measurement of financial performance. This dimension is focused on beneficiaries and shareholders and considers achieving financial success equal to giving value to beneficiaries and shareholders."Customer dimension" concerns measurement of factors, which create value for the customer. Product or service attribute, customer's mental image of organization and its reputation and name, its relationship with customer and valuing customer for realization of strategies are examples of this aspect. The third dimension in BSC is paying attention to internal processes, which reinforces the two other financial and customer dimensions. To realize this objective and satisfy the customer, organization should specify strategic points and processes, which can be the best in them. In other words, internal processes accomplish two vital constituents of organizations' strategy: 1. They have the task of producing and delivering the offered value to the customer. 2. They also improve organization's processes and reduce costs and in doing so they support productivity constituents from financial point of view (Kaplan & Norton, 2004). The dimension "growth and learning" concerns employees' empowerment, organization's information system quality, and tools and equipment arrangement in order to achieve the intended objectives. The third dimension's processes will be successful when organization possesses skilled and motivated employees and provides correct and timely information. Success in these fourfold structures depends on the fact that each one of these perspectives is in line with organization's strategy. However, the vague point in BSC is the association and integration present in the four parts in cause and effect chain in all the four views. In general, BSC is based on the principle that organization's learning and growth measurements are as the drivers for business internal processes measurement and internal process measurements in turn, are as the drivers of measurements from customer viewpoint (Papalexandris et al., 2004). Kaplan and Norton (1998) believed that BSC by providing information on four different aspects prevents organization's important information from remaining idle in simple models. This model is focused on criteria with importance.

2.3 Process management and BSC

In unstable and changing environment of global markets today, monitoring organization's processes and aligning them with strategic objectives has become an organizational imperative (Kaplan & Norton, 2001). In an organization, hundreds processes occur simultaneously each one which somehow create value. Art of strategy is identification of and superiority in a few numbers of processes which are critical and in providing the offered values plays an essential role. All organization's processes should be managed well. However, a few numbers of strategic processes needs special care and attention, because these processes play a crucial role in creating strategic differentiation. BSC innovation gives rise that this tool is an up-stream and when BSC is combined with process mapping, it plays the most important functionality in execution of process management (Juran & Blanton, 2000) and it can properly reveal process measurements and performance key indicators (Uddin,2004). BSC can be regarded a perfect and broadly employable tool for performance measurement, since it properly plans and controls an organization's processes (Davisv & Albright, 2004; Lawrie & Cobbold, 2004; Pinero, 2002). In fact, in BSC, processes are considered as strategic drivers of strategic weapons and they are optimally used in order to achieve and protect strategic position even when business environment is in change (Smith, 2006). In general, it can be stated that this method emphasizes on evaluations of management area, manufacture and production, financial and human resource processes and is based on strategy.

3. Research methodology

3.1. VIKOR Multi-Criteria Decision-Making Technique

VIKOR method was introduced as an applicable method for implementation in MCDM (Opricovic, 2004; Tzengt, 2005) in which ranking takes place based on selecting a set of options in presence of

inconsistent criteria. Actual problems usually are characterized by several contradictory criteria without commensurability and there may be no satisfactory solution for all criteria. Therefore, a compromise solution for resolving the problem of some inconsistent criteria may help decision maker for reaching a final decision. Compromise solution the basis of which was founded by Yu (Yu, 1973) and Zeleny is a feasible and close to ideal solution. Here, compromise means the created agreement by mutual advantages. At length, VIKOR model for solving multi-criterion problems is described based on the following stages: *m* under study options can be represented as a_1, a_2, …, a_m and *n* evaluation criteria as c_1, c_2, …, c_n and ranking of each option as a_j, *j = 1, …, m*. In mutual criteria, c_i, i = 1, …, n is specified as f_{ij}. Next, VIKOR Compromise Ranking Algorithm can be considered comprised of the following phases.

Step 1. Determining the best *f* + *i* and the worst *f* – *i* for all criteria.

$$f_i^+ = \max_j f_{ij}, f_i^- = \min_j f_{ij}$$

Normally $(f_1^+, f_2^+, \cdots, f_n^+)$ represents the ideal scores and $(f_1^-, f_2^-, \cdots, f_n^-)$ represents the anti-ideal scores. Therefore, we have

$$S_j = \sum_{i=1}^{n} w_i \frac{(f_i^+ - f_{ij})}{(f_i^+ - f_i^-)}, S_j \in [0,1] \qquad S_j = \max_{i=1}\left[w_i \frac{(f_i^+ - f_{ij})}{(f_i^+ - f_i^-)}, R_j \in [0,1] \right]$$

Step2. Calculation of Sj and Rj values for j = 1, …, m which will be the representative mean and the worst scores for the option aj and the below relation can be introduced for their calculation:

Here $w_i(\sum_{i=1}^{m} w_i = 1, w_i \in [0,1] i = 1, \cdots, n)$ represents the relative importance of the specified criteria by decision maker. In this research, to calculate weights vector, Shannon Entropy Method has been used and due to observance of brevity principle we have dispensed with presentation of its mathematical algorithm and have explained VIKOR algorithm in details.

Step3. Calculation of Qj value for j = 1, …, m, using the following relations:

$$Q_j = \frac{v(S_j - S^+)}{(S^- - S^+)} + \frac{(1-v)(R_j - R^+)}{(R^- - R^+)}$$

where

$$S^+ = \min_j S_j, S^- = \max_j S_j \quad R^+ = \min_j R_j, R^- = \max_j R_j$$

Step4. Options ranking based on value of *Q, R* and *S* in ascending direction so as three ranking list are specified as *Q [•], R [•]* and *S [•].*

Step5. Providing option j_1 related to *Q [1]* as compromise solution, if C_1 of the option j_1 has an acceptable advantage, in other words, *Q [2] – Q [1] ≥ DQ* where *DQ = 1 / (m – 1)* is number of options.

3.2. Dynamic system

System's dynamics can be considered as a methodology for management of complex systems with feedback. These systems may involve various areas such as strategic management (under title of strategic dynamisms), process management, economy, urban issues and other social and human areas. Forrester from MIT University (Forrester, 1961) originated this method in early 1960s. Components of systems dynamics models can be classified into causal loop diagrams – stock and flow diagrams

and in a comprehensive model, as is shown in Fig. 2, complex problems can be translated into a dynamic model.

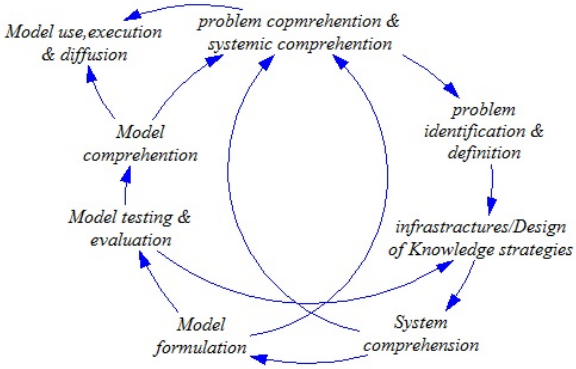

Fig. 2. Steps of dynamic system approach for complex problems

4. Research implementation

4.1. Dynamic BSC model

BSC can be regarded with levels of similarity with systematic thinking approach (Sterman, 2000). When organization is considered as a system, only by adopting limited measures (in terms of quantity) but important and strategic and establishing cause and effect relationships (loop-like) between them and specifying share of each element in model's internal and external variables, the model's behavior can be determined. Systemic and powerful approach of systems' dynamism can provide managers with suitable criteria for performance measurement and setting visions and composition of strategic scenarios without influencing internal actions of BSC's quadruplet structures (Nielsen, 2008). Therefore, it seems that this systematic approach to be very desirable in resolving some BSC problems. Hence, given BSC's limitations and study of this methodology in various researches by assuming a static state for it, dynamic modeling approach for design and use in BSC in a dynamic and chaotic situation can be regarded suitable for overcoming problems and more clarification of relationships between BSC's quadruplet structures and internal relationships of these structures. Hence, for the proposed model of this research, BSC can be modeled in very preliminary state as follows. It is obvious by development of this model's variables and profiting from experts' experiences and views a more comprehensive model can be obtained from dynamic model of BSC. To develop BSC dynamic model with emphasis on internal processes structure, first, given views of experts and top managers, the key elements of each part should be collected. For this purpose, to design and model this aspect of BSC, prior research on this subject has been reviewed and using experts' views, final factors have been selected which are presented in Table 2.

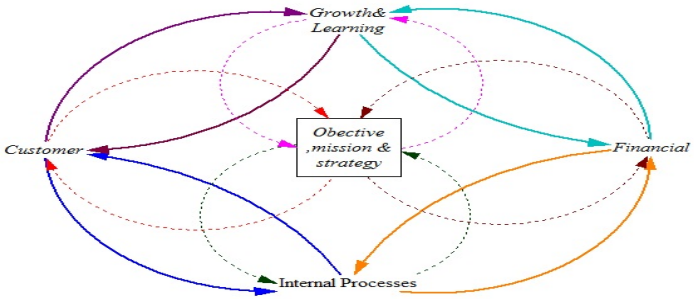

Fig. 3. BSC Dynamic Model

Next step is to identify the cause and effect relationships among variables and to use the cause and effect cycles. Therefore, it is necessary to explain the cause and effect cycles briefly and finally the proposed model of internal processes in BSC with dynamic approach will be analyzed and utilized.

Table 2
Key factors in development of BSC internal processes Structure (Van Gramberger & Saull, 2001; Richards, 2007; Gurd, 2008; Happasalo et al., 2006; Fernanes et al., 2006; Kaplan & Norton, 2001)

1. Challenges and problems in achieving goals	11. Individuals' learning rate and success in achieving goals
2. Selection and design of research and development process and its effect on process management	12. Integrity in collaboration with other BSC structures
3. Effect degree of internal resistance on process execution preliminaries	13. Benefit obtained from relationships and collaboration
4. Information fluidity	14. Usefulness of process fundamentals
5. Coordination in activities	15. Education (training) of people involved in process
6. Alignment between objectives in complex processes	16. Innovation management and offering innovative strategies
7. Alignment of process with budget	17. use of creative methods in process technology development
8. Execution quality and process design quality	18. processes' safety and security degree
9. percentage of annual expenditures on process updating	19. Technological risk control in process and risk management
10. Use of Manual methods (manual processes smoothing)	20. Lead time of process (preparation) Process execution time

4.1.1. Cause and effect cycle& components of system dynamic

This diagram is a tool to draw causal connections between a set of variables or involved factors within a system. The main elements of cause and effect loops are variables and arrows. Variable is a situation, action or decision, which can influence other variables or be influenced by them. Arrow represents either causal correlation between two variables or degree of change in these variables. Fig. 4 shows one of the cause and effect relationships by exactly specifying relationships between the variables. This model can be interpreted that population as the main variable has positive impact on birth rate and death rate in the sense that as the population grows, birth rate and death rate will increase and the variable population itself is influenced by birth and death rates. The higher the death rate becomes, the fewer the population becomes and the higher the birth rate becomes, the more the population increases.

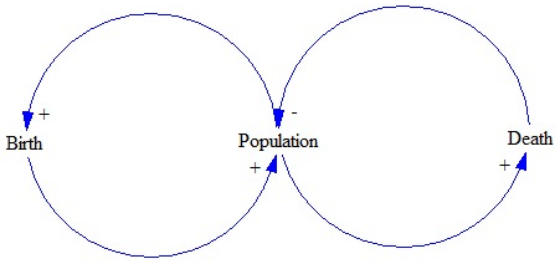

Fig. 4. Cause and effect diagram

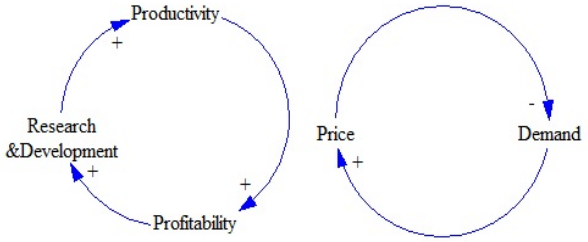

Fig. 5. Positive and negative loops in cause and effect diagram

It is positive in the sense that change of cause in one direction will result in effect change in other direction and negative relationship indicates variables' opposite change and direction. Development of internal and external factors gives rise to complexity of the model design, hence it is necessary that in model design, considering experts' view, those factors and variables to be studied which are expected to have the most effect on the whole system's behavior. For this purpose, by asking experts' view we have extended the above proposed preliminary model. Fig. 6 indicates comprehensive model of determinants of internal processes with emphasis of dynamism of these factors. Considering the above model, it can be stated that internal processes are influenced and impact through an aligned and increasing path from other BSC's structures. Besides, in other causal loops, we observe the variable' positive-negative relationships. For example, other BSC's structures will lead to increased integrity of the policies and this impact results in increased integrity of the processes' internal factors. Therefore, integrity of the proposed factors affects internal resistance degree in preliminary stages of process

implementation. Sum of these positive influences creates a positive and augmented impact on activity coordination and reduces challenges and problems in the way of reaching the objectives, passiveness reduction of design quality problems and increased quality again, reduces challenges and eventually effect of this reduced challenges will be expressed in process management improvement.

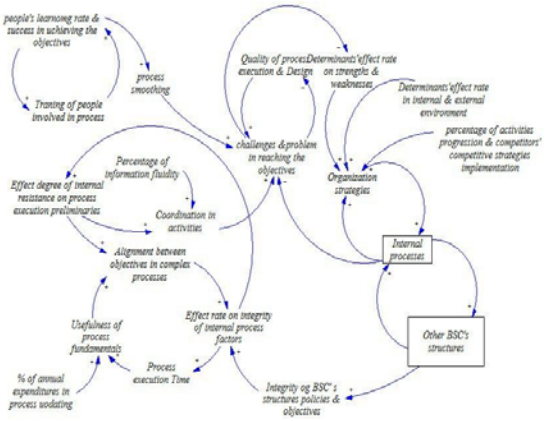

Fig. 6. Dynamic modeling of internal process factor & its effect in process management

Table 3 shows ranking of the 20 determinants in process management at three levels. Paying attention to priority of these factors can provide a more optimum model for business process management to organizations and managers. In this research, only determinants of internal processes in business processes management using BSC are tried to be accurately and scientifically identified.

Table 3
Ranking of 20 factor of process management by VIKOR

Factor	0		0.5		1	
	Q	RANK	Q	RANK	Q	RANK
1	0.834625	14	0.632285	12	0.429945	10
2	0.17608	4	0.288419	8	0.400759	9
3	0.173127	3	0.243986	6	0.314846	8
4	0.338501	7	0.230784	5	0.123067	5
5	1	15	1	15	1	15
6	0.325581	5	0.205621	3	0.08566	3
7	0.338501	7	0.26963	7	0.200759	6
8	0.325581	5	0.205621	3	0.08566	3
9	0.342193	9	0.45859	10	0.574988	12
10	0	1	0.000569	1	0.001138	2
11	0.651163	11	0.481234	11	0.311304	7
12	0.674419	13	0.719359	14	0.7643	13
13	0.162791	2	0.081395	2	0	1
14	0.651163	11	0.711115	13	0.771067	14
15	0.342193	9	0.417974	9	0.493755	11
16	0.508306	13	0.527718	13	0.54713	14
17	0.488372	12	0.530226	14	0.572079	15
18	0.834625	17	0.88585	19	0.937075	19
19	0.162791	2	0.194976	3	0.227162	7
20	0.834625	17	0.560427	15	0.286229	8

5. Conclusion and recommendation

Today, with entrance of advanced technologies into organizations and increased complexity of intra-organizational activities, necessity of paying attention to organization's internal activities and processes is felt more than ever. From among the all existing processes inside organization, there are only a few numbers of vital processes which play a crucial role in creating organization's strategic differentiation. Hence, organizations are bound to identify these processes and eventually their management. BSC model as a comprehensive system will be among the managerial techniques with flexible and high capability in business processes management. This model with dynamic relationship

with other organizational aspects such as customer, finance, learning and effective and internal factors in these structures will lead to a better identification and analysis of external and internal variables in business Management. We suggest that in future research, other aspects of BSC will be identified and their ranking will be investigated. Furthermore, to remove some ambiguities from some causal loops, we recommend Fuzzy Logic to be employed and after design of a comprehensive and dynamic model, using experts systems, to embark on decision making.

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