A Comprehensive Systemic Model of Innovation Management : Total Innovation Management (TIM)

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Abstract

In today's knowledge based economy, innovation is a crucial factor for success and survival of businesses. Therefore, all industries highly to be in need of effective innovation management .In this research , a comprehensive model of innovation management (Total Innovation Management – TIM) have been designed on the basis of an extensive theoretical review and according to the incorporated systemic approach . The TIM model embraces the most main factors and aspects of a broad view of effective innovation management in industrial organizations,included innovation resources , innovation processes and outcomes (26 hypotheses). The model was then examined and validated through an empirical and field study among industry managers .The data gathering instrument was a researcher-made questionnaire which its reliability coefficient was accepted .The Structural Equation Modeling (SEM) analytical methodology by LISREL software was used to analysis the data. Research findings indicate that the hypotheses was supported and the model was validated .The TIM model embraces three main comprehensiveness related to innovation resources, innovation processes and outcomes. The model has suggested a comprehensive innovation management system, that included several sub-systems .

Keywords : Innovation Management , Innovation Model , Total Innovation Management , Organizational Innovation , Innovation System

1. Introduction

Today, industry and business is knowledge based and innovation is the most vital factor for creating value and competitive advantage. Thus the ability to innovate is one of the most important core competence of the organizations for survival . Numerous businesses are competing to survive in this ever increasing challenging and highly volatile environment , and innovation is the most important factor in shaping a corporation's success throughout the coming years.

Today's business challenge is to unshackle its innovation capacity to control growth and profitability while achieving leadership in its targeted markets. Global economic forces and financial constraints have made innovation-driven growth more essential . The need for innovation is imperative (Tidd and Bessant , 2005) . Innovation widely recognized by academics and industry The body of literature around the topic of organizational creativity and innovation management is relatively young and grew considerably over the recent decades . The most literature on innovation management models has limitations . First , innovation is very narrowly defined and technology-oriented . In this narrow view, innovation focus on R&D, new product development , product innovation or the product/process dichotomy . Whereas innovation is not limited to this and a broad view of innovation is necessary . A second limitation of the literature is the lack of a rich typology for innovation . Most innovation typologies focus on the degrees or types of technological innovation , while innovation is multifaceted and goes beyond technology , therefore a new innovation typology is needed (Howells and Tether ,2007, Sawhney, et al ,2006). A comprehensive model of innovation management model needs to embrace all main factors and aspects of corporate innovation in an integrated way . This research proposed Total Innovation Management model as a comprehensive , consolidated and systemic approach to the innovation management .

2.THEORETICAL BACKGROUND

Although there are different views and perspectives of innovation , a common theme in all definitions of innovation is that it is a new ideas that is put into practice while paying special attention to its usefulness . A broad , innovation define as an initiative in any dimensions of the business system to create substantial new value for customers and the firm (Sawhney,2006). Innovation management define as the active and conscious organization , control and execution of activities that lead to innovation (Hanson and Birkinshaw , 2007).

An overview of related literature shows that innovation management models developed over time . The main reason for this change is the change in the environment in which innovation take place. According to the Rothwell (1994), there are five generations of innovation management models. The first and second generation of innovation management models are linear models explaining innovation as either being pulled by market needs (1950-Mid 1960s), or pushed by technology(Mid 1960s-Early 1970s). The third generation model(Early 1970s-Mid 1980s) is a coupling model that recognizes the influence of technological capabilities and market needs within the firm . The fourth generation model (Early 1980s-Early 1990s) is an interactive approach that views the innovation process as parallel activities across organizational functions . The fifth generation model (Early 1990s –now) emphasis on the network. Major characteristics of the network model are the influence of external environment and the effective communication with external environment . Innovation happens within a network of internal and external stakeholders . The establish links between all the role-players is important (Rothwell , 1994) .

An extensive literature review by Researchers indicate that studies on the innovation management in the recent decades, has provided us with a broad range and various types of innovation management models, such as Tornansky and Fisher(1990),Ebert(1992), Taam (1992), Rothwell(1994),Ulrich(1995),pleschak(1996),Cooper(1996),Bleicher(1999), Lawson and Samson(2001),Galluj(2002),Brandenberg(2002),Pan,Beers and Kleinich(2003) , Sauber (2003),Bessant(2003),Chesbrough(2003),Trot(2005),Guffin and Mischell(2005), Galanakis (2006, Laptasic,Shaw and Litner(2006),Mage(2006),Kearney(2006),Chen and sawhney (2006),Preeze and lou(2008),Stamm(2008),Birkinshaw,Hamel and Mol (2008), Skarzinsky and Gibson(2008). A depth overview of innovation management models by researcher shows that all have their advantages and disadvantages , and no model can claim to be comprehensive , covering most main factors and aspects of innovation. All of the models are imperfect and ignore several aspects of the innovation management . Innovation management models have become more complex, more inter-disciplinary and more integrated (Eveleens , 2008).The relative importance of different models of innovation management varied by time-period because of different external influences (Miller et al 2000). In support of a broader view of innovation , some researchers state that non-technological innovations are as important as technological innovation , and there are many more dimensions to innovation such as organizational innovation and marketing innovation (OECD,2005).According to Shapiro (2001), enterprises should try to realize 24/7 innovation (all time innovation) for rapid response to the needs of customers . Consequences of the innovations such as social and environmental consequences of the innovations recently is an important topic. Environmental innovation or Eco-innovation refer to the innovations that throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resources use compared to relevant alternatives (Speirs et al,2008).
Golestan Hashemi (2002,2004,2009) proposed a concept of Total Innovation Management (TIM) and the following related keynotes :1.Creative and exploratory analysis and distinguish of customer needs (value creation and answer to latent demands of people) , 2.Continuous and ceaseless creativity and innovation , 3.Replace improvement –orientation with innovation , 4. Creativity enhancing , 5. Knowledge/ Innovation – based works , 6. Continuous creative re-engineering and Changes ,7. Participation of all employees as innovator , 8. Creative strategies , Forecasting and Strategic management of Innovation, 9. Networking , 10. Creative Structure and culture,.11.Creative / Inventive Problem Solving and systematic innovation methodologies such as TRIZ .
Xu et al (2002,2006,2007) proposed a theoretical framework of Total Innovation Management based on tri-totality in innovation .The first , includes innovation in all technological and non-technological elements such as strategy, culture, organization, institution and market .The second relates to innovation by all individuals involved . The third is innovation at all time and in all space. The findings from the literature review, help to extract and articulate the main generic characteristics and components of innovation management towards a comprehensive model of innovation management .The process is dynamic and all of the components are amenable to a system-wide . The domain of such a model is broad .

3. Hypothesis Development and the Research Model

As the result of an extensive literature review , as mixed findings are observed in prior studies, null hypotheses are proposed. Constitution of the research framework is based on the systemic approach. Thus the research model (Total Innovation Management Model) has a systemic structure that constitute inputs (innovation resources) , processes (innovation processes) and outputs (innovations and related aspects), as shown in figure 1.

3.1.Hypothesis

The hypotheses are associated with inputs , processes, outputs and their relationships .

Hypotheses related to inputs :

H1: Creative ideas of employees is a component of the innovation resources .
H2: Applied researches of employees is a component of the innovation resources .
H3: Research and Development (R&D) is a component of the innovation resources .
H4: Marketing research is a component of the innovation resources .
H5: Forecasting studies is a component of the innovation resources .
H6: Creative ideas of customers(stakeholders) is a component of the innovation resources .
H7: External research co-operations is a component of the innovation resources .
H8: Purchase of innovation is a component of the innovation resources .
H9: External information resources is a component of the innovation resources .

Hypotheses related to processes :

H10: Innovative organizational structure is a component of the innovation processes .
H11: Innovative organizational culture is a component of the innovation processes .
H12: Innovation in all of the value chain is a component of the innovation processes .
H13: Innovation in all of the organizational processes is a component of the innovation processes .
H14: Innovation in all times (24/7) is a component of the innovation processes .
H15: Creativity and innovation techniques is a component of the innovation processes .
H16: Information and communication technologies is a component of the innovation processes .
H17: Managerial systems is a component of the innovation processes .

Hypotheses related to outputs :

H18: All types of the innovations is a component of the outputs .
H19: The quantity of the innovations is a component of the outputs .
H20: The rate of the innovations is a component of the outputs .
H21: The quality of the innovations is a component of the outputs .
H22: Consideration of the individual consequences of the innovations is a component of the outputs .
H23: Consideration of the social consequences of the innovations is a component of the outputs .
H24: Consideration of the environmental consequences of the innovations is a component of the outputs .

Relationships :

H25: There is a significant relationship between input and process .
H26: There is a significant relationship between process and output .

3.2. Research Model

The research model (Total Innovation Management model) is the following :

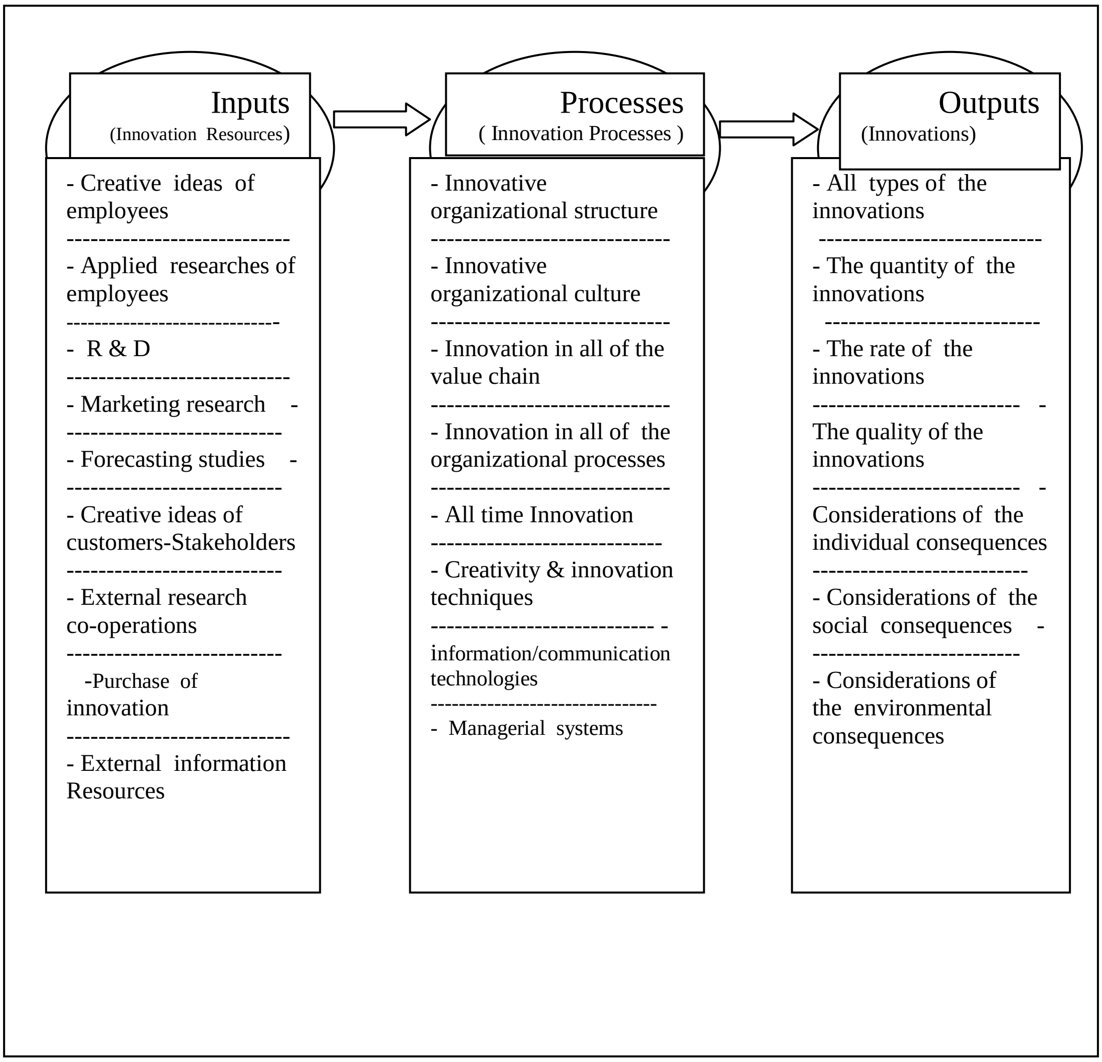


Figure 1. Research Model

In this systemic model , components of the outputs are endogenous variables, and components of the inputs and processes are exogenous variables . Also inputs , processes and outputs are as latent variables and related components are as manifest variables .

4. Research Methodology

4.1 Research Design

Survey design method was used in this research . The data collection instrument was a researcher-made questionnaire .

4.2 Questionnaire

The questions was based on the research model and theoretical backgrounds . Thus the questionnaire embraces items related to the research model, all measured by using a five-point Likert-type scale . Cronbach's alpha was used to verify internal consistency reliability . Cronbach's coefficients of questionnaire shows a significant reliability of 0.921.The questionnaire was pre-tested and revised .

4.3 Sampling and Data Collection

Sampling was done by stratified random method from the 950 iranian medium and large industries. Data collection was done by approaching 360 employees from mention above industries , mostly middle managers . 308 usable samples were obtained after excluding the incomplete ones, yielding a 85.5 % response rate .

4.4 Data Analysis

Data analysis involves descriptive statistics and structural equation modeling using LISREL structural equation program . LISREL is designed to estimate and test structural equation models (SEMs) . SEMs are statistical models of linear relationship among latent (unobserved) variables and manifest (observed) variables . For this research LISREL was used to investigate the causal relationships ,where the path coefficients are tested for significance and goodness-of-fit. The path diagram of the structural model specified is proposed based on the research model .

5. Structural Equation Modeling (SEM) Results

5.1 Models

Figure 2. shows the significance (t-test) model , and Figure 3 shows the standard estimated model, included path coefficients for research variables .

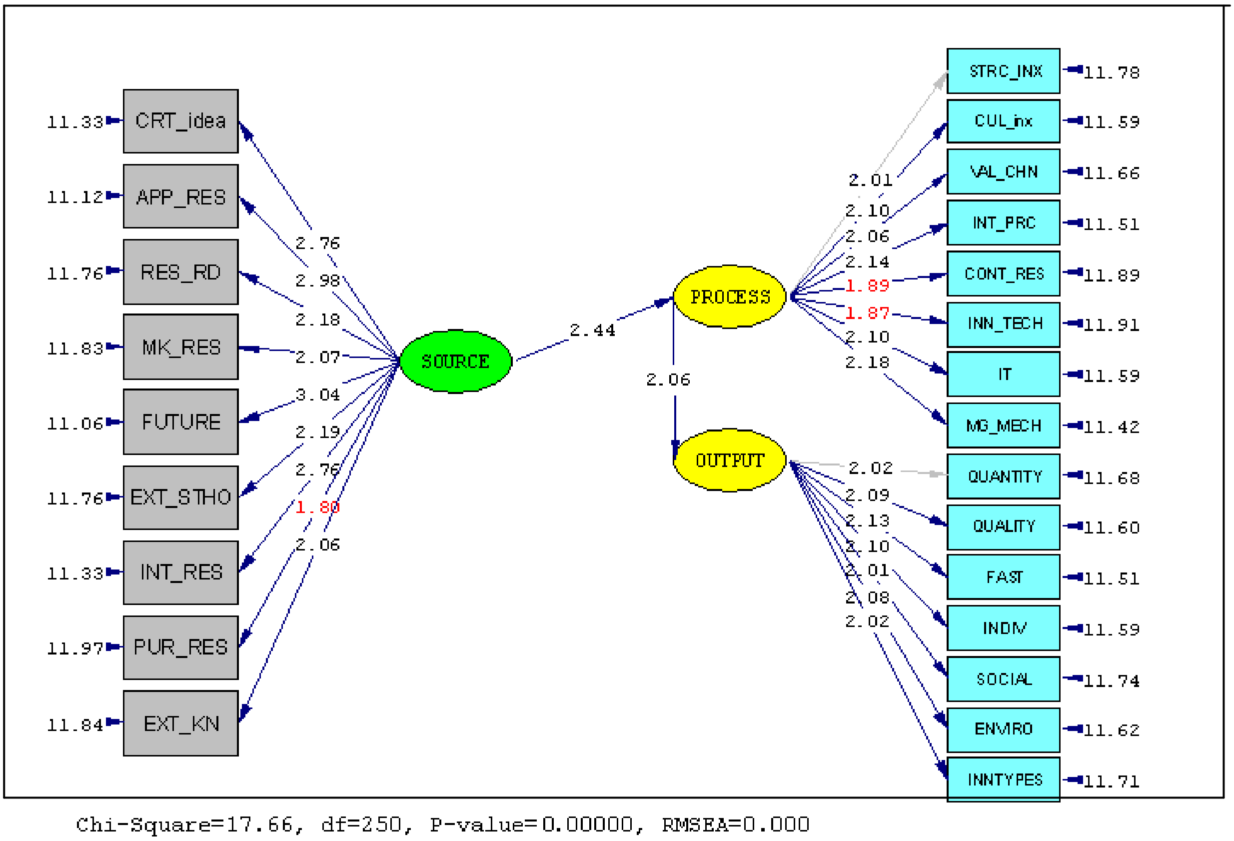
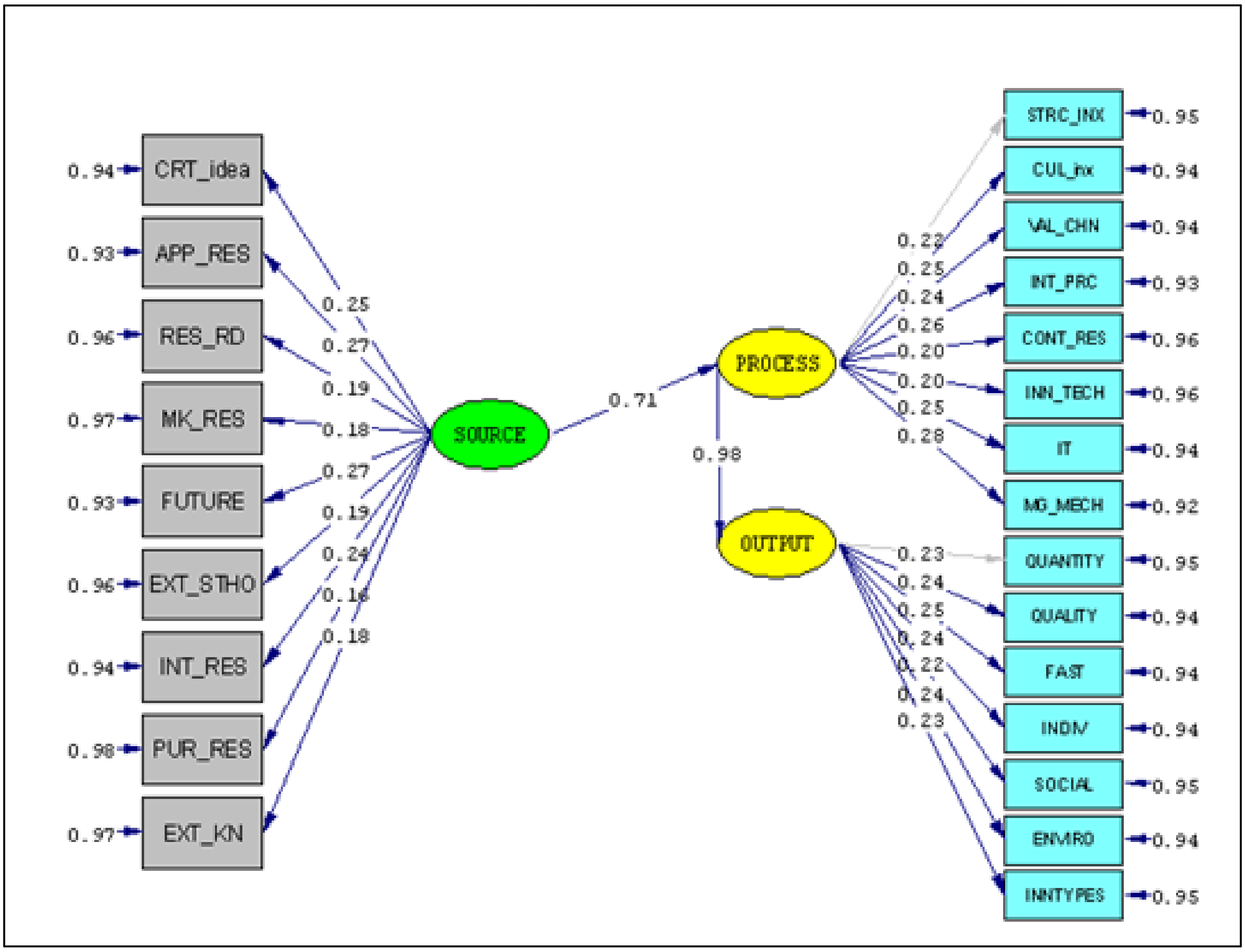


Figure 2. The significance (t-test) model



Chi-Square=17.66, df=250, P-value=0.00000, RMSEA=0.000

Figure 3. Standard estimated model (Path coefficients)

5.2 Goodness-of-Fit Measures

Table 1. shows goodness-of –fit measures for estimated model .Regarding SEM applications , the Likelihood- ratio chi- square and the goodness -of – fit index are basic measures of absolute fit of the model . In the present research, the chi-square value of 17.66 with 250 degrees of freedom and ratio of chi-square to degrees of freedom value of 0.66 was found to be statistically significant (acceptable range is 3 or less).The root mean square error of approximation (RMSEA) is 0.00 (acceptable range is 0.1 or less). The root mean square residual (RMSR) value is 0.013 (acceptable range is 0.05 or less).Another absolute fit measures (fitting indexes) shows that the model is marginally acceptable at best (Table 1).

Table 1. Goodness of Fit Measures for the Estimated Model

Goodness- of-fit measures	Estimated model	Acceptable range
Absolute fit measures		
Likelihood –ratio chi- square (χ^2)	17.660	
Ratio of chi-square to degree of freedom (χ^2/df)	0.066	< 3
P-value	0.000	< 0.05
Root mean square of approximation (RMSEA)	0.000	< 0.1
Goodness-of-fit index (GFI)	0.995	> 0.9
Adjusted goodness-of-fit index (AGFI)	0.994	> 0.9
Root mean square residual (RMSR)	0.0135	< 0.05
Standardized Root mean square residual (SRMSR)	0.0130	< 0.05
Relative fit index (RFI)	0.908	> 0.9
Normed fit index (NFI)	0916	> 0.9
Non-normed fit index (NNFI)	0.912	> 0.9

5.3 Hypothesis Results

Apart from the model's general fit for the data, it is also important to test its parameters. The significance tests for the structural model parameters are the basis for accepting or rejecting the proposed relationships between exogenous and endogenous constructs(Hair et al ,1998). The results of the models shown in figure 2 and 3 provided strong support for hypothesis (Table 2). H1,H2,H3,H4,H5,H6,H7 and H9 were accepted that are components of the innovation resources(Table 2). H10,H11,H12,H13,H16,H17, and H18 were accepted that are components of the innovation processes in the research model .H19,H20,H21,H22,H23 and H24 were accepted that are components of the outcomes in the research model .(Furthermore non-direct relationships of components related to H8, H14 and H15 confirmed by using the correlation technique) . H25 and H26 were accepted that there is strength relationship between inputs and processes and between processes and outputs (Table 2) .

Table 2. Hypothesis results for the structural model

Research hypothesis (TIM model)	Estimate	t value	Conclusion
Components of the Inputs (Innovation Resources)			
H1: Creative ideas of employees	0.25	2.76	Supported
H2: Applied researches of employees	0.27	2.98	Supported
H3: Research and Development (R&D)	0.19	2.18	Supported
H4: Marketing research	0.18	2.07	Supported
H5: Forecasting studies	0.27	3.04	Supported
H6: Creative ideas of customers(stakeholders)	0.19	2.19	Supported
H7: External research co-operations	0.24	2.76	Supported
H8: Purchase of innovation	0.16	1.80	Not supported
H9: External information resources	0.18	2.06	Supported
Components of the Processes(Innovation Processes)			
H10: Innovative organizational structure	0.22	2.01	Supported
H11: Innovative organizational culture	0.25	2.10	Supported
H12: Innovation in all of the value chain	0.24	2.06	Supported

H13: Innovation in all of the organizational processes	0.26	2.14	Supported
H14: Innovation in all times	0.20	1.89	Not supported
H15: Creativity and innovation techniques	0.20	1.87	Not supported
H16: Information and communication technologies	0.25	2.10	Supported
H17: Managerial systems	0.28	2.18	Supported
Components of the Outputs(Expected Outcomes)			
H18: All types of the innovations	0.23	2.02	Supported
H19: The quantity of the innovations	0.23	2.02	Supported
H20: The rate of the innovations	0.25	2.13	Supported
H21: The quality of the innovations	0.24	2.09	Supported
H22: Consideration of the individual consequences of the innovations	0.24	2.10	Supported
H23: Consideration of the social consequences of the innovations	0.22	2.01	Supported
H24: Consideration of the environmental consequences of the innovations	0.24	2.08	Supported
Relationships			
H25: A significant relationship between input and process .	0.71	2.44	Supported
H26: A significant relationship between process and output .	0.98	2.06	Supported

6. Discussion , Conclusion and Implications

The proposed model of Total Innovation Management (TIM) has provided a useful comprehensive , incorporated and systemic framework for investigating key factors of innovation management .

It consolidates main components of innovation resources , innovation processes and expected outcomes under a more dynamic and systemic platform synergistically. The TIM model embraces three main comprehensiveness or totality : comprehensiveness in innovation resources, comprehensiveness in innovation processes, and comprehensiveness in outcomes. The model has suggested an extensive innovation management system , that included several sub-systems with dynamic and synergetic interactions . The model also presented a new alternative extensive , integrated , developmental and systemic study and formulation approach to all elements of organizational creativity and innovation . The model provides a better understanding of innovation management . Several powerful theories such as complexity theory and social system theory supported the model . This paper has several implications for industrial managers. It leads to an applicable powerful managerial system for innovation . An important message to managers is that a more effective innovation system needs to be comprehensive , integrated and systemic . Hence, providing a Total Innovation Management system in industries can help to development of corporate innovation capabilities for creation of value and competitive advantages . Industry managers should try to support TIM system . This paper also has several directions for future research . This study can be performed in service industries .Also this study can be performed in small and medium enterprises (SME).

References

Alkemade,Floortje and et. (2007).Analysing emerging innovation systems : a functions approach to foresight. International Journal of Foresight and Innovation Policy,vol.3,no.2,2007. Alves,Jorge and et.(2007).Creativity and Innovation through Multidisciplinary and Multisectoral Cooperation.Journal Comilation,Volume 16,No.1,2007. Andriopoulos,Constantine and Dawson,Patrick (2009).Managing Change, Creativity and Innovation.SagePublications.

Bessant,John.(2003).High-Involvement Innovation .Wiley.-Birkinshaw, Julian and Hamel,Gary(2008).Management Innovation. Academy of Management Review , 2008 , Vol.33,No.4,825-845.

Chaturvedi,Mukesh.Kumar,Aseem & Rahul, Manmohan(2009).Managing Innovation and New Product Development, Concepts and cases .PHI Learning.

European Innova (2008). The European Eco-Innovation Platform (Eco-IP). Innova. Eveleens,Chris(2010).Innovation Management ; a literature review of innovation process models and their implications .Lecture-NL.

Eversheim ,Walter(2009).Innovation Management for Technical Products ; Systematic and integrated product development and production planning . Springer. Fischer,Bruce D(2001).Managing Innovation-An Analysis of the Literature. Midwest Business Administration Association Conference.

Goffin,Keith & Mitchell, Rick (2010) . Innovation Management , Strategy and Implementation Using the Pentathlon Framework . Palgrave Macmillan . -Golestan Hashemi , Sayed Mahdi (2002).An Organizational Creatology Approach : Total Innovation Management. Journal of Creatology and Inventive Problem Solving .No.5, October 2002, (in Persian).

Golestan Hashemi,Sayed Mahdi .(2004).TRIZ,TQM & TCIM . TRIZ Journal ,Dec.2004. Golestan Hashemi,Sayed Mahdi(2009).A Creatological Approach to the Creativity and Innovation Management and R&D:Total Creativity&Innovation Management(TCIM) System and TR&I. 6th International Symposium on Management of Technology(ISOMOT2009) . Lawson,Benn & Samson,Danny (2001).Developing Innovation Capability in Organizations A Dynamic Capabilities Approach.International Journal of Innovation Management, Vol.5, No.3,pp,377-400.

OECD(2002).Oslo Manual ,OECD Guidelines for Collecting & Interpreting Innovation Data.OECD.

OECD(2008).Systematic Eco-Innovation Report. OECD.

O'Sullivan,David and Dooley ,Lawrence(2009). Applying Innovation .SAGE Publication ,Inc. Panne,Gerben . Beers,Cees & Kleinknecht,Alfred (2003).Success and Failure of Innovation , A literature Review . International Journal of Innovation Management ,Vol.7,No.3, pp.1-30. Preez ,Niek & Louw, Louis (2008). A Framework for Managing the Innovation Process. Portland International Conference on Management of Engineering & Technology, PICMET 2008.

Riederer,John.Baier,Melnie.Graefe,Gernot(2005).Innovation Management- An Overview and some Best Practices.C-LAB Report,Vol.4(2005)No.3.

Rothwell,Roy(1994).Towards the Fifth-generation Innovation Process .International Marketing Review,Vol,11,No.1, 1994,pp,7-31.

Sauber, Tim and Tschirky, Hugo(2006).The Next Generation of Innovation Strategy Formulation Process .IEEE.

Schiederig,Tim.Tietze,Frank and Herstatt,Cornelius (2011).What is Green Innovation? A quantitative literature review.Humburg University of Technology,Working Paper No.63. Silverstein,David.DeCarlo,Neil and Slocum , Michael (2008).Insourcing Innovation; How to Achieve Competitive Excellence Using TRIZ.Auerbach Publications, Taylor & Francis

Group. Skarzynski , Peter and Gibson , Rowan (2008) . Innovation To The Core , A Blueprint for Transforming the Way Your Company Innovates . Harward Business Press .
Smith , Marisa(2008).Factors Influencing An Organisation's Ability To Manage Innovation: A Conceptual Model . International Journal of Innovation Management,Volume 12 , Issue 4 (2008),pp.655-676.
Song, Gang . Zhang,Nan & Meng,Qingguo(2009).Innovation2.0 as a Paradigm Shift: Comparative Analysis of Three Innovation Models . International Conference on Engineering Management and Services (EMS2009).
Stamm,Bettina Von.(2008).Managing Innovation , Design and Creativity .Wiley.
Sundbo,Jon.Fuglsang,Lars.(2002).Innovation as Strategic Reflexivity.Routledge .
Tidd,Joe(2006).A Review of Innovation Models. University of Sussex .
Tidd,Joe.Bessant,John and Pavitt,Keith(2005).Managing Innovation;Integrating technological, market and organizational change . Wiley .
Xu,Qingrui.Zheng,G.et al(2002).Towards capability-based Total Innovation Management The emerging new trend of innovation management- a case study of Haier Group.Isomot and ICMIT02 Proceedings.Zhejiang Univ.Press.
Xu,Qingrui.Zhu,Ling and Zhen,G.(2004).The measurement of total innovation capacity Case study of several Chine firms . Engineering Management Conference.
Xu,Qingrui and et.(2006).Total Innovation Management : a novel paradigm of innovation management in the 21st century .Journal of Technology Transfer (2007) 32:9-25.
Xu,Qingrui and et.(2007).Haier Tao of Innovation: A Case Study of the Emerging Total Management Model. Journal of Technology Transfer, (2007)32:27-47.
Wagner and et. (2006).The firm as innovation system: applying complexity Principles to drive new product development. IAMOT2006.