

Designing a performance appraisal system based on balanced scorecard for improving productivity: Case study in Semnan technology and science park

Mohammad Hemati^{a*} and Majid Mardani^b

^aAssistant professor, management Department, Islamic Azad University, Semnan Branch, Semnan, Iran

^bM.A student, management Department, Islamic Azad University, Semnan Branch, Semnan, Iran

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ABSTRACT

Today, organizations for holding and improving their competing merit use performance measurement for evaluation, control, supervision and improvement of their trading processes. Medium and small companies in technology and science parks are very useful in economic revivification and technology development. Technology and science parks have provided necessary consultations, information, suitable equipments, and services for developing technology unites and prepare them for independent presence in industry. One of the necessary elements for the success and improvement of performance in these companies is to establish and implement balanced scorecard, which can be used to reach desired goals, strategies and to improve performance. In this article, we use a structured method for calculating efficiency of four perspectives of balanced scorecard. Statistical society of this research was Semnan technology and Science Park and seven experts are selected for answering questions of the survey. We also complete questionnaire and determine index and relative importance of all indices. For developing strategic goals of Semnan technology and science park according to four perspectives of balanced score card (finance, growth and learning, internal process), six meetings were hold and finally all crisis macro goals index were identified and they were analyzed for evaluating performance.

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1. Introduction

These days, we see different reports on the average number of years people live in the world and realize the average life expectation is somewhere between 60 to 80 years but the average life cycle of in industry in many European and North American enterprises are only limited to 12.5 years. The primary objective of many science park organizations is to increase the average life cycle as much as possible. This is a fact that many small and medium scale businesses (SMEs) are the basis of economic growth in developing countries and science park units could significantly contribute to the growth of such organizations.

* Corresponding author. Tel:+98- 9125326924
E-mail addresses: mo928hem@yahoo.com (M. Hemati)

Performance measurement is one of the most important management techniques to see how effective management team performs his/her duties. There are literally different methods for measuring the relative performance of a particular firm and many of them rely on financial figures. However, there are always some non-financial indices, which are more important than financial data. Although traditional performance measurement relies solely on financial figures but Kaplan and Norton (1992) explained that intangible assets are the most important part of an organization. These days, we witness that a small group of people build a business unit with virtually small amount of investment and in less than a few years; the business model is sold billions of dollar. An example of this event is a one billion dollar take-over bid that facebook offered for a small firm who were operating with 13 people in 2012.

Therefore, we can conclude that performance traditional measurements established based on management accountancy system is not reliable (Koskela & Stenbacka, 2009; Dobisi, 2011).

Because of these limitations, characteristic of non-financial performance measurement has been emerged in this field. Basically, these properties are associated with organizational strategy and they have emerged to non-financial measurement. Therefore, multi-dimensional and uniform performance management systems have been extended, which could divide them to two separate groups (Wongrasem & Simmons, 2003; Wu et al., 2009; Khan et al., 2011).

- 1) The first group is associated with evaluation techniques. Examples of these kinds of techniques include Deming Award in Japan, Malkom Baldrig in U.S.A, European Award for Quality Award or EFQM, etc.
- 2) Performance measurement based on comprehensive factors associated with financial and non-financial figures. Examples of these techniques include data envelopment analysis (DEA), balanced score card (BSC), etc. So, one of problems that necessitate research is manner of recognition, prioritizing of model variable.

In this article, we consider a method for modeling of performance evaluation system based on balanced scorecard for improving performance of Semnan science and Technology Park.

2. Research conceptual framework

Kaplan and Norton (1992) are believed to be the first who in traduced the idea of BSC. They introduced their results with the name of performance measurements in future organization (that has been done in 1990) as BSC. They believed that BSC is capable of translating strategic goals and organization mission into a group of performance measurement. In addition, these two researchers improved BSC to prepare strategies and to increase in organization and control management with three articles in 1993, 1994 and 1996 office of growing centers of science ministry, researches and technology (Kaplan & Norton, 1996). The primary objective of BSC is to provide a comprehensive perception on organization financial and non-financial figures, which would help them implement organization strategies. The results of this article is to investigate the relationship between financial and non-financial items (Huang, 2009). BSC was a measurement system that place financial index by non-financial index. Four measurement perspectives in this method include (Kaplan & Norton 1992; Ashley et al., 2008; Tohidi et al., 2010, Wu et al., 2011):

A: Financial B: Customers C: Internal process D: Learning and growth

In 1996, BSC has been emerged to measurement instrument and indices have been associated with each other using cause and effect relationships. So financial indices were final output, which show financial results and lead to growth and promotion of organization in long term. Therefore, for promotion financial performance of organization, there are two solutions:

- 1: Income growth
- 2: Productivity improvement

To setup a long term strategy, we need to look for long term objectives while we measure the short-term goals in terms of productivity (Kloot & Martin, 2008) and Kaplan and Norton consider the following classification for intangible assets,

1: Human capital 2: Informational capital 3: Organizational capital (Kaplan & Norton, 2000).

Today, BSC has been specified as a strategic management and learning system, which is based on company general goals. BSC pays attention to create values in long term and the primary objective of BSC is to shape strategy (Kaplan & Norton, 2005).

3. Methodology

3.1 Research goals

- Designing and evaluating performance of Semnan University Technology and Science based on BSC,
- Specifying and evaluating essential goals related to park's strategies and determining indices for each goal,
- Considering measure of effect of variables of BSC on performance of Semnan University Technology and Science Park,
- Continues improvement of Semnan University Technology and Science Park by redirecting the necessary feedbacks to park performance layers.

3.2. Research questions

- What is the effect of weights of four perspectives on performance of Semnan University Technology and Science Park?
- What are essential goals related to park strategies and what is index of each goal?
- What is the evaluating performance of Semnan University Technology and Science Park based on BSC model?

3.3 Research variables

Different methods have been provided for implementing and modeling BSC and the proposed model of this paper uses “Niyon” method, which is based on activity for implementing and modeling BSC in Semnan University Technology and Science Park. Niyon (2002) divides stages of implementation of BSC into the following three phases as follows,

1: planning phase 2: developing phase 3: performing and establishing phase

3.4 Research statistical Population

Statistical population of this research include experts, managers and experts of Semnan University Technology and Science Park in different unites. Because, method of collecting data in this research is survey, so the data has been collected by holding meetings with park's managers and staffs.

3.5 Research executing stages

Stages of implementing BSC can be divided to three total steps:

First step: planning stage

Stages of this step include:

1: Developing goals for BSC

When starting, the biggest principles, which create difficulty in this project, are deleted.

2: Determining organizational unit for BSC

In this stage all unites of Semnan University Technology and Science Park have been determined and specified for establishing and implementing.

3: Getting executive supporter:

Executive supporter of this project is Semnan University Technology and Science Park.

4: Building balanced score card team.

This team includes park's chief, public relations responsibility, support manager, responsible of office of relation to industry, etc.

5: Preparing project program

Semnan university technology and Science Park for implementing BSC could prepare a plane of development (strategic goal map) for implementing this project.

6: Developing a plane of establishing relation

BSC project needs participation of all staff and is first condition for participating park's people, establishing relation and intercourse with them about BSC.

Second step: development step

Stages of this step include:

1: Collecting and distributing required materials

Preparing forms of collecting information and BSC for measuring each of respects have been done in this stage.

2: Development with endorsing on commission, respective and strategy

In this stage commission, respective, goals, duties and preparing park's performance aspects of different unites have been considered and analyzed.

3: Interviewing with park's top managers

Making cultural, educational aspects of BSC model and stages of performing BSC have been performed in this stage.

4: Developing strategic goals in each of aspect of BSC

Achieving and grouping them in balanced scorecard aspects have been done in this stage.

5: Selecting performance measurement for strategic goals

In this stage, vital goals and their indices for evaluating and measuring performance have been considered and analyzed.

Third step: establishment and executing step

Stages of this step include:

1: Determining proportional value of BSC using analyzes data hierarchy

Determining relation among goals, criteria, indices and programs for park's process, unites; staff for determining proportional values of BSC are executed in this stage.

2: Calculating efficiency and achieving to goals of indices in different domains

In this stage, efficiency of each goals and indices has been calculated.

3: Calculating efficiency of park

This stage is last stage from implementing steps of balanced scorecard. In this stage, efficiency of park total has been calculated. In Fig. 1 algorithm and flowchart of executive stages have been provided.

Also output these meetings and their stages have been provided in Table 1 and Fig 2.

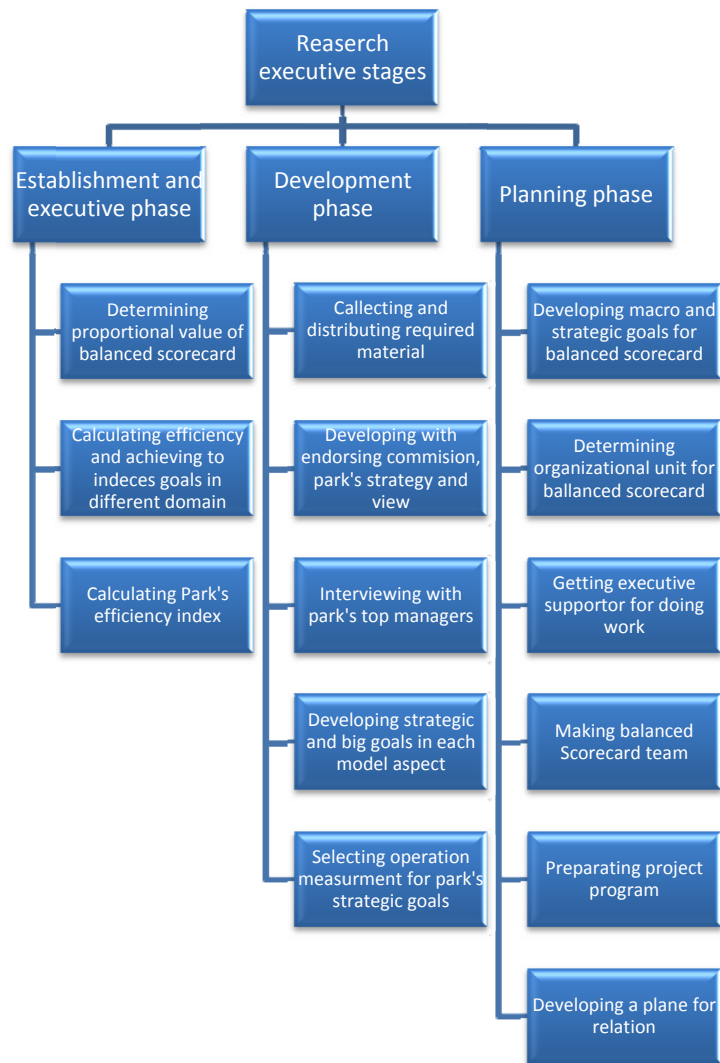


Fig. 1. Research stages executive algorithm.

Table 1

Macro goals in balanced scorecard in Semnan Technology and Science Park

Row	BSC Perspective	Crisis macro goals	Support assistance
1	Financial Perspective	Make trading ideas and application university survey results	Support assistance / technology assistance
2	Learning and growth Perspective	Completing active and dynamic cycle for developing initiative Helping to increasing wealth in society by developing knowledge centered economic	technology assistance
3	Customer Perspective	Using public and university equipment for supporting, and extending technology in society	Support assistance
4	Internal process Perspective	Supporting creation and extension of technology small and medium firms and supporting research firms with technology developing and employment goal	technology assistance / Support assistance

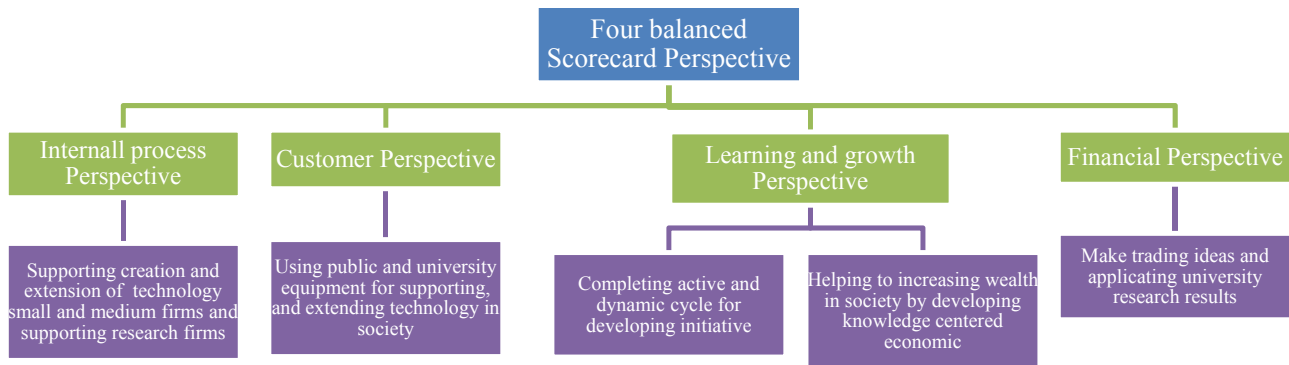


Fig. 2. Macro goals in balanced scorecard perspective in Semnan Technology and Science Park

4. Data Analyses

In this section, we present details of the implementation of the proposed. We also explain details of our findings on essential macro goals for the proposed model.

4.1. Selecting performance indices for park's essential macro goals

In this stage, all indices related to each strategic goal have been collected and among them, the most suitable index has been selected. In Table 2, abstract of essential macro goal and indices are presented.

Table 2

Essential macro goals and determined performance measurement in Semnan University Technology and Science Park

BSC Perspective	Essential macro goals	Performance measurement	Organizational unit	
1	Financial Perspective	Make trading ideas and application university research results	Percent rate of financial support from fixed planes	Support assistance / Financial unit
			Rate of spend budget in along improving and extending park	Support assistance / Financial unit
			Rate of spend budget in doing research	Support assistance / Financial unit
2	Learning and growth Perspective	Completing active and dynamic cycle for developing initiative	Efficiency rate of park's supporting from technology units	Technology assistance / Research unit
			Number of technology unit to develop	Technology assistance / Developed center unit
		Helping to increasing wealth in society by developing knowledge centered economic	Percent of growth of technology units from scientist environment	Technology assistance / Developed center unit
			Hold educational hours for technology units	Support assistance / Human resource unit
3	Customer Perspective	Using public and university equipment for services, supporting, initiative and extending technology in society	Number of provided ideas in market	Technology assistance / Intellectual property unit
			Rate of credit provided to technology unit	Support assistance / Financial unit
			Rate of credit provided to units in firm in festival	Support assistance / Financial unit
			Satisfaction rate of technology units from park	Support assistance / Industry unit
4	Internal process Perspective	Supporting creation and extension of technology small and medium firms and supporting research firms with technology developing and employment goal	Percent of using equipment by technology unit	Support assistance / Supplies unit
			Rate of using improving process of doing work	Technology assistance / Research unit
			Percent of existence of promotion , and encouragement in park	Support assistance / Financial an Industrial unit
			Rate of using information technology to doing works of technology units	Support assistance / Information technology unit

4.2. Establishment and executing

Different organizations based on the nature of their activities perform various activities depending on their priorities to determine their balanced scorecard values. Park's managers, experts and elites determine these values in Semnan university science and Technology Par using a continuous improvement. In this article based on Fig 3 and using technique of group analytical hierarchy process (AHP), we determined importance and indices values (Wongrassamee et al., 2003).

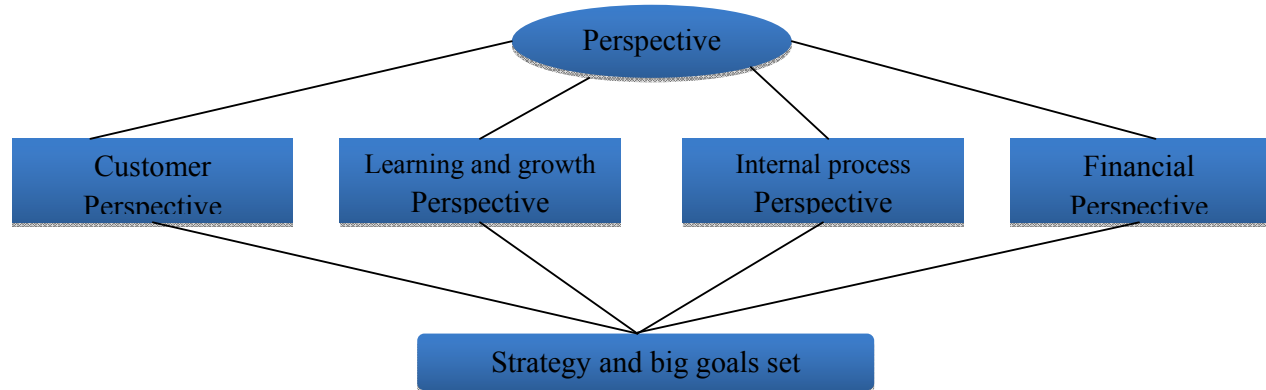


Fig. 3. Hierarchy plane of strategies set (Niazi, 2011)

We have calculated different weights associated with four BSC perspectives and they are summarized in Table 3 and Table 4.

Table 3

Pair comparisons matrix of balanced scorecard perspective in the respective of experts

Balanced scorecard perspective	Customer Perspective	Learning and growth Perspective	Internal process Perspective	Financial Perspective
Financial perspective	0.38	0.35	1.55	1.00
Internal process perspective	0.41	0.21	1.00	0.64
Learning and growth perspective	2.46	1.00	4.78	2.89
Customer perspective	1.00	0.41	2.44	2.64
Total	4.25	1.97	9.77	7.17

Table 4

Values of pair comparisons matrix of balanced scorecard perspective in the respective of experts

Balanced scorecard perspective	Customer Perspective	Learning and growth Perspective	Internal process Perspective	Financial Perspective	Wi
Financial perspective	0.089	0.178	0.159	0.139	0.141
Internal process perspective	0.096	0.107	0.102	0.089	0.099
Learning and growth perspective	0.579	0.508	0.489	0.403	0.495
Customer perspective	0.235	0.208	0.250	0.368	0.265
Total	1	1	1	1	1

4.3. Calculating indices in different perspective

In Semnan University Technology and Science Park balanced scorecard team from interviewing with experts and elites, competitor information and also with regarding to relation each measurement with other measurement, targeted measurement. As it mentioned, four perspectives and balanced scorecard indices have specific values that are effective in calculations related to different levels. Recent rate of achieving to each index related to ideal value and to total efficiency for each balanced scorecard perspective and Semnan University Technology and Science Park's efficiency received regarding to following calculations.

$$X_i = F_i/T_i$$

$$X_i = \text{Percent rate of achieving to I index to goal value.}$$

F_i = Real rate of I index. T_i = Ideal rate of I index

$Y_j = \sum W_{ij} * X_{ij}$ Y_j = Efficiency of J perspective W_{ij} = Value of I perspective in J perspective
 perspective X_{ij} = Percent rate of achieving I index in J perspective

$Z = \sum W_j * Y_j$ Z = Park's efficiency total

W_j = Value of J perspective Y_j = J perspective's efficiency total

Table 5 macro goals, performance measurement, indices values, also efficiency score of Semnan University Technology and Science Park in 2010.

Table 5

Calculating balanced scorecard indices from financial perspective in Semnan University Technology and Science Park

Row	Essential goals in financial perspective	Performance measurement	W_{ij}	F_i	T_i	X_i	$W_{ij} * X_i$	$Y_i = \sum W_{ij} * X_i$
			Indices values	Existent values	Ideal values	Percent Rate achieving to goal	Efficiency of each index	Efficiency of total perspective
1	Make trading ideas and applying university research results	Percent rate of financial support from fixed planes	0.406	2110	2268	93%	37.7%	95.3%
2		Rate of spend budget for long term improvement	0.356	1596	1680	95%	33.8%	
3		Rate of budget spending	0.238	252	252	100%	23.8%	

Internal process perspective plays important role in performance improvement of parks. In other words, they help technology units and provide strategies for keeping, attracting and accepting technology units to park, and in order hand they move along park's financial goals to meet beneficiary's expectations. Table 6 provide macro goals, performance measurement, indices values and also efficient of internal process perspective of Semnan University Technology and Science Park in 2010.

Table 6

Calculating balanced scorecard indices from internal process perspective in Semnan University Technology and Science Park

	Essential goals in internal process perspective	Performance measurement	W_{ij}	F_i	T_i	X_i	$W_{ij} * X_i$	$Y_i = \sum W_{ij} * X_i$
			Indices values	Existent values	Ideal values	Percent Rate achieving to goal	Efficiency of each index	Efficiency of total perspective
1	Supporting creation and extension of technology small and medium firms and supporting research firms with technology developing and employment goal	Rate of using improving process of doing work	0.112	30	43	69.7%	7.8%	80.5%
2		Percent of existence of promotion, and encouragement in park	0.694	78	100	78%	54.1%	
3		Rate of using information technology to doing works of technology units	0.194	55	60	91.6%	18.6%	

Today commission of all firms is focuses on customers: “Best and first commission in providing value to customer”. Customer perspective indicate park's strategy and process for providing service to technology unit and reflect what is important for units that really is value chain for technology units. Table 7 provides macro goal, performance measurement, indices values and efficiency score of Semnan University Technology and Science Park in 2010.

Table 7

Calculating balanced scorecard indices from customer perspective in Semnan University Technology and Science Park

Row	Essential goals in customer perspective	Performance measurement	W_{ij}	F_i	T_i	X_i	$W_{ij} * X_i$	$Y_i = \sum W_{ij} * X_i$
			Indices values	Existent values	Ideal values	Percent Rate achieving to goal	Efficiency of each index	Efficiency of total perspective
1	Using public and university equipment for services, supporting, initiative and extending technology in society	Rate of credit provided to technology unit	0.671	3048	3810	80%	53.6%	80.5%
2		Rate of credit provided to units in firm in festival	0.069	350	430	81%	5.5%	
3		Satisfaction rate of technology units from park	0.126	85	100	85%	10.7%	
4		Percent of using equipment by technology unit	0.134	40	50	80%	10.7%	

Learning and growth perspective identify necessary substructure for long-term growth and park's duration. This perspective with strengthening park's principle resources, which includes people, system and trends can decrease existing gap in park between capabilities and capacities. Table 8 provides macro goals, performance measurement, indices values also efficiency of learning and growth perspective of Semnan University Technology and Science Park in 2010.

Table 8

Calculating balanced scorecard indices from learning and growth perspective in Semnan University Technology and Science Park

Row	Essential goals in learning and growth perspective	Performance measurement	W_{ij}	W_{ij}	F_i	T_i	X_i	$W_{ij} * X_i$	$Y_i = \sum W_{ij} * X_i$
			Goals values	Indices values	Existent values	Ideal values	Percent Rate achieving to goal	Efficiency of each index	Efficiency of total perspective
1	Completing active and dynamic initiative cycle for developing initiative	Efficiency rate of park's supporting from technology units	0.541	0.514	50	57	87.7%	45%	45.8%
2		Number of technology unit to develop		0.327	43	50	86%	28.1%	
3		Percent of growth of technology units from scientist environment		0.088	30	45	66.6%	5.8%	
4		Hold educational hours for technology units		0.071	142	171	83%	5.8%	
5	Helping to increase wealth in society by developing knowledge centered economic	Number of provided ideas in market	0.459	1	28	43	65.1%	29.8%	75.6%

4.4 calculating Park's total efficiency index

With calculating park's total efficiency index, park's performance in four perspectives of learning and growth, internal process, customers and financial have been measured that can show these calculations in table 9. With inserting above cases in performance evaluation system, one can expect that this system cause to increasing stimulation staff, managers and technology units and therefore improving Semnan University Technology and Science Park.

Table 9

Total efficiency of Semnan University Technology and Science Park

Row	Balanced Scorecard Perspective	W_{ij}	Y_j	$W_{ij} * Y_j$	$Z_j = \sum W_{ij} * Y_j$
		Perspective values	Total efficiency	Efficiency in each perspective	Total efficiency
1	Financial Perspective	0.141	95.3%	13.4%	80%
2	Internal Process Perspective	0.099	80.5%	7.9%	
3	Customer Perspective	0.265	80.5%	21.3%	
4	Learning and Growth Perspective	0.495	75.6%	37.4%	

As we can observe from the results of Table 9, learning and growth perspective” with 37.4% score has highest score in Semnan University Technology and Science Park, and “internal process perspective” with 7.9% score has lowest score in Semnan University Technology and Science Park.

5. Results

Table 10 shows BSC perspectives, parks strategic, essential macro goals measurement index, final score and efficiently of each perspective. The proposed model of this article indicates that one can evaluate park's performance with total efficiency and it is possible to do corrective actions in activities to determine appropriate measurement indexes, efficiency of Technology and Science Park of Semnan University.

As we can see from the results of Table 10, total efficiency of financial perspective was 13.4%. Therefore, we can say that this perspective in Technology and Science Park has acceptable score, since there were some limitations on budgets.

Learning and growth perspective efficiency was 37.4%. Since Semnan University Technology and Science Park's growth and learning perspective has been made out of two essential goals and five indices, one can say that this perspective in Technology and Science Park has relatively good performance. In addition, the same arguments hold for customer perspective, which maintains a total efficiency of 21.3%.

Customer perspective includes some public measurement such as customer satisfaction, customer keeping, customer attracting, customer profitability, customer loyalty, market share, etc. Finally Semnan Technology and Science Park's internal process perspective was 7.9%. Since Semnan University Technology and Science Park's internal process perspective has been made from one essential goal and three indices, one can say that this perspective in Technology and Science Park has lowest score. The reason for having low performance was that the unit was recently established Park. Thus, the programs for receiving these goals and determinants must be prepared by Park's managements.

Table 10**Perspective efficiency , goals and indices in Semnan University Technology and Science Park**

Row	Perspectives of balanced scorecard	Efficiency of each Perspective	Essential macro goals	Efficiency of each goal	Index (performance measurement)	Efficiency of each index	Total efficiency
1	Financial Perspective	13.4%	Make trading ideas and applicability university research results	95.3%	Percent rate of financial support from fixed planes	37.7%	80%
					Rate of spend budget in along improving and extending park	33.8%	
					Rate of spend budget in doing research	23.8%	
2	Learning and Growth Perspective	37.4%	Completing active and dynamic cycle for developing initiative	45.8%	Efficiency rate of park's supporting from technology units	45%	
					Number of technology unit to develop	28.1%	
					Percent of growth of technology units from scientist environment	5.8%	
					Hold educational hours for technology units	5.8%	
					Helping to increasing wealth in society by developing knowledge centered economic	29.8%	
3	Customer Perspective	21.3%	Using public and university equipment for services, supporting, initiative and extending technology in society	80.5%	Rate of credit provided to technology unit	53.6%	
					Rate of credit provided to units in firm in festival	5.5%	
					Satisfaction rate of technology units from park	10.7%	
					Percent of using equipment by technology unit	10.7%	
					Rate of using improving process of doing work	7.8%	
4	Internal Process Perspective	7.9%	Supporting creation and extension of technology small and medium firms and supporting research firms with technology developing and employment goal	80.5%	Percent of existence of promotion , and encouragement in park	54.1%	
					Rate of using information technology to doing works of technology units	18.6%	

6. Conclusion

We have explained that research parks play essential role in developing economy since they these units could provide new ideas for industries. Industries could implement the ideas developed in pilot plan scales in research parks. In fact, many premature ideas could be first initiated in such units and interested investors or venture capitals could use new ideas to start new businesses, which could end up having some value added firms.

The proposed model of this paper implemented BSC for one of recently established research parks in province of Semnan, Iran. We have made an assessment on four measures of BSC perspectives and determined the present status of these units.

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