Determining the relationship between science and technology development indicators in private sector industries of Iran via path analysis based on cooperative game theory

Mostafa Jafari[1], Majid Tootooni[2*] (Corresponding author), Meisam Jafari Eskandari[3]

[1]Department of Industrial Engineering, Iran University of Science & Technology, Iran
[2]Department of Industrial Engineering, Iran University of Science & Technology, Iran
[3]Department of Industrial Engineering, Payame Noor University, I.R. of Iran
M_tootooni@iust.ac.ir

Abstract: This paper reviews the interactive relationship between science and technology performance indicators used by Iran private sector industry based on balanced scorecard approach, using a combination of path analysis and game theory. There are four dimensions to the evaluation of support provided by development organizations in the Iran Ministry of Industries and Mines to empower the private sector in domains of science and technology based on the scorecard approach. In the first step, evaluation indices were derived based on field studies, and accordingly bilateral questionnaires were developed. These Indicators were grouped into some categories, named strategic issues of that field, followed by the assessment of correlation between them. Next, relationships between these issues were examined by means of the concept of game theory in the form of a multi-factorial structure, and ultimately, executive paths were determined based on priorities to achieve desired goals and objectives. In this study, the concept of scenario building has been analyzed for the first time based on the concept of game theory by means of Shapely value in order to draw effective cause and effect relationships in the form of path analysis process. This study may help managers understand the management of key indicators of success and identify critical paths and the way to deal with critical situations. Ultimately, the calculated results were compared with the results of path analysis using regression analysis and expert opinion to show the closeness of criteria importance between this new approach and the regression method.
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1. Introduction:

In recent decades, profound changes have been made in industrialization processes. The most visible changes can be seen in the role of government and development of private sector. Recent advances in communication and technology production combined with global and regional trade liberalization implies significant increases in the productivity of private firms.

Definitely, changes in the role of government, on the one hand, and globalization, on the other hand, have made private sector development planners and industrial policymakers focus on private sector industry. Private sector capabilities requires a complex set of rules of extensive physical infrastructure, environments with macroeconomic stability, development of financial markets, attraction of foreign direct investment, development of small and medium industries, labour market regulations, IT improvement systems and training and learning needs so that it could follow the path of permanent change in all aspects of industrial development. Realization of these goals usually needs a general consensus and effective efforts by government.

In the present era, dramatic changes in knowledge management, has made the use of evaluation systems inevitable so that lack of these systems in different aspects of the organization, including assessment of resources and facilities, staff, goals and strategies has been considered as a symptom of organizational disease. In a study in the United States, Baldwin and Clark (1992) reported that the main reason for decreased competitive ability in American organizations was directly related to inappropriate use of performance measurement systems by managers [1].

Wilson (2003) conducted a study on the failure of organizations in successful implementation of performance evaluation systems and found that the most important strategy to overcome challenges in measurement systems was to use balanced scorecards and to define and analyze processes [2].

Performance measurement system through balanced scorecards was first introduced by Kaplan and Norton in 1992. Criticizing traditional methods of measuring performance based on financial criteria, they introduced the necessity of using non-financial criteria [3]. A study, conducted on 500 companies in

2004, showed that at least 60% of companies used balanced scorecards to assess their organizations.

Preliminary results from organizations that have adopted scorecard to evaluate their organizations show that these organizations have successfully resolved many obstacles in implementing strategies by means of this approach. Comprehensive studies on barriers to successful strategies in organizations have helped classify these barriers into six areas which are summarized and shown in figure 1 [4, 5].

Balanced Scorecard is defined as a cause and effect model to determine in what indicators the organization is leading or in what indicators the organization has a low performance.

Despite widespread use of balanced scorecard, only a few studies have yet been conducted on the cause and effect relationship among different aspects of balanced scorecard framework. Balanced scorecard assumes that cause and effect relationships are established between four dimension, including growth and training, internal processes, financial, and customer aspects [6].

These relationships are very important because, unlike traditional methods, they allow managers to measure performance based on non-financial criteria and use them to predict organizational financial performance. On the other hand, each cause and effect relationship requires a time interval between cause and its effect. Thus, it is very difficult to create real relationships between all the considered aspects. Different methods have been used for establishing this relationship, including the use of key performance indicator and mathematical modelling. Here, the use of multivariate analysis methods such as path analysis can be a more reliable technique. In this paper, we propose a combined approach based on balanced scorecard to analyze paths to show fields of factors which are used to draw strategy maps. In addition, for the first time, we considered the concept of scorecard, instead of statistical concepts, to determine the most effective paths and priorities based on desired conditions.

First, we assess the private industrial sector supported by development organizations affiliated with the Ministry of Industries and Mines. Then we try to identify indicators, variables and strategic issues followed by reviewing the basic concepts and structure of game theory. After that, we will explain by a scenario concept that how these interactions are developed between proposed components. Finally, the results and conclusions will be assessed.

2. Development organizations affiliated with the Ministry of Industries and Mines

In the third five-year program of economic development, it was decreed that state-owned enterprises were to be organized within the establishment framework of specialized mother companies and subsidiaries of specialized mother companies. According to a schedule approved by the Cabinet, Subsidiaries can be transferred to non-governmental sector via stock exchange or auction by the privatization organization. In certain cases where the transfer cannot be made via stock exchange or auctions due to problems of financial structure and human resources or absorption of technology and capital, the transfer would be made through negotiation in accordance with proposed regulations by the Ministry of Finance and Economic Affairs as approved by Cabinet.

Development organizations affiliated with the Ministry of Industries and Mines which are evaluated in this study include:

a) Industrial development and renovation organization of Iran (IDRO)

b) Organization of development and renovation of mines and mineral industries of Iran

c) Organization of small industries and industrial towns of Iran

d) Modern Industry organization

e) Bank of mines and industry

f) Organization of geological exploration and mining

Figure 2 illustrates a review of the market value of organizational assets in past years shows increased ascending shift from tangible assets toward intangible assets as a major competitive component in organizations.

☒ By examining the performance of these organizations in supporting and empowering the private sector in terms of science and advanced technologies, we identified eight components based on experts' opinion. These components considered for designing balanced scorecard system include: development of financial resources; development of human resources and management capabilities; improving quality and access to national and global standards, education development, research and innovative technologies; competitive intelligent; technology export development; promoting cooperation between enterprises in advanced sciences; and development of new technology schemes consistent with the needs of consumer market. In the first place, it is necessary to identify and categorize different aspects of evaluation consistent with the components of balanced scorecard. In this regard, following several meetings, four prevalent components of balanced scorecard were identified, which were thought to include the above-mentioned dimensions as follows:

☒ **The Financial aspect**: development of financial resources.

☒ **The Customer aspect**: development of new technology plans consistent with the needs of consumer market, improving quality and access to national and global standards.

☒ **The Internal Processes aspect**: competitive intelligent, technology export development, and promotion of cooperation between enterprises in advanced sciences.

☒ **The Growth and Learning aspect**: development of human resources and management capabilities, education development, research and innovative technologies.

3. Game Theory

Game theory involves a significant part of decision making process under uncertainty conditions. Following its introduction, Game theory was developed by Emily Bourl and Van Noman, although it is not exactly clear that who should be introduced as the founder of the theory [7]. For each game, three factors are necessary [7]:

a) Players

b) Players' strategies that are allowed under rules of the game

c) Utilities or results

In this study, the main approach is use a game with n-players and balanced scorecard. Hence, in this section, we try to focus on this type of game and wish to become more familiar with its basic concepts.

Suppose a limited number of players (n) shown by a set like $N = (1,2,3,...,n)$. Each subset $K \subseteq N$ of this set is called a coalition. N/K is used to display the supplementary set of K in N or $K \subseteq N$ which refers to players that are not in the coalition of K. Suppose the coalition with K persons can earn the amount of maximum guaranteed points, $V(K)$. We call $V(K)$ a property function, which is defined in terms of $K \subseteq N$. This function will satisfy the following properties:

1. $V(\phi) = 0$;

2. For all $K, L \subseteq N$ that $K \geq L \neq \phi$, we have $V(K \cup L) \geq V(K) + V(L)$;

The first property states that the value of an empty coalition is equal to zero. The second one is called additive property and states that the value of a coalition composed of two components is at least equal to their total individual values.

Many types of solution concepts have been proposed in literature for n-player cooperative games. One important solution, which is proposed by Shapely in 1953, is known as Shapely value. The Shapley value indicates the relative benefit that accrues to each player in a coalition. However, we note that the value applies to transferable utility (games with side paying). Shapely value in non-transferable utility was presented by Shapely in 1969 and extended more by Mashler and Owen in 1992 [7]. Suppose that $G(n)$ is the set of all games (all possible property functions) with n players. Shapely value of ψ is a mapping $\psi : G(n) \rightarrow E^n$ (E^n is an n-dimensional Euclidean space) that satisfies the following conditions:

1. Symmetry: If players i, j are replaced in a particular game, V, then $\psi v_i = \psi v_j$. ψv_i shows the reward obtained by person i in game V under Shapely value.

2. Performance: $\sum_{i=1}^{n} \psi v_i = V(n)$;

3. Additive: $\psi(v+h)_i = \psi v_i + \psi h_i$;

4. Void player: $\psi v_\phi = 0$;

In 1953, Shapely showed that ψ is unique and proved the following theorem:

$$\psi v_i = \frac{1}{n!} \sum_M [V(K_i \cup \{i\}) - V(K_i)]$$

, so that for all n different transforms ($n!$ number mode), M changes and K_i is a set of players that are placed before i in the sequence of M.

Based on the drawn components, we consider each aspect of scorecard as a player in the first step. In this assumption, we considered the development of financial resources aspect as the first player with two components, client aspect as the second player with two components, internal processes aspect as the third player with three components, and, finally, learning and growth aspect as the fourth player with two components. This scheme is drawn based on Latin squares in multifactor analysis. Each cell in table 1 shows a combination of factors together in each field, and our goal is to obtain Shapely values for these co-operations in each aspect of the balanced scorecard.

4. Building cause and effect relationships

Balanced Scorecard is a cause and effect model to determine in what indicators the organization is leading or in what indicators the organization has a poor performance. Cause and effect relationships are established among four aspects, including education and growth aspect, internal processes aspect, customer aspect and financial aspect. On the other hand, every cause and effect relationship requires a time interval between cause and its effect. Thus, it is very difficult to create real relationships among all the considered aspects. In our first step in dealing with eight field categories in scorecards, we require an initial model based on defaults. For this purpose, a questionnaire was prepared, which addressed every aspect of strategic issues. For the validation of this questionnaire, we first distributed it among six experts (1 person from each development organization). Following the analysis of the results, the reliability of the questionnaire was calculated to be 0.87 using Cronbach's alpha formula, indicating that the questionnaire had an acceptable reliability index. Next, the questionnaire was distributed again among the experts, and, finally, the default original model was introduced based on strategic issues (see in Figure 3).

In this paper, we used path analysis method with balanced scorecard approach to assess the performance of six organizations in providing support for private sector and to determine cause and effect relationships between the indicators defined. Figure 3 shows the conceptual model used in this study. This Figure illustrates the causal relations among the factors related to each aspect and a number of 11 hypotheses are linked together using arrows. Accordingly, we formulated and tested the following hypotheses as follows:

H1: Development of education, research and new and applied technologies have a positive effect on improvement and cost reduction.

H2: Development of education, research and new and applied technologies have a positive effect on competitive intelligent for increasing knowledge-based exports.

H3: Building an agile structure and integrating scientific and technological systems have a positive effect on outsourcing and supporting private sector in order to empower them.

H4: Development of education, applied research and new technologies have a positive effect on outsourcing and supporting private sector in order to empower them.

H5: Outsourcing and supporting private sector in order to empower them has a positive effect on initiation and pioneering in service delivery models in line with the absorption of new technologies and creation of customer loyalty.

H6: Competitive intelligent for increasing knowledge-based exports has a positive effect on the development of indigenous scientific and technological patterns consistent with the needs of the consumer market.

H7: Improving and reducing costs have a positive effect on initiation and service delivery models in line with the absorption of new technologies and creation of customer loyalty.

H8: Developing indigenous scientific and technological patterns consistent with the needs of the consumer market have a positive effect on increasing organizations' financial support of development of technology-based knowledge in the private sector.

H9: Developing indigenous scientific and technological patterns consistent with the needs of the consumer market have a positive effect on increasing revenues by the private sector in the area of science and technology.

H10: Pioneering and service delivery models in line with the absorption of new technologies and creation of customer loyalty have a positive effect on increasing organizations' financial support of development of technology-based knowledge in the private sector.

H11: Pioneering and service delivery models in line with the absorption of new technologies and creation of customer loyalty have a positive effect on increasing revenues by the private sector in the area of science and technology.

After analyzing and establishing cause and effect relationships for the development organizations of the Ministry of Industries and Mines, we tried to collect experts' opinions, from each organization, about the most important and applicable operational indicators in each of the balanced scorecard aspects. Hence, in the first step, we both conducted -individual interviews with each organization's experts and did library studies in collections in order to extract indicators and identify their effect and applicability. Eventually, a questionnaire was developed consistent with the aforesaid activities. After selecting the components and preparing the questionnaire, we distributed the scale among 10 people from within the population randomly to evaluate its validity on each aspect of the scorecard. The data obtained from questionnaires were used to calculate the reliability of the scale using Cronbach's alpha formula. The obtained alpha values confirmed the reliability of the questionnaire. Then questionnaires were distributed among 25 experts from each organization.

We evaluated the effective factors, which helped empower the private sector, based on two characteristics: degree of influence and current situation. Table 2 illustrates the mean scores and standard deviation as the total scores. In the tables designed to measure the degree of influence, number 1 is used for low-impact factors, number 2 refers to factors with moderate impact and number 3 is used for high-impact factors. In addition, in order to measure the current status of factors enabling the private sector, number 1 is used for a situation where the organization is too weak on that factor; number 2 for poor condition; number 3 for regular condition; number 4 for good condition; and number 5 show a supreme condition of the organization.

Path analysis is a multivariate analysis, which is used for practical investigation of a set of relationships that is shown in a form of linear cause and effect model [8]. The advantages of path analysis over methods, like regression, include utility of integrated tests of coefficients instead of using separate tests, the ability to test models with multiple dependencies between coefficients, etc. [9]. In the first step, we examined the correlation between the discussed factors. Table 3 illustrates the detailed results of this analysis.

On the other hand, we tried to validate the paths and relationships. To this end, we run two-sided t-test. To do the statistical analysis, the first type of error is considered as 0.01, 0.05 and 0.1, and the results are analyzed separately. Table 4 illustrates the results of this analysis.

5- Analysis of results

In growth and learning aspect, five indicators are used in this study. These indicators determine whether the development organizations have equipped themselves with the following tools to provide support for the private sector to develop new sciences and technologies. The tools include educational services to empower the work force in industrial enterprises, consulting services and software (technical, managerial, financial, marketing, research, etc.) to industrial enterprises, targeted research and development in the industrial sector, promotion of good work culture in industrial enterprises, and supporting private enterprises to participate in international markets in the realm of science and technology.

In internal processes aspect, seven indicators have been considered. These include deregulation and reduction of bureaucracy for private sector involvement, consistency of the country's legal system with international legal system, creation of necessary platforms and facilitation of the assignment of companies to the private sector, partnerships and help to create strategic alliances between industrial enterprises, creation of basic infrastructure (guarantee fund, information centres, etc.) for export development, targeted subsidies and export awards, and supporting high-risk technologies.

Development organizations had an acceptable performance in helping private sector to create strategic alliances, but they need to continue and refine processes to increase productivity and organizational performance.

Performance criteria in customer aspect consist of five indicators. In two of these indicators, helping firms to design products consistent with the advancements and daily needs and making investment to achieve technology and new industries and localizing them, their performance was good while, in three indicators pertaining to pioneering and service delivery model in line with modern technology to attract and create loyalty in customers, their performance was poor. These indicators include helping to implement scientific development market systems, helping firms produce and deliver world-class services and support the development of global market for small industries through establishment of commercial networks.

Financial aspect is evaluated based on six key indicators including the level of support provided by fiscal regime to encourage investment in the field of technology, access to mid-term financing for new investments, credit facilities for private sector information technology development, guarantee and security for industrial investment, facilitation of processes to get banking facilities, and banking sector openness.

After compiling key indicators in each aspect of balanced scorecard, we examined correlations and tested hypothesis relations. Table 4 illustrates the results of statistical analysis. As indicated in this table, H1 examines the relationship between two components of education development, research and new and applicable technologies and reduction of costs and improvement in two areas of growth and learning and internal processes. The validity of H1 was approved at the level $\alpha = 0.1$ ($p = 0.06 \prec 0.1$). H2 and H3 hypotheses examine the relationship between the components of growth and learning and internal processes, which were tested and approved at the level $\alpha = 0.05$ ($p = 0.02 \prec 0.05$ *and* $p = 0.01 \prec 0.05$). H4 hypothesis, which considered the relationship between two components in internal processes and customer aspect, showed a high correlation between these two components at the level $\alpha = 0.01$ ($p = 0.007 \prec 0.01$). H5 and H6 hypotheses, which examined the relationships between the components of internal processes and customer, were tested and validated at the level $\alpha = 0.1$ ($p = 0.06 \prec 0.1$ *and* $p = 0.08 \prec 0.1$). H7 and H8 were tested at the level $\alpha = 0.05$, and their validation was approved ($p = 0.03 \prec 0.05$ *and* $p = 0.03 \prec 0.05$). H9 hypothesis, which is related to customer and financial components, was tested at the level $\alpha = 0.1$, and its credibility was confirmed at this level ($p = 0.09 \prec 0.1$). H10 hypothesis was also validated at the level $\alpha = 0.01$. H11 hypothesis, that examined an internal relationship in financial aspect, was validated at the level $\alpha = 0.1$.

After validating the desired relationships, we calculated Shapely values among the extracted components as a strategy in order for each aspect of balanced scorecard to be considered as a player so as to determine the effectiveness of components in achieving major goals. In the first, we must determine the initial value of $V(i)$, with i as a component, to determine Shapely values of the components based on the drawn path in the previous section. To determine this value, we used hierarchical analysis approach in fuzzy mode (FAHP). Figure 4 shows model perspective weights and causal indicators extracted from Fuzzy AHP method.

After calculating weights for each component using FAHP method, we will consider these values as $V(i)$. Next, we will consider calculated paths to determine the Shapely value for each component in the path. The Shapely values of eight drawn paths are show in Table 5.

After determining paths, we, assisted by experts, calculated the necessary values for determining Shapely values. Table 5 presents a detailed specification of the necessary information. After that, based on the rules and proven theorem of Shapely value, we calculated these values for each component on the respective path. Table 6 illustrates the path analysis results of the examined relationships.

Subsequently, we calculated the weighted average to calculate and classify the optimal path. Ranked paths are shown in the table 7.

In this paper, we considered a new approach based on the weight assigned to each factor influencing the path. In this way, each factor will achieve the importance relative to its effectiveness based on the type of the chosen path. This is a new evolutionary approach in the identification and importance of factors in cause and effect paths in strategy maps of organizations. In our approach, we considered a dominant concept based on game theory in cooperation mode where the estimated coefficients in regression equation were the desired values on relationships vectors. This is unlike traditional approaches that work based on path analysis via regression method. Here, we used the drawn paths as the basis for determining the weight of factors, and rankings are based on this approach.

6- Validation of Cause and effect relationship model

To evaluate the model, we first examine the stability of established relationships. In order to analyze the stability of relationships, we will test the validation of results using a statistical stability measuring approach. In this test, we will use factor analysis method to select every chosen factor. The fundamental assumption in factor analysis technique is that the factor underlying the variables can be used to explain complex phenomena, and observed correlations among variables is the result of shared factors among variables [10]. Factor analysis technique in this article includes dividing a factor into two dimensions and evaluating statistical results by eliminating one of these dimensions. The main goal of this phase is to make decision about the stability of established relationships. Output results show that the results are acceptable in regard to actual approaches in existing systems. In the next step, we compared the path analysis method based on game theory and regression analysis. The results were given to experts to test their validity and accuracy of facts. Figure 4 illustrates the results of path analysis between the default relationships and their coefficient values based on the evaluation of linear regression relationship.

In calculating these coefficients, a factor on top level was first assumed as the dependent variable, and then all factors, that are likely to have an impact on this factor, were considered as independent variables. After that, we used multiple regressions. When linear regression coefficients of factors were obtained in the equation, the highest coefficient was selected and identified as the most effective factor. In the next step, the factor, identified as the most effective factor in the previous step, was considered as a dependent factor in this stage. Then all other factors, that are likely to have an impact on it, were considered as independent variables. By calculating linear coefficients of the regression equation, the highest coefficient was then considered as the most effective factor. This procedure continued until we reached the last non-affected factor. Values written besides vectors in figure 5 are coefficients obtained from linear regression equations. Similarly, we followed all the above steps with another factor on top level and continued the entire process.

After calculating regression coefficients and drawing Figure 4, we interviewed experts in order to validate the proposed model based on performance indicators in real situations. In regression path analysis, calculated values for each vector are figured out via partial analysis between every two components; however, it is indeed desirable that factor analysis for each factor be considered as its effect on total value chain. All experts have emphasized considering this benchmark. In path analysis approach based on game theory, paths were considered as value chains for the organization. Through planning of the above components, Organizations can plan in a synergistic path for organizational values. In this new approach, unlike traditional partial approach based on regression, planning is mostly based on organizational value chain, and the importance of each factor is measured in a total form.

7- Conclusion

Scorecard is a set of indicators that are chosen from four areas of financial, customer, internal processes and learning and development aspects and their relations [3]. A study conducted in the U.S. in 2005 showed that 64% of companies are using balanced scorecard to assess their organization [11]. The purpose of this study was to assess cause and effect relationships between performance indicators of science and technology development in the private sector supported by development organizations of the Ministry Industries and Mines in the BSC structure. In this regard, a new approach was used in the process of path analysis via cooperative game theory. For this purpose, after establishing cause and effect relationships, we used statistical analysis and evaluated their influence at the desired levels. Then, consistent with game theory in the cooperation mode, we extracted Shapely values to determine the importance of each factor based desired path and extracted values. Then we prioritized these paths. In this study, we developed a new approach for the first time in relation to the concept of cause and effect relationships to determine the actual weight of each factor based on its influence on the desired path. Results show that drawn paths in the evaluation of effective factors indicate a new emphasis on renewal of existing structures with the aim of improving knowledge in private enterprises to enter international competitions. Lack of attention to this important factor can cause a great gap between private enterprises and current economic activities in the world so that, over time, these firms may be to left out of the trade activity cycles. This shows that organizational processes and knowledge-based organizational operations should monitored by ongoing and continuous observations. Also, according to the long-term visions of Islamic Republic of Iran and fourth economic development plan for sustainable growth, knowledge-based development, active interaction with the world's economy, competitiveness of economy as stimulants without executive support, on the one hand, and isolation of strong and professional entrepreneurs of previous generation, and lack of strategic thinking and movements in enterprises, on the other hand, has prevented private sector firms from having a suitable position in our country's economy and global competitiveness.

Table 1. Latin square design for the relationship between perspectives of Balanced Scorecard

		Player 2			
		I		**II**	
Player 1	**I**	Player 3 (I), Player 4 (I)	Player 3 (I), Player 4 (II)	Player 3 (I), Player 4 (I)	Player 3 (I), Player 4 (II)
		Player 3 (II), Player 4 (I)	Player 3 (II), Player 4 (II)	Player 3 (II), Player 4 (I)	Player 3 (II), Player 4 (II)
		Player 3 (III), Player 4 (I)	Player 3 (III), Player 4 (II)	Player 3 (III), Player 4 (I)	Player 3 (III), Player 4 (II)
	II	Player 3 (I), Player 4 (I)	Player 3 (I), Player 4 (II)	Player 3 (I), Player 4 (I)	Player 3 (I), Player 4 (II)
		Player 3 (II), Player 4 (I)	Player 3 (II), Player 4 (II)	Player 3 (II), Player 4 (I)	Player 3 (II), Player 4 (II)
		Player 3 (III), Player 4 (I)	Player 3 (III), Player 4 (II)	Player 3 (III), Player 4 (I)	Player 3 (III), Player 4 (II)

Table 2. Effective factors and indicators in establishing the relationships between science and technology development

α	SD	Mean	No. of Respondent	**Factors and effective indicators**	**Field**	α	SD	Mean	No. of Respondent	**Factors and effective indicators**	**Field**
0.905	Development of indigenous scientific and technological patterns consistent with the needs of the consumer market (C1)				***Customer***	0.873	Increasing financial support for developing technology-based knowledge in the private sector **(F1)**				***Finance***
	0.352	3.67	150	Helping firms to design products consistent with the advancements and daily needs			0.623	2.91	150	The level of support provided by fiscal regime to encourage investment on technology	
							0.233	1.49	150	Access to mid-term financing for new investment	
	0.920	3.52	150	Investment to achieve new technologies and industries and localization of them			0.414	2.87	150	Credit facilities for development of information technology in private sector	
0.798	Leadership and service delivery patterns to absorb					0.776	Increasing income in the area of science and				

	new technologies and create customer loyalty (C2)				
	0.014	3.21	150	Facilitating the implementation of scientific development market systems	
	0.047	2.92	150	Helping firms to produce and deliver world-class services	
	0.031	3.22	150	Support the development of global market for small industries through establishment of commercial networks	
0.832	**Development of education, research and new, applied technologies (L1)**				***Growth & Leaning***
	0.266	2.9	150	Providing educational services to empower the work force in industrial enterprises	
	0.446	2.2	150	Providing consulting services and software (technological, managerial, financial, marketing, research, etc) for industrial enterprises	
0.876	**Creation of an agile structure and integration of scientific and technological systems (L2)**				
	0.617	3.22	150	Targeted research and development in industrial sector	
	0.418	2.76	150	Propagation of a good work culture in industrial enterprises	
	0.325	3.28	150	Supporting private enterprises to participate in international markets in the realm of science and technology	

	technology by the private sector (F2)				
	0.06	3.85	150	Guarantee and safety of industrial investment	
	0.403	2.46	150	Facilitation of processes to get bank loans	
	0.324	2.60	150	Banking sector openness	
0.697	Outsourcing and supporting private sector in order to empower them (I1)				***Internal Processes***
	0.18	2.48	150	Deregulation and reduction of bureaucracy to facilitate private sector involvement	
	0.763	2.40	150	Consistency of the country`s legal system with international legal system	
	0.710	2.42	150	Creation of necessary platforms and facilitation of the transfer of companies to the private sector	
0.744	Building competitive intelligent for increasing knowledge-based exports (I2)				
	0.039	3.11	150	Partnerships and help to create strategic alliances among industries enterprises	
	0.198	3.13	150	Creating basic infrastructure (guarantee fund, information centers,...) for export development	
0.677	Improving and reducing costs (I3)				
	0.112	2.95	150	Targeted subsidies and export awards	
	0.087	2.83	150	Supporting high-risk technologies	

Table 3. Correlation matrix of factors

	L1	L2	I1	I2	I3	C1	C2	F1	F2
L1									
L2	**0.103**								
I1	**0.621**	**0.709**							
I2	**0.830**	**0.213**	**0.091**						
I3	**0.902**	**0.051**	**0.167**	**0.066**					
C1	**0.207**	**0.139**	**0.021**	**0.688**	**0.104**				
C2	**0.361**	**0.072**	**0.906**	**0.429**	**0.593**	**0.173**			
F1	**0.152**	**0.248**	**0.023**	**0.121**	**0.065**	**0.862**	**0.931**		
F2	**0.078**	**0.028**	**0.107**	**0.301**	**0.245**	**0.235**	**0.796**	**0.841**	

Table 4. Statistical results of cause and effect model

Relative Element	Independent Element	Efficacy	Hypothesis	$T-Value$	$P-Value$	α	Result of Test
I3	L1	+	H1	1.96	0.062	0.1	✓
I2	L1	+	H2	2.24	0.026	0.05	✓
I1	L2	+	H3	2.63	0.014	0.05	✓
I1	L1	+	H4	2.93	0.007	0.01	✓
C2	I1	+	H5	1.94	0.064	0.1	✓
C1	I2	+	H6	1.79	0.086	0.1	✓
C2	I3	+	H7	2.2	0.038	0.05	✓
F1	C1	+	H8	2.3	0.031	0.05	✓
F2	C1	+	H9	1.72	0.099	0.1	✓
F1	C2	+	H10	2.87	0.008	0.01	✓
F2	C2	+	H11	1.73	0.094	0.1	✓

Table 5. Shapely values of components of model paths

Path	Value of Components		
$F1 \leftarrow C2 \leftarrow I1 \leftarrow L1$	$V(C2)=0.104$	$V(I1)=0.042$	$V(L1)=0.093$
	$V(L1,C2)=0.211$	$V(L1,I1)=0.123$	$V(F1)=0.156$
	$V(I1,F1)=0.214$	$V(I1,C2)=0.171$	$V(L1,F1)=0.286$
	$V(L1,C2,F1)=0.396$	$V(L1,I1,C2)=0.301$	$V(C2,F1)=0.293$
	$V(L1,I1,C2,F1)=1$	$V(I1,C2,F1)=0.377$	$V(L1,I1,F1)=0.321$
$F1 \leftarrow C1 \leftarrow I2 \leftarrow L1$	$V(C1)=0.139$	$V(I2)=0.124$	$V(L1)=0.093$
	$V(L1,C1)=0.293$	$V(L1,I2)=0.258$	$V(F1)=0.156$
	$V(I2,F1)=0.403$	$V(I2,C1)=0.374$	$V(L1,F1)=0.286$
	$V(L1,C1,F1)=0.512$	$V(L1,I2,C1)=0.442$	$V(C1,F1)=0.345$
	$V(L1,I1,C2,F1)=1$	$V(I2,C1,F1)=0.628$	$V(L1,I2,F1)=0.507$
$F1 \leftarrow C2 \leftarrow I3 \leftarrow L1$	$V(C2)=0.104$	$V(I3)=0.03$	$V(L1)=0.093$
	$V(L1,C2)=0.211$	$V(L1,I3)=0.173$	$V(F1)=0.156$
	$V(I3,F1)=0.214$	$V(I3,C2)=0.201$	$V(L1,F1)=0.286$
	$V(L1,C2,F1)=0.396$	$V(L1,I3,C2)=0.331$	$V(C2,F1)=0.293$
	$V(L1,I3,C2,F1)=1$	$V(I3,C2,F1)=0.469$	$V(L1,I3,F1)=0.405$
$F1 \leftarrow C2 \leftarrow I1 \leftarrow L2$	$V(C2)=0.104$	$V(I1)=0.042$	$V(L2)=0.123$
	$V(L2,C2)=0.257$	$V(L2,I1)=0.211$	$V(F1)=0.156$
	$V(I1,F1)=0.214$	$V(I1,C2)=0.171$	$V(L2,F1)=0.320$
	$V(L2,C2,F1)=0.501$	$V(L2,I1,C2)=0.391$	$V(C2,F1)=0.293$
	$V(L2,I1,C2,F1)=1$	$V(I1,C2,F1)=0.377$	$V(L2,I1,F1)=0.414$
$F2 \leftarrow C2 \leftarrow I3 \leftarrow L1$	$V(C2)=0.104$	$V(I3)=0.03$	$V(L1)=0.093$
	$V(L1,C2)=0.211$	$V(L1,I3)=0.173$	$V(F2)=0.189$
	$V(I3,F2)=0.287$	$V(I3,C2)=0.201$	$V(L1,F2)=0.303$
	$V(L1,C2,F2)=0.509$	$V(L1,I3,C2)=0.331$	$V(C2,F2)=0.451$
	$V(L1,I3,C2,F2)=1$	$V(I3,C2,F2)=0.518$	$V(L1,I3,F2)=0.414$
$F2 \leftarrow C1 \leftarrow I2 \leftarrow L1$	$V(C1)=0.139$	$V(I2)=0.124$	$V(L1)=0.093$
	$V(L1,C1)=0.293$	$V(L1,I2)=0.258$	$V(F2)=0.189$
	$V(I2,F2)=0.391$	$V(I2,C1)=0.374$	$V(L1,F2)=0.303$
	$V(L1,C1,F2)=0.517$	$V(L1,I2,C1)=0.442$	$V(C1,F2)=0.462$
	$V(L1,I1,C2,F2)=1$	$V(I2,C1,F2)=0.663$	$V(L1,I2,F2)=0.577$
$F2 \leftarrow C2 \leftarrow I1 \leftarrow L1$	$V(C2)=0.104$	$V(I1)=0.042$	$V(L1)=0.093$

Path	Value of Components		
	$V(L1,C2)=0.211$	$V(L1,I1)=0.123$	$V(F2)=0.189$
	$V(I1,F2)=0.292$	$V(I1,C2)=0.171$	$V(L1,F2)=0.303$
	$V(L1,C2,F2)=0.509$	$V(L1,I1,C2)=0.301$	$V(C2,F2)=0.451$
	$V(L1,I1,C2,F2)=1$	$V(I1,C2,F2)=0.445$	$V(L1,I1,F2)=0.398$
	$V(C2)=0.104$	$V(I1)=0.042$	$V(L2)=0.123$
	$V(L2,C2)=0.257$	$V(L2,I1)=0.211$	$V(F2)=0.189$
$F2 \leftarrow C2 \leftarrow I1 \leftarrow L2$	$V(I1,F2)=0.292$	$V(I1,C2)=0.171$	$V(L2,F2)=0.364$
	$V(L2,C2,F2)=0.553$	$V(L2,I1,C2)=0.391$	$V(C2,F2)=0.451$
	$V(L2,I1,C2,F2)=1$	$V(I1,C2,F2)=0.445$	$V(L2,I1,F2)=0.501$

Table 6. Path analysis results for 8 paths based on shapely values

		Player 2							
		I				**II**			
Player 1	**I**	-	-	-	-	0.230	0.209	0.279	0.196
		-	-	-	-	0.283	0.278	0.275	0.250
		0.179	0.271	-	-	-	-	-	-
		0.286	0.264	-	-	-	-	-	-
		-	-	-	-	0.223	0.231	-	-
		-	-	-	-	0.293	0.254	-	-
	II	-	-	-	-	0.212	0.186	0.225	0.185
		-	-	-	-	0.339	0.264	0.322	0.238
		0.167	0.266	-	-	-	-	-	-
		0.311	0.257	-	-	-	-	-	-
		-	-	-	-	0.2	0.192	-	-
		-	-	-	-	0.336	0.268	-	-

Table 7. Ranking of model paths

Rank	Weighted Average	Path
5	0.25587	$F1 \leftarrow C2 \leftarrow I1 \leftarrow L1$
6	0.25525	$F1 \leftarrow C1 \leftarrow I2 \leftarrow L1$
4	0.25654	$F1 \leftarrow C2 \leftarrow I3 \leftarrow L1$
8	0.25404	$F1 \leftarrow C2 \leftarrow I1 \leftarrow L2$
2	0.26232	$F2 \leftarrow C2 \leftarrow I3 \leftarrow L1$
3	0.2588	$F2 \leftarrow C1 \leftarrow I2 \leftarrow L1$
1	0.26372	$F2 \leftarrow C2 \leftarrow I1 \leftarrow L1$
7	0.25407	$F2 \leftarrow C2 \leftarrow I1 \leftarrow L2$

Corresponding author:
Majid Tootooni
M_tootooni@iust.ac.ir

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