

# Innovation Managers' Competencies: Identification and Prioritization Using a Multi- Criteria Decision Making (MCDM) Fuzzy Technique

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## Abstract

In leading organization, considering to strategic intellectual assets capabilities of managers and their management talent are more important. An excellence of organization depends on the development of attitudes and capabilities of managers. On the other hand, managers' abilities and the creating power of effective organizational strategies are the most important factors to promote motivation, commitment and loyalty of employee. In recent decades, industrial organizations are facing the pressure of innovation, thus an effective innovation management seems necessary that this will be achieved by specific job roles and competencies and special management skills. In order to ensure the ability of managers in areas of innovation, these competencies should be evaluated and also, it is needed to take necessary actions for developing and expanding them. This study aims to identify and prioritize the most influential and eligibility criteria for innovation managers. In present study, we identified and recognize criteria merit for innovative managers, and we used F.DEMATTEL method to determine the relationship and how it influence on measures and its severity of influence, also F.ANP is used to prioritize criteria. The result of this research includes a model that consists of three major criteria and 15 sub-criteria. In

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research model, future studies, management of change and evolution, innovation and entrepreneurship are achieved the first to third priorities.

**Keywords:** Competency, Innovation managers, Innovation organizations, FUZZY ANP, FUZZY DEMATEL

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## Introduction

According to Cameron, management means the work and development with the people, this means being responsible, making clearly and good communication, keeping promise, and recognizing own; that requires the ability of delegation and the powerful sense and giving creativity to subordinates, and also requires courage tenacity and being a quick learner. (Cameron, 1997) Competencies include behaviors that help a successful management and business performance as well; so competencies are key factors that allow an individual to achieve their goals and improve their performance. (Arditi, et al. 2013)

Competencies are used to increase organizations and employees performance and an efficiency of competitive advantage. In addition, case studies show that organization use competencies for various reasons such as: increased staff productivity, decreased training costs, reduced employees' displacements, focused on the capacity of individuals rather than their jobs, transferred valuable behaviors and reinforced team and mutual behaviors. (Robinson, et al., 2007)

Some of the important reasons of competencies include: Increased performance by determining competencies of the job duty executor. Improving executor's competencies allows them to achieve higher levels of performance.

Competencies are focused on personal development rather than performing successful work that is according to the traditional approach.

No merits can be achieved without the particular organizational requirements. (Dubois, 2002)

Additionally, as a result of several changes in recent times such as the dynamic nature of the changing and competitive environment, flattened organizational environment, globalization of organizations and other cases, it is increasingly revealed that organizations need to merited and suitable managers and new approaches. "Competency approach" is one of the newest and the most important approaches that were raised as an effective thought to cope with these changes. (Nwokah & Ahiauzu, 2008) On the other hand, the role of innovation managers will be highlighted and its importance will be increased by development of technology and innovation the nature of the industries. Now, these questions are raised:

- What competencies (criteria and sub-criteria) must have innovation managers to be successful in their jobs and tasks?

- What are these criteria and sub-criteria weighted?

- How is the relationship between criteria and sub-criteria and their impact (how much do they impact)?

This study aims to seek answers to these questions and achieve research purposes by helping faculty, employees and managers of innovation and research and development area.

### **Review of research materials and methods**

The research materials and methods is presented in three sections included the concept of competency, innovation and innovation managers, and reviewing competency models.

#### *Competency*

Competency is both a feature and a skill. For example, in the most general sense, competency is "a fundamental characteristic of the person which leads to an effective and/or superior performance in a job" (Klemp, 1980); or "a combination of knowledge, skills and features which are used in the workplace" (Middleton & Long, 1990). In previous study, a wide variety of competencies is detected that cover the entire range of management decisions. Fayol (1949) and Katz (1974) the first individuals worked in this area, but the largest and most extensive studies have been published in management magazines and literatures. For example, there are some studies: Boyatzis, 1982; Mintzberg 1973, 1983; Koontz, O'Donnell & Weinrich, 1984; Whetton & Cameron, 1984; Albanese, 1989; Greatrix & Philips, 1989; Colloff & Goodge, 1990; Tichy & Charan, 1991. Many organizational and managerial studies are considered a wide range of conditions such as management process, roles, skills, attributes, personal characteristics, and demands (Gilmore & Carson, 1996). Although, it may be appropriate for a manager who has all the complementary qualifications of management, but it is unlikely that any managers could have all significant abundance of characteristics. In fact, there are no single set of competencies that are applicable to all managerial positions (jobs) and any managerial works could not be completely described by a set of competencies as well; so competencies that are needed to recognize are an agreement between management coaches and trainers (Albanese, 1989).

Several definitions of other researchers are presented in Table 1.

Table 1 Definitions of Competencies in the view of some researchers

Researchers	Year	Competency Definition
Harris, et al.	1995	Competencies are as a quality of being a worthy, having skill, knowledge, enough or good experience, and having qualifications for the task.
Ley, et al.	2006	Personal characteristics (like knowledge and skills), emotional characteristics (eg. attitudes and values), behavioral & motivational characteristics. Those characteristics of a person that are enable him or her to succeed in a particular job or situation.
Draganidis & Mentzas	2006	Explicit and tacit knowledge, behaviors and skills that give necessary potential to person for performing an effective task.
Passow	2007	Knowledge, skills, abilities, attitudes and other characteristics that enable a person to do suitably the work (such as the right decisions and doing effective works) in complex and uncertain situations.
Sanchez	2010	Competencies are related to each other as a category of knowledge, skills, attributes, attitudes that are influenced on individual's jobs and are related to the performance of individuals in work, it will be evaluated by acceptable standards and improved through education and development.

### *Innovation and Innovation Managers*

Over the past years, most managers are considered innovation as providing new products and services that are part of the duties of research and development department in company. These innovations have been significantly altered customer's expectations based on competitive advantage; however, this success is obtained by luck or visionary and legendary leaders like Steve Jobs, Richard Branson and Akio Morita; but such glance and approach to innovation is outdated. Factors such as globalization, blurred industry boundaries, an explosion in the availability and accessed to information, increased the dissemination of knowledge and the development of partnerships and enterprises, have been dramatically changed an outlook of innovation; so companies and organizations need to quickly revise their assumptions about innovation. (Loewe & Chen, 2007)

According to one of the broadest recent studies in Europe 2010<sup>2</sup>, innovation management is consisted of the ability of managing ongoing inventions/ideas for products, services, processes, production methods and new organizational forms, or a basic improvement of a business model and their successful implementation. An important point is the definition of "Successful". It means being successful in business environment through successful results in sustainable revenues and profitable growth. In

<sup>2</sup> Imp3rove: A European Project with Impact. 50 Success Stories on Innovation Management

fact, all aspects of innovation management should be directed towards accomplishing the ultimate goal of steady growth business (Riel, 2011).

The following figure is showed aspects of innovation management that is presented by A.T. Kearney namely House of Innovation.

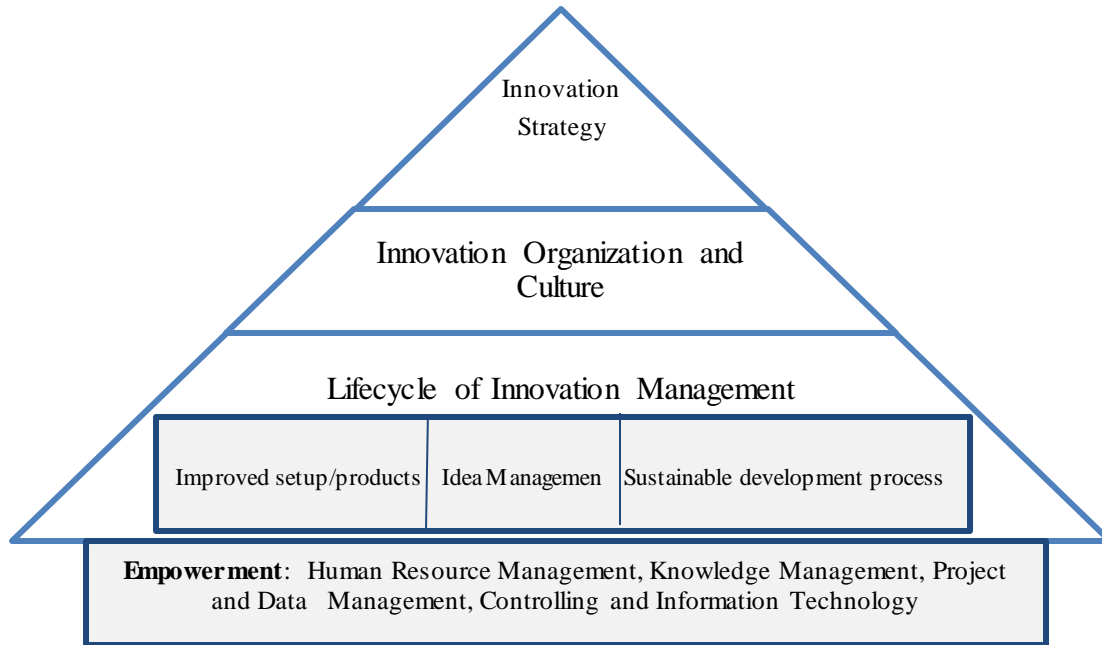


Figure 1 House of Innovation; Institute of A.T. Kearney (Rile, 2011)

Today, most innovation company will benefit high-technology industries that are faced with a variety of challenges. In fact, in this industry, "speed" is a major distinction factor, and it is why innovative products, frequent technical innovations, and providing innovative solutions to customers are very vital. (Tavakoli et. al., 2015).

In the future decades, companies that be able to manage innovation and economically benefit from it will be survived and succeeded, while they are struggled with topics such as complex organizational processes, rapid technological change, increased risk, uncertainty, cost, demands for greater flexibility in market and low barriers to entry into most businesses. Today, managers found that successful researches are different from innovation, and their difference is in the capability of providing research results to the market. Additionally, companies are expanded different looks beyond the organizational boundaries in line with increasingly diverse and distribution of resources in industries and geographic areas, and often they will create common intellectual properties after entering a good partnerships. The process of creating new and innovative ideas and eventually transferring them to market are very complicated and sensitive. Successful innovation needs to both discipline and flexibility in such a dynamic environments. In fact, strict argumentation has been proposed on the importance of traditional management controls in supporting the transition innovation process. These control systems can be noted to planning, entrepreneurship, marketing and recent business strategies. (Thamhain, 2005)

### *Competency Models*

A competency model is consisted of a competency lists that is obtained with viewing employees satisfaction performance or expected performance for a particular job and it can be helpful to analyze skills and compare between existing competencies and required competency of organization and individuals (Draganidis & Mentzas, 2006). In other words, competency models are consisted of the most important competencies that truly affect outstanding and leading performance (Cochran, 2009). The purpose of collecting competency model in each organization is to present a model for integrating human resources system performance. Some valid competency frameworks and models with subject/area are presented in Table 2.

Table 2 Competency studies and areas

Row	Researchers/Organizations	Years	Competency researches areas and applied fields
1	Spencer & Spencer	1993	American Organization Managers
2	Sandwith	1993	General managers competency
3	Lawson & Limbrick	1996	Competency of HR Managers
4	LCM	1999	Leadership Competency Model
5	Carson & Gilmore	2000	Competency of Marketing Competency of Small and Medium Enterprises
6	UNIDO	2002	Competency of Managers and Employees
7	Dulewicz & Higgs	2003	Leadership Competencies in Leadership Styles
8	Chung-Herrera et al.	2003	Competency of Housing Industry Leaders
9	European Central Bank	2004	Competencies of Bank Managers
10	Hayton & Kelley	2006	Competency of Entrepreneurial Managers
11	Patanakul & Milosevic	2008	Competency of Project Managers
12	Melaia, et al.	2008	Competencies of Marketing Managers in South Africa
13	Young & Dulewicz	2009	Competency Management and Leadership in the Navy
14	Qiao & Wang	2009	Competency of Middle Managers
15	Muller & Turner	2010	Competency of an Engineering and Manufacturing, IT and Organizational Changes
16	Hay Group	2010	Competencies of First and Middle Managers
17	Liu, et al.	2011	Professional Competency for Marketing Managers of Taiwan
18	Van Wart & Kapucu	2011	Competency of crisis Management
19	Wang, et al.	2011	Competency Model for Chinese EHS <sup>3</sup> Managers
20	Ariel	2011	Competency of innovation Managers
21	Hay Group	2012	Competencies of First and Middle Managers
22	Jamshidi et al.	2012	Competency of Oil and Gas Companies

<sup>3</sup> Environment, health and safety

			Managers
23	Arditi et al.	2013	Competencies management of male and female Managers of the Sweden Construction Industry
24	Takey & Carvalho	2014	Competency of Project managers in Engineering Company

Andreas Riel (2011) by considering three phases to achieve an innovation found that it is necessary to understand them. These three phases are as follow: 1. **Discovery**: creating or identifying high-impact market opportunities, 2. **Incubation**: testing through the technology and business in the designing of a sustainable model for a new business. 3. **Acceleration**: development of a business until it can stand on its own. Therefore, managers presented the required competencies in each phases for analyzing important competencies. Competencies of innovation managers of his view are included: the first phase: scientific and technical competencies related to subject, being able to percept and understand the market, systematic thinking, network development, identifying and developing opportunities, leadership of teams in strategic thinking. The second phase: creating a new business at the same speed of creating new information, creating multi-task team, integrating and leadership, identifying resources, flexibility and agility to change direction if needed; and in the third phase: commercial capabilities such as scaling/calibration process, imposing discipline and expertise. (Riel, 2011)

By helping review and analysis of existing models in the literature, criteria and sub-criteria were extracted that researchers have considered for competency of managers in past years, and they are used in the next stages of the research and the research method.

## Research Method

Process of research method is shown in Figure 2.

After librarian studies, field studies are begun with interviews from experts in this research. Experts of innovative organization area (case study: research organization) and experts of industries (industries with high-tech nature) have been interviewed.

In present study, experts are selected and defined as follows:

The industrial people: based on individuals qualifications include a Bachelor's degree and more, at least 15 years of relevant experience in the field of innovation, and the management layer: all the three layers of operation, middle and senior.

Academics: at least an associate professor, related expertise area and teacher of management (innovation, technology, MBA), and industrial engineering courses with related researches.

There were no experts with listed characteristics in the area of innovation industries, and thus all available experts were interviewed.

30 experts have been used in exploration and semi-structured interviews, and eventually 6 experts have been used in the prioritization section and weighting criteria.

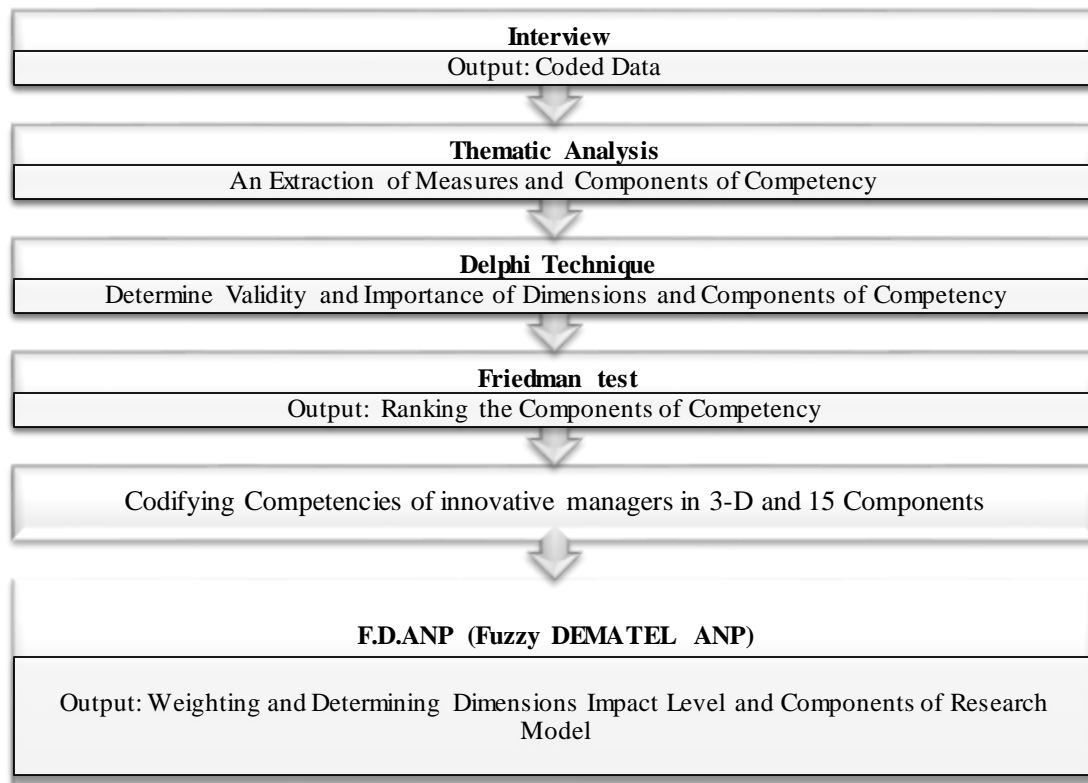


Figure 2 Process of research method

In this study, thematic analysis technique was used to analyze collected data from interviews, F.DEMATEL (evaluating experimental methods and decision making test) was used to determine relationships and their impacting the performance and their severity, and a Fuzzy Analytic Network Process (F.ANP) was used to prioritize the criteria.

FUZZY set theory can also be effectively used to represent an existing ambiguity in the decision-making of human thinking. To cope with the involved uncertainties in the decision-making process, a natural language can be more effective in to calculate. A linguistic variable is a variable whose values are expressions natural language, words phrases or sentences in a natural language. These variables are used as terms of language not numbers and can be effectively used to describe quantitative phrases. A natural language approach is a natural and effective way for decision-makers in their expression of calculation. In practice, linguistic variables can be represented by FUZZY numbers. (Jeng & Tzeng, 2012)

The scope of this study included manufacturing organizations with innovative area and managements. Since, innovation our country is more happened in high-tech industries, experts in various industrial fields in high-tech industries have helped us in present research. However, this research and the proposed model can be used in organizations and manufacturing industries that have an innovation managers and departments (leading organization).



### Data analysis process using thematic analysis

The Thematic analysis includes a continuous movement back and forth between datasets, the summary coded data and a data analysis that arise. Analysis will be stated at the first phase of writing and there is a movement back and forth between different stages (Braun & Clarke, 2006).

### Data Analysis Stages using F.D.ANP

FUZZY DEMATEL method is evaluated the effects structures between criteria, and tried to solve the problem that organizations are faced with them and improved them by performing a group decision-making in FUZZY phase. The phases of this method are as follows: (Jeng & Tzeng, 2012)

**Phases1.** Create direct FUZZY matrix relationships through determining the influence of i criteria to j with tips of Table 3.

Table 3 Natural Language for pair-wise comparisons

Natural Language for pair-wise comparisons		FUZZY NO.
Very high influence	4	(0.75, 0.75, 1)
High influence	3	(, 0.75, 1 0.5)
Low influence	2	(0.25, 0.5, 0.75)
very low influence	1	(0, 0.25, 0.5)
No influence	0	(0, 0 , 0.25)

**Phase2.** Normalize direct matrix relationships through relations 1 and 2:

$$\tilde{X} = K \cdot \tilde{X} \quad (1)$$

$$k = \min \left[ \frac{1}{\max_{1 \leq i \leq n} \sum_{j=1}^n \tilde{A}_{ij}}, \frac{1}{\max_{1 \leq i \leq n} \sum_{i=1}^n \tilde{A}_{ij}} \right] \quad i, j = 1, 2 \dots n \quad (2)$$

**Phase3.** Calculate general matrix relationships with relation 3.

$$\tilde{T} = \tilde{X}(I - \tilde{X})^{-1} \quad (3)$$

**Phase4.** Determine  $\tilde{R}$  and  $\tilde{D}$  vectors through relations 4 to 6:

$$\tilde{T} = [\tilde{t}_{ij}] n \times n, \quad i, j = 1, 2 \dots n \quad (4)$$

$$\tilde{R} = [\sum_{j=1}^n \tilde{t}_{ij}] = [\tilde{r}_i] n \times 1 \quad (5)$$

$$\tilde{D} = [\sum_{i=1}^n \tilde{t}_{ij}] = [\tilde{d}_j] 1 \times n \quad (6)$$

**Phase 5:** Calculate  $(\bar{R} + \bar{D})$  and  $(\bar{R} - \bar{D})$  and plan the impact of relationships on coordinate axes.

-The formation of the limiting super-matrix

The rhythmic super-matrix is converged through  $\lim_{K \rightarrow \infty} (W^\alpha)^K$  relation to form the limiting super-matrix, and ultimately the final weight will be specified by DANP method.

### *Validity and Reliability*

Two questionnaires were used in this study. The first questionnaire has Likert scale that its validity is confirmed by expert specialists, and its reliability is calculated by using Spss 23 and Cronbach  $\alpha$  coefficient for all dimensions after experts told their view, and because this coefficient is greater than 0.7 for dimension, it can be said that the questionnaire is reliable. A standardized questionnaire is used for the second part that is selected from Jeng & Tzeng article (2012).

Table 4 Reliability Test by helping Cronbach's Alpha

Model Dimension	Volume	Cronbach's Alpha
First Dimension	30	0.801
Second Dimension	30	0.843
Third Dimension	30	0.93

### *Results and their Analysis*

Results of the thematic analysis are showed in the following table.

The weight restrictions will be applied in the model due to high number of identified criteria, nativization criteria and decreased inputs and determination the importance of inputs to each other and evaluation their validity as well. A questionnaire with 30 questions was designed (that each question represents a sub-criteria/component). According to the results validation of components used by experts; and considering the mean and standard deviation of components criteria, FRIEDMAN test was used to rank and grade the components.

- A questionnaire with the range of Likert-type was used to perform DELPHI technique and FRIEDMAN test, and SPSS VERSION 23 was used to statistically analyze their data.

Considering the average rating components after FRIEDMAN test, 15 most important competencies were identified as follows:

Systematic thinking, strategic thinking, decision-making, creative thinking, communication skills, configuration and system integration, confidence, future studies,

flexibility and adaptability, innovation and entrepreneurship, problem-solving skills, ethics and commitment, team building and networking skills, human resource management, change management.

Table 5 Thematic analysis steps

Thematic Analysis Steps	Description	Output
First Step	Introduction to Data	Take notes and mark semantics (meanings and patterns searching)
Second Step	Create first codes	Coding with code included three items (e.g. 6S8 and 5M11). Data were coded from interviews of 15 experts of innovation industry cores, 113 coded data, 5 other data, and interviews of 15 experts of research organization, 143 coded data, and 9 other data.
Third Step	Search Theme	Identify 44 sub-theme
Forth Step	Review themes	Extract 30 final themes from 44 primary themes
Fifth Step	Definition and naming themes	According to the topics and concepts in the sub-themes, this 30 themes were classified into three main themes: Managerial and strategic Individual and perceptual Knowledge and skill.
Sixth Step	Reporting	The selected and named themes in fifth step are regulated in a conceptual model

So, 15 above criteria with higher ratings were selected for the final solution.

Table 6 Competencies criteria for innovation managers

Main Criteria	Sub-Criteria	Abbreviation signs
Managerial and strategic C <sub>1</sub>	strategic thinking	C <sub>11</sub>
	human resource management	C <sub>12</sub>
	decision-making	C <sub>13</sub>
	change management	C <sub>14</sub>
	future studies	C <sub>15</sub>
Individual and perceptual C <sub>2</sub>	confidence	C <sub>21</sub>

	creative thinking	C <sub>22</sub>
	flexibility and adaptability	C <sub>23</sub>
	Systematic thinking	C <sub>24</sub>
	ethics and commitment	C <sub>25</sub>
Knowledge and Skill C <sub>3</sub>	communication skills	C <sub>31</sub>
	team building and networking skills	C <sub>32</sub>
	problem-solving skills	C <sub>33</sub>
	innovation and entrepreneurship	C <sub>34</sub>
	configuration and system integration	C <sub>35</sub>

6 experts are asked to evaluate the inter-relationship between criteria, and calculate pair-wise comparisons between criteria presented in the above table from the point of view of impact level of i criterion in benchmark on j criterion in column.

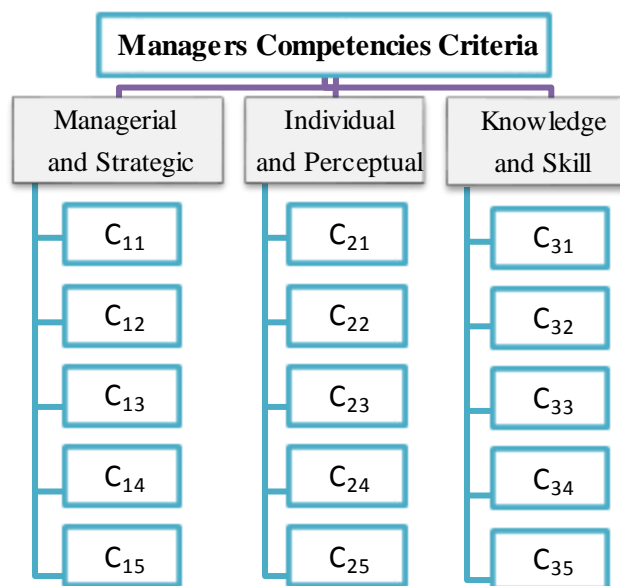


Figure 3 Research Model

Then, all experts views about an impact level of i criterion on j criterion will be calculated, and the final results of these pair-wise comparisons are composed of fuzzy direct relations matrix to the main criteria and all sub-criteria.

In the continuation of DEMATEL FUZZY, the normalized matrix is formed the FUZZY direct relations, and then the general direct relations will be achieved. The total

sum of columns elements and row elements of  $\tilde{T}$  matrix are calculated the main criteria and sub-criteria, and they have been named  $\tilde{R}$  (impacted) and  $\tilde{D}$  (influenced) vectors that the calculations are presented in Table 7.

Table 7 Values of  $\tilde{R}$ ,  $\tilde{D}$ ,  $\tilde{R} + \tilde{D}$ ,  $\tilde{R} - \tilde{D}$

Criteria and Sub-criteria	$\tilde{R}$	$\tilde{D}$	$\tilde{R} + \tilde{D}$	$\tilde{R} - \tilde{D}$
Managerial and strategic	7.536	10.75	18.29	-3.218
strategic thinking	1.104	0.567	1.671	0.537
human resource management	0.589	0.792	1.381	-0.202
decision-making	0.734	0.726	1.46	0.009
change management	0.646	0.935	1.581	-0.289
future studies	0.91	0.964	1.874	-0.054
Individual and Perceptual	9.762	7.441	17.2	2.321
confidence	0.695	0.826	1.521	-0.131
creative thinking	0.894	0.799	1.694	0.095
flexibility and adaptability	0.939	1.081	2.02	-0.142
Systematic thinking	1.039	0.806	1.845	0.233
ethics and commitment	0.525	0.58	1.104	-0.055
Knowledge and Skill	9.109	8.212	17.32	0.897
communication skills	1.053	0.795	1.848	0.259
team building and networking skills	1.156	0.931	2.087	0.226
problem-solving skills	0.714	0.958	1.672	-0.243
innovation and entrepreneurship	0.94	1.1	2.04	-0.161
configuration and system integration	0.699	0.779	1.478	-0.08

As Table 7 shows the maximum amount of  $\tilde{R}$  is related to "Individual and Perceptual competencies" criterion that is presented the greatest impact of this criterion on other criteria, and the maximum value of  $\tilde{D}$  is related to "managerial and strategic competencies" criterion that is showed the severity of influenced this criterion than other criteria.

Also, the greatest  $\tilde{R} + \tilde{D}$  (an importance value) is related to Managerial and strategic competencies that this criterion interacts more with other criteria, and the lowest  $\tilde{R} + \tilde{D}$  is related to "Individual and Perceptual competencies" criterion that this criterion interacts least with other criteria.

Criteria which have  $\tilde{R} - \tilde{D}$  positive indicator in accordance with Table 7, are represented the certain efficiency of these types of criteria, and Criteria which have  $\tilde{R} - \tilde{D}$  negative indicator, are represented the certain impact of these types of criteria than other criteria. So, "Individual and Perceptual competencies" are the most influence criterion and "Managerial and strategic competencies" criterion is the most impact

criterion between the main criteria, respectively. In general,  $\tilde{R} - \tilde{D}$  positive indicator is counted as caused criteria, and  $\tilde{R} - \tilde{D}$  negative indicator is counted as impact affected criteria.

Finally, cause-effect relationships were drawn by using points with  $\tilde{R} + \tilde{D}$  and  $\tilde{R} - \tilde{D}$  based on  $\tilde{T}$  matrix and the basis of impact criteria on each other in a Cartesian coordinate system. Table 8 shows communications level of DE-FUZZY, and Table 9 presents sub-criteria. On the basis of Tables 8 and 9 data, the cause-effect diagram is shown in Figure 4.

Table 8 General DE-FUZZY communications matrix between criteria

	Criterion	C1	C2	C3
C1	Managerial and strategic competencies	0.79	0.74	0.868
C2	Individual and Perceptual competencies	1.42	0.71	1.016
C3	Knowledge and skill competencies	1.25	0.92	0.733

Table 9 The general DE- FUZZY communications matrix between sub-criteria

	C <sub>11</sub>	C <sub>12</sub>	C <sub>13</sub>	C <sub>14</sub>	C <sub>15</sub>	C <sub>21</sub>	C <sub>22</sub>	C <sub>23</sub>	C <sub>24</sub>	C <sub>25</sub>	C <sub>31</sub>	C <sub>32</sub>	C <sub>33</sub>	C <sub>34</sub>	C <sub>35</sub>
C <sub>11</sub>	0.048	0.082	0.073	0.101	0.101	0.063	0.052	0.072	0.056	0.032	0.052	0.062	0.07	0.083	0.053
C <sub>12</sub>	0.048	0.082	0.073	0.101	0.101	0.063	0.052	0.072	0.056	0.032	0.052	0.062	0.07	0.083	0.053
C <sub>13</sub>	0.048	0.082	0.073	0.101	0.101	0.063	0.052	0.072	0.056	0.032	0.052	0.062	0.07	0.083	0.053
C <sub>14</sub>	0.048	0.082	0.073	0.101	0.101	0.063	0.052	0.072	0.056	0.032	0.052	0.062	0.07	0.083	0.053
C <sub>15</sub>	0.048	0.082	0.073	0.101	0.101	0.063	0.052	0.072	0.056	0.032	0.052	0.062	0.07	0.083	0.053
C <sub>21</sub>	0.048	0.082	0.073	0.101	0.101	0.063	0.052	0.072	0.056	0.032	0.052	0.062	0.07	0.083	0.053
C <sub>22</sub>	0.048	0.082	0.073	0.101	0.101	0.063	0.052	0.072	0.056	0.032	0.052	0.062	0.07	0.083	0.053
C <sub>23</sub>	0.048	0.082	0.073	0.101	0.101	0.063	0.052	0.072	0.056	0.032	0.052	0.062	0.07	0.083	0.053
C <sub>24</sub>	0.048	0.082	0.073	0.101	0.101	0.063	0.052	0.072	0.056	0.032	0.052	0.062	0.07	0.083	0.053
C <sub>25</sub>	0.048	0.082	0.073	0.101	0.101	0.063	0.052	0.072	0.056	0.032	0.052	0.062	0.07	0.083	0.053
C <sub>31</sub>	0.048	0.082	0.073	0.101	0.101	0.063	0.052	0.072	0.056	0.032	0.052	0.062	0.07	0.083	0.053
C <sub>32</sub>	0.048	0.082	0.073	0.101	0.101	0.063	0.052	0.072	0.056	0.032	0.052	0.062	0.07	0.083	0.053
C <sub>33</sub>	0.048	0.082	0.073	0.101	0.101	0.063	0.052	0.072	0.056	0.032	0.052	0.062	0.07	0.083	0.053
C <sub>34</sub>	0.048	0.082	0.073	0.101	0.101	0.063	0.052	0.072	0.056	0.032	0.052	0.062	0.07	0.083	0.053
C <sub>35</sub>	0.048	0.082	0.073	0.101	0.101	0.063	0.052	0.072	0.056	0.032	0.052	0.062	0.07	0.083	0.053

- Managerial and strategic competencies
- Individual and Perceptual competencies
- Knowledge and skill competencies

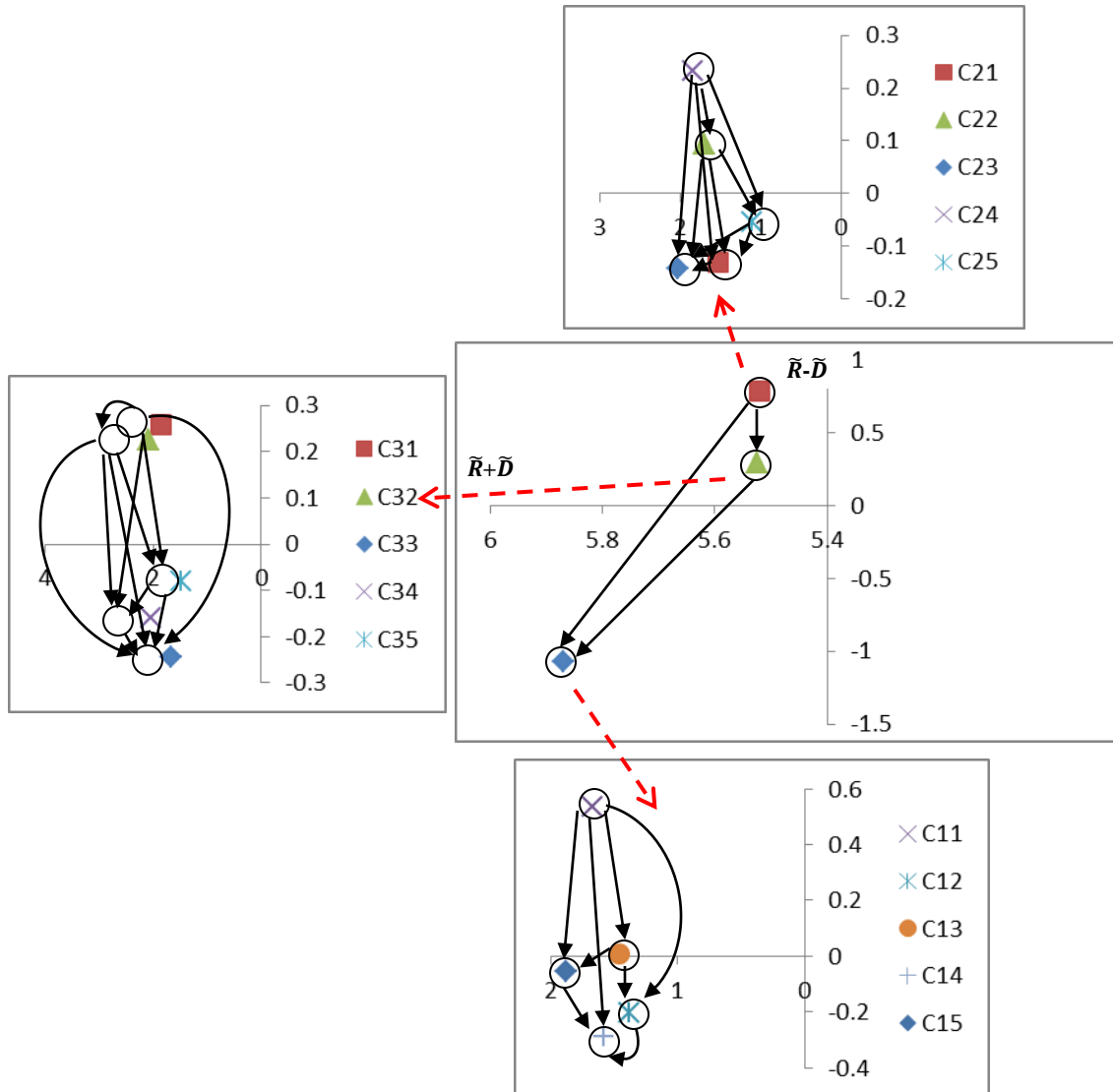


Figure 4 The map of communications network

- Weighting criteria by using FUZZY-ANP

In this stage, a normalized weight will be obtained for criteria and non-weighted super matrix will be formed, and then the weighted super matrix will be obtained. Then, the non-weighted super matrix will be converged that is formed a limited matrix and the weight of indicators will be obtained.

Finally, after de-fuzzy weights by the center of gravity method, the weight of criteria and sub-criteria will be determined and obtained that is presented in Table 10.

Table 10 Weight and priority of competencies criteria for innovation managers

Weight and relative priority of main criteria		code	Weight and relative priority	Weight and final priority
Managerial and strategic C <sub>1</sub>	0.41 (1)	C <sub>11</sub>	0.119 (5)	0.048 (14)
		C <sub>12</sub>	0.203 (3)	0.082 (4)
		C <sub>13</sub>	0.181 (4)	0.073 (5)
		C <sub>14</sub>	0.248 (2)	0.1005 (2)
		C <sub>15</sub>	0.249 (1)	0.101 (1)
Individual and perceptual C <sub>2</sub>	0.28 (3)	C <sub>21</sub>	0.229 (2)	0.063 (8)
		C <sub>22</sub>	0.191 (4)	0.052 (12)
		C <sub>23</sub>	0.26 (1)	0.072 (6)
		C <sub>24</sub>	0.202 (3)	0.056 (10)
		C <sub>25</sub>	0.118 (5)	0.032 (15)
Knowledge and Skill C <sub>3</sub>	0.32 (2)	C <sub>31</sub>	0.162 (5)	0.052 (13)
		C <sub>32</sub>	0.195 (3)	0.062 (9)
		C <sub>33</sub>	0.218 (2)	0.07 (7)
		C <sub>34</sub>	0.259 (1)	0.083 (3)
		C <sub>35</sub>	0.164 (4)	0.053 (11)

Table 10 shows the most weight sub-criteria related to "Future Studies" criterion which belongs to Managerial and strategic competencies sub-criteria and obtains` the first priority. "Change Management" criterion obtains the second priority, the third priority belongs to "Innovation and Entrepreneurship" criterion, the forth priority belongs to "Human resource management" criterion, "decision-making" criterion obtains the fifth priority, and finally, the sixth priority belongs to "Flexibility and Adaptability" among 15 benchmark criteria that assigned almost %51.14 of the total weight, and this shows the importance of these sub-criteria.

## Conclusions

This research aims to determine and prioritize innovation manager's competencies, and Multi-criteria decision-making (MCDM) FUZZY approach was used to achieve this goals. Regarding to the relationships between criteria and uncertainty view of experts, F.DEMATL was used to determine relationships between factors. F.ANP was used to determine the weight and rank priority of competencies criteria for innovation managers.

EXCEL software and F.DEMATEL approach was used to analyze and solve data. It is shown that "Individual and perceptual competencies" is the most influence criteria and



"Managerial and strategic competencies" is the most impact criteria. Additionally, solving problem by using F.ANP approach showed that the greatest weight and the first priority are related to "Future Studies" criterion.

The influence sequence of the innovation manager's competencies will be as follows:

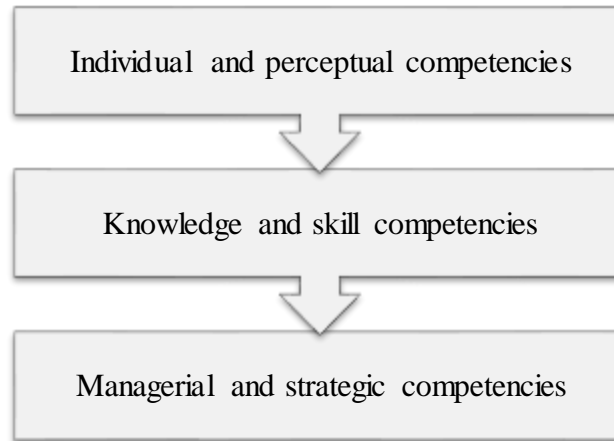


Figure 5 Influence of sequence of criteria

Other results consist of:

"Managerial and strategic competencies" criteria is attributed the first priority of strategic level to itself by weighting 0.405 between the core competencies. Thus, it can be concluded that sub-criteria of this criteria have a great important, and an organization should be spent its more time and energy to empower innovation managers.

"Future Studies" is obtained the most important level by weighting %10.1 between sub-criteria. This shows the importance of this component in competencies criteria for innovation managers in leading and innovative organizations. Thus, it can be concluded that the most important task of innovation managers is to visualize the potential futures and plan for them. Innovation managers must identify and explore the future by recognizing past data processes, current change signal, possible and happening situations in future. In fact, innovation managers should go further than anticipating and discovering the future and focus to shape the future.

"Change management" is obtained the second priority level by weighting %10. This criterion emphasize that innovation managers should plan the process of evolution in attitudes, structures, policies, and so on ... in some parts or the whole of organization, because as Peter Drucker says: we could not manage innovation and change, human beings can only go beyond of it. Indeed, the view of Drucker is a pioneer in innovation and change.

"Innovation and Entrepreneurship" component is obtained the third priority level by weighting %8.28. So, it could be said that Innovation and Entrepreneurship are an important factors and one of the most valuable competencies for an innovation manager

as well. This mentions to the tendency of people to be creative and face to new experiences and pursue new ideas. This competency includes a motivational dimension that is based on innovation, complexity, and ambiguity tolerance. Additionally, it includes a cognitive dimension that processes and organizes data. Innovation managers need to provide a necessary organizational environment to create and foster ideas. Creating such an environment requires encourage staff and support them for providing innovative ideas, then helping to allocate organizational resources to them, and convince others to support ideas.

### **Suggestions for future studies**

Since, "Managerial and strategic competencies" criteria was the most influential criteria between the core criteria, prerequisites and influential factors should be completely examined, and appropriate mechanisms should be designed and implemented to strengthen influential competencies.

"Future Studies" is obtained the first priority between sub-criteria. Since, this issue is a new and updated issue in the world; it is recommended that workshops and training courses related to Future Studies held for innovation managers. In addition, if necessary, professors and academic elite or successful organization are used in this section.

Multi-criteria decision-making (MCDM) FUZZY approach was used in this study, so it is recommended to implement other MCDM methods for example: Importance-Performance Analysis (IPA), ISM, and so on in similar studies.

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