

## **Improvement of Project Management Office Performance: An Empirical Investigation of Effective Factors in Iranian Construction Industry**

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### **Abstract**

Project management office (PMO) is a new emerging concept in Iranian construction industry. Executives expect this organizational unit to add value to the business, and meet the demands of stakeholders by performing specialized tasks ranging from providing project management support to portfolio management. In this regard, PMO managers have long faced the question of how to improve the performance of project management office. Regarding the lack of research on this subject, current study focuses on identifying and analyzing the factors positively affecting the project management office performance in Iranian construction industry. The theoretical basis is extracted from the literature, and a field research is conducted for examining factors in Iranian construction industry. The parametric t-test is used to identify key factors, and the interpretive structural modeling is applied to provide an overview on their interrelationships. The final conceptual model indicates 9 factors in 6 levels grouped in 3 category (dependent, linkage and driver variables). Furthermore, the findings provide Iranian construction companies with common understanding, and practical guidelines to steer their project management offices toward creating higher value.

**Keywords:** Project management office, performance management, interpretive structural modeling (ISM), Iranian construction industry.

### **1- Introduction**

Many surveys on project management offices have been carried out by researchers since 2000, and the results show that the implementation of project management office (PMO) has been increased. The findings of a survey conducted by Dai reveals that PMO implementation increased substantially from 1990 to 2000 (Dai, X, Wells, 2004). Furthermore, surveys conducted by PMSolutions showed an increase in the number of organizations having some form of PMO from 47% in 2000 to 80% in 2014 (PMSolutions, 2014). Although there is a substantial increase in the number of organizations having a project management office, but none of the prior studies have not presented a model or framework for PMO performance. Executives often ask for higher value from this organizational entity, and PMO managers are often hard pressed to show value. Executives even may quit PMO if it does not bring value to the business. At least three independent surveys have shown that the average age of PMOs is approximately two years (Aubry et al, 2010).

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Additionally, a recent research has shown that organizations often reconfigure their PMOs every few years (Hobbs et al, 2008). Gartner presented a PMO study at the Symposium ITXPO and showed that over the last 7 years 50% of all PMO's failed, and one major factor is that executives assume that PMOs do not add sufficient value to the business. Findings of a survey revealed that approximately 68% of stakeholders perceive their PMOs to be bureaucratic and only 40% of projects met their goals in terms of time, cost and quality. Studies also showed that 50% of project management offices close within three years (Gartner, 2014). Five reasons why PMOs fail to deliver value are mentioned below:

- Value perceived as offering little or no value
- Lack of senior sponsorship for PMO
- Lack of authority
- The PMO resources are inexperienced
- PMO operates as an audit function

Often PMOs provide value to the business, but do not measure it. This issue often leads to the perception that PMOs do not add value. An important step to overcome this perception is to identify PMO performance factors to show how PMOs can improve their outcomes. In this regard, it is necessary to identify factors affecting the PMO performance. The current state of knowledge of PMO provides practitioners with very few resources. Therefore, the practitioner community is looking for practical guidelines to act more effective in directing their PMOs. In this regard, the high level objective of this research is to explore key factors improving PMO performance in Iranian Construction Industry. Construction Industry is considered as a driver for Iranian economy so that its share of the gross national product is up to 7 percent, and its impact on key industries such as transport, insurance, steel and cement industry is significant (Islami, 2008). The key entities of construction industry include employer, engineering design consultant, contractor and management consultant (Parchami & Matinkoosha, 2015). Managing the complex interactions between these entities in a dynamic business environment has created the necessity for organizations to centrally coordinate and manage their projects. In this regard, establishing a PMO is considered as a solution for addressing these needs (Arbabi, 2008):

- Developing applicable procedures for managing the projects
- Developing project management tools and techniques
- Managing the interdependencies among projects
- Resource Sharing
- Monitoring the performance of projects
- Developing the project management capabilities

The result of a comprehensive survey conducted by PMsolutions Institute on 544 organizations in 2012 reveals that the higher the performance of the PMO, the more values it brings to the organization (PMsolutions, 2012). Therefore, it is important to put emphasis on factors affecting PMO performance. In this regard, we conduct an in-depth research into PMO performance to identify its aspects and analyze effective factors to construct a conceptual model using interpretive structural modeling (ISM). Interpretive structural modeling is considered as an effective method for identifying relations among variables related to a certain problem. This method has been used in many researches to represent the variables and their relationships within a framework.

## **2- Research Methodology**

### **2-1- Objective**

The current study focuses on describing various aspects of PMO performance, and is considered as a descriptive research. This study was conducted through a survey in Iranian construction industry in 2014. The main objective of the study is to identify key factors positively affecting the PMO performance, and the questions which will be addressed in this study are mentioned below:

- What factors can potentially affect the PMO performance (regarding the literature review)?
- What are the key factors improving the PMO performance in Iranian construction companies?
- How are these factors interrelated?

### **2-2- Problem statement**

#### **2-2-1-Complexity**

Complexity is a property of a model making it difficult to formulate. The interpretive structural model in current research is considered as a low-complexity model because ISM provides a plausible and simple way to incorporate elements and their interrelations in a simple graph. However, if the number of variables increases, the complexity of the model will increase. In this study, there are 9 input variables for interpretive structural modeling process.

### 2-2-2-Assumptions

Assumptions made in current ISM modeling include:

- Transitivity is a basic assumption in interpretive structural modeling. It means if variable A is related to variable B, and B is related to variable C, then A is necessarily related to C.
- The relationships between variables can be mutual. If A is related to variable B, and B is related to variable A, then the relationships between A and B is considered mutual.
- The proposed model is interpretive as the judgment of the experts decides about the interrelations among elements.

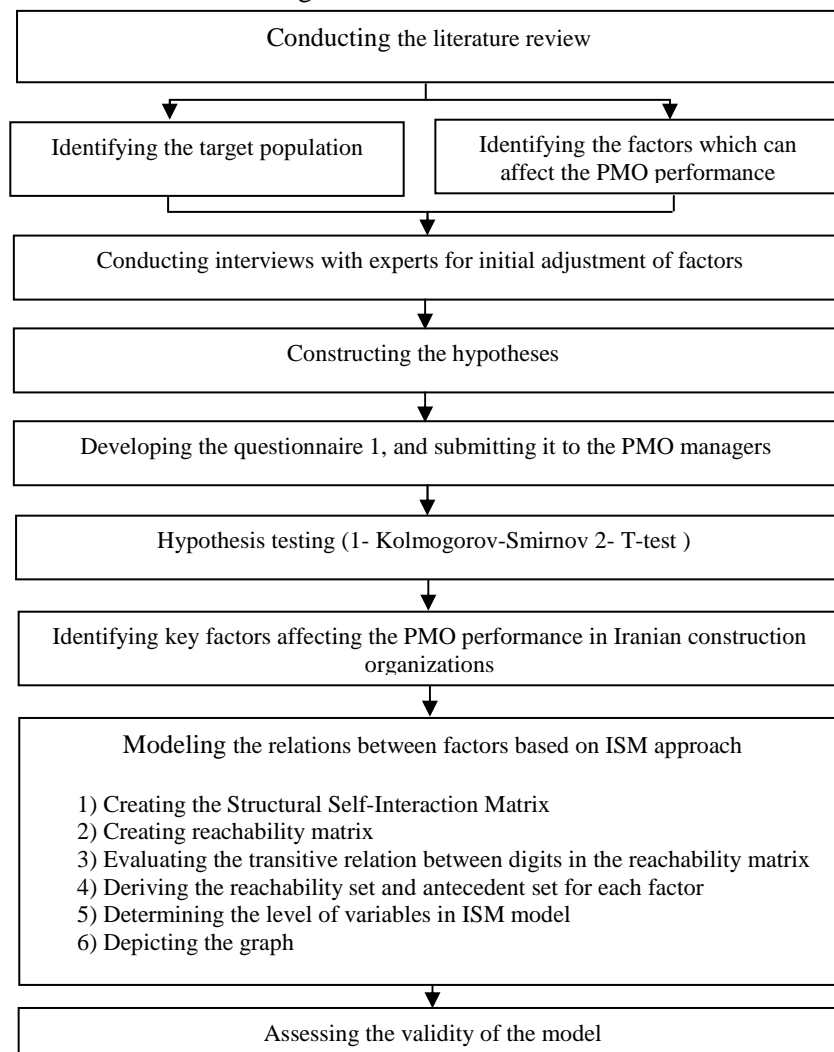
### 2-2-3- Limitations

The limitations of current ISM modeling include:

- There may be many variable to a problem. If the number of variables increases, the complexity of the model will increase. Therefore, only limited number of variables which are most affecting a problem can be considered in the model.
- The ISM model does not presents the intensity of interrelations among variables.

### 2-3- Steps

The steps of the research are shown in figure 1.



**Figure1.** Steps of the research

### **3- Literature Review**

#### **3-1- Trend of prior researches on PMO**

##### **(1997 - 2000): Introducing basic concepts**

Studies conducted on PMO have mainly focused on defining characteristics and typologies. Researchers such as Wysocki, Dinsmore and Englund investigated into project management office functions in project-based organizations, while others put emphasis on PMO structural aspects in enterprises. Early studies in the late 1990s were focused on basic concepts of project management office. Murphy explained the services of Project Support Office as a supportive element that applies project management techniques (Murphy, 1997). Bolles highlighted the entity and basic functions of project support office (Bolles, 1998). Knutson offered a theoretical framework for implementation of project office by concentrating on steps of unfolding project discipline into a viable project office (Knutson, 1998). Fleming and Koppelman highlighted the functions of the project office in assisting project teams (Fleming and Koppelman, 1998), and Bates provide insight into the establishment of project management office and its requirements (Bates, 1998). Dinsmore presents a general framework for understanding how project office functions can fit and customize into different firms (Dinsmore, 2000). Kwak explained the value of project management offices in organizations, and proposed basic guidelines for assessing this value emphasizing on strengths and weaknesses of PMO characteristics (Kwak, 2000).

##### **(2001 - 2009): Adopting practical approach**

Block and Frame adopted a practical approach in conducting research in this field, and performed a survey in 2001 to investigate project managers' perspectives on project offices (Block & Frame, 2001). Some researchers tried to share the best practices of project management office in different businesses. Dai and Wells focused on implementation and use of project management offices in different environmental conditions through a two-year empirical study. In this study, PMO services and their influence on project performance were examined (Dai & Wells, 2004). Kerzner described project management office as a strategic planning center and shed light on risks associated with executing functions (Kerzner, 2004). Desouza and Evaristo offered the basic PMO models and mentioned effective factors in PMO performance based on a survey in 32 IT organizations (Desouza & Evaristo, 2006). Furthermore, Aubry and Hobbs examined project management office functions in organizations through a comprehensive survey conducted in more than 500 European organizations (Aubry & Hobbs, 2007). Hobbs also evaluated the characteristics of project management offices in organizations. In this study, the correlation between performance and legitimacy of PMOs were examined (Hobbs, 2007). Anderson carried out an empirical research into PMOs and proposed a number of principles in PMO success (Andersen et al, 2007). In another study, Hurt and Tomas evaluated the role of PMO in building value to the organizations (Hurt & Thomas, 2009).

##### **(2010-2015): Assessing the role and effects of PMO in organizations**

Recent researches on PMO, have been focused on assessing specific effects of this organizational entity on different aspects. Aubry and colleagues tried to shed light on the reality that the role of project management offices in firms has changed. In this study, data from 17 case studies was obtained, and eventually 35 change factors in 6 groups were identified as major drivers that define the change in the role of project management offices (Aubry et al, 2010). Artto & Kulvik conceptualized PMO as a broader organizational unit in terms of functions, and obtained data from 4 firms to provide evidence that PMO can be considered as an integrative organizational arrangement. The researchers also explored the organizational and managerial mechanisms in innovation projects (Artto & Kulvik, 2011). Aubry and colleagues examined three roles of project portfolio management office, and their effects on the success of portfolio. They analyzed 278 portfolios to identify the roles of project portfolio management office, and assess the roles' impact on portfolio performance (Aubry et al, 2012). Pemsel and Wiewiora conducted an in-depth empirical study to assess the role of project management office in organizations as a knowledge broker. They examined PMO's functions in terms of knowledge sharing, and conducted a survey in 7 firms. Furthermore, these researchers proposed guidelines for adaption of PMO's services to the needs of knowledge sharing (Pemsel & Wiewiora,

2013). Karayaz and Gungor investigated the strategic alignment of project management offices in different organizational level through a case studies in Turkey (Karayaz and Gungor, 2013). Some researchers have focused on PMO configuration in the multi-project environment. Mariusz offered a typology of PMO functioning (Mariusz, 2014), and Tsaturyana and Muller conducted research into the integration of multiple PMOs in large firms (Tsaturyana & Muller, 2015). There is a lack of study on the characteristics of project management office in Iranian organizations. Parchami and Matin Koosha performed a survey in 2015. They identified and analyzed the organizational variables affecting the characteristics of PMO in Iranian project-based organizations of the construction industry (Parchami and Matin Koosha, 2015). However, they do not focus on the elements of PMO performance in Iranian firms.

### **3-2- Literature's gap**

Considering the above-mentioned researches, one can find a gap in the literature. In fact, none of the prior studies have offered a framework of factors affecting the PMO performance, whereas it is a needed area of research. Two studies have just mentioned a number of success factors, but without any hypothesis testing.

### **3-3- Identifying Factors from the literature**

The results of the literature review revealed that two prior studies have mentioned a number of success factors of PMO. Desouza and Evaristo mentioned effective factors in PMO success based on interviews with senior managers and directors of PMOs in 32 IT organizations (Desouza & Evaristo, 2006). In this study, the relations among these factors have not been analyzed.

These success factors include:

- Building a strong foundation
- Establishing the background
- The right project for the right manager
- Clear reporting lines
- PMO charter and related documents
- Metrics to evaluate PMOs

Anderson carried out a study into PMOs and mentioned that organizations should allow their PMOs to progress at the right speed, starting at core needs (methods and tools) and only moving to governance and portfolio management when the organization maturity is higher and senior management supports the PMO. According to the results of this study, a number of principles in PMO success are listed (Andersen et al, 2007):

- Design the PMO based on objectives
- Cover the true needs of the organization, as identified from the PMO stakeholders
- Ensure top management support
- PMO services should be free of charge to the projects.
- Do not develop the PMO into a bureaucratic control unit
- Resource the PMO with experienced senior Project Managers
- Focus on improved project management practices

Although a number of factors have been mentioned, the researchers have not conducted any forms of hypothetical testing to construct a conceptual framework.

As well as two above-mentioned studies, other researchers imply the success factors in their articles. All in all, a comprehensive literature review was conducted and some factors were extracted. The factors which can potentially affect the PMO performance are mentioned below:

- **Employing qualified project managers**

In some organizations, project managers are considered as PMO staff. In these organizations project managers are selected by PMO, and have to report to the PMO manager. Project managers are considered as key members of PMO, and it is necessary that they understand the organizational fit of their projects as an element of the project portfolio, and a part of the corporate strategy. Therefore, this organizational entity needs to employ qualified project managers (Rajendra et al, 2009). Successful project management offices rate project managers based on their knowledge, talent and

experience. This rating helps PMO to adopt and employ suitable managers for strategic projects, and make advantage of their experience to steer project toward success (Desouza & Evaristo, 2006).

- **Senior management support**

Senior management support gives PMO the authority to properly execute its functions in the organization. The resistance against the implementation and development of project management office may increase when senior managers are less supportive (Bolles, 2007). A recent survey on 502 PMOs revealed that senior management support plays an important role in improving the PMO performance (Hobbs & Aubry, 2010). Support of senior managers is important in terms of resource allocation and delegation of authority (Zayyan, 2010).

- **Improving the organizational project management maturity level**

A survey conducted on 502 PMOs showed that project management maturity level has close relationship with PMO performance (Hobbs & Aubry, 2010). Therefore, the efforts in improving project management maturity level are vital for PMO to improve its organizational effectiveness (Kerzner, 2005). Project management maturity is associated with the level of project management capabilities, and paves the way for PMO to bring more value to the organization. Furthermore, the project management maturity has a direct relationship with the PMO maturity level (PMsolution, 2012).

- **Executing the right functions**

The PMO success in the organization is highly dependent upon its functions. In other words, the type and number of functions characterize its entity and performance in achieving the vision of the host organization (Hill, 2013). Hence, this factor can potentially affect the PMO performance.

- **Developing standards and methodologies**

Standards and methodologies developed by project management office should be aligned with the organizational needs. Methodologies provide guideline for project budgeting, project planning, status reporting, risk management and change control (Rajendra et al, 2009). Project management offices are responsible for developing the project management standards and methodologies, and improving the ability of organization in implementing these methodologies. This is a primary function of PMO influencing the other initiatives and programs (Desouza & Evaristo, 2006). Developing project management standards and methodologies enables PMO to (Hill, 2013):

- Create a standard approach for managing the projects.
- Implement a common life cycle.
- Provide necessary requirements of data collection from projects for analysis of performance.

- **Developing Competencies of Project Managers**

Developing competencies of project managers is a way to ensure that they are capable of dealing with project complexities, customer expectations, interactions between project team members, and communicating with internal and external stakeholders. This is a primary function of PMO which can be considered as an element of PMO performance improvement (Desouza & Evaristo, 2006).

- **Supporting projects**

Project success is tied to PMO success. PMOs need to provide the appropriate level of support for projects so that project teams can focus on the things at which they can have greater impact to achieve project success. Therefore, offering support services to project teams is an effective factor increasing the value of the project management office in organization (Pellegrinelli & Garagna, 2009). PMOs can support the projects through providing useful information, facilitating the reporting process, project planning and establishing timely and effective communication with project teams (Zayyane, 2009).

- **Acquiring necessary resources**

There are several examples that key resources of the project management office change over time, and this, in turn, can be a major risk at the same time. The stakeholders may hinder the development of project management office by resisting against initiating its programs as well as allocating resources. The project management office needs adequate financial resources to run its initiatives, and cannot be successful without adequate financial support (Zayyane, 2009). The amount of PMO resources, which include staff, budget, infrastructures, softwares and tools depends on many factors from its size to the centralization of services (PM Solutions, 2010).

- **Realizing the mission and objectives of PMO**

Project management office helps the organization understand and apply the professional practices of project management and integrate it to the business objectives (Rad & Levin, 2002). The realization of PMO mission and objectives help this organizational body achieve organizational support toward running its programs and initiatives (Hobbs & Aubry, 2010). Successful PMOs have very clear evidence to prove their eligibility. In fact, their mission and objectives can be clarified, and its authorities can be formalized using an official document entitled PMO charter (Desouza & Evaristo, 2006).

- **Developing Knowledge Management**

Post project analysis is taken into account by PMOs as an efficient tool for supporting the project teams and the whole organization. Implementing a formal process to report project findings to stakeholders for capturing the lessons learned facilitate continuous improvement of processes and procedures (Rajendra et al, 2009). In fact, knowledge sharing enables the organization to face unusual events and solve problems in an easier way (Zayyane, 2010). Project Management Offices play an important role in organizational learning. Because they provide tools and methods to facilitate the process of learning from projects (Desouza & Evaristo, 2006). This factor enables PMOs to add value by acquiring and sharing knowledge among organizational units and projects (Rad & Levin, 2002).

- **Obtaining organizational companionship**

The concept of organizational companionship refers to the cooperation of organizational body, particularly project team members, with the project management office in executing its functions through providing timely and accurate data, collaborating and actively participating in its programs. Therefore, It is necessary for PMO to set common language, and personnel should be informed of the objectives of the PMO to be aware of its value (Hobbs & Aubry, 2008). This, in turn, leads to higher organizational companionship and help improving the organizational culture which is an effective factor in facilitating PMO initiatives. Studies show that organizational companionship positively affects the PMO performance (Hobbs & Aubry, 2010).

- **Obtaining decision making power**

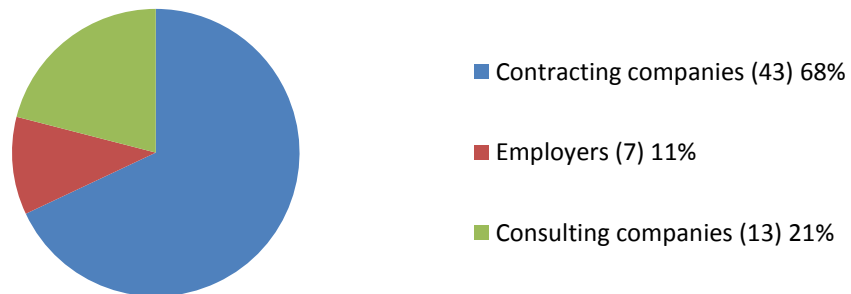
The results of a survey carried out on 502 project management offices indicate that decision making power directly affects the PMO performance (Hobbs & Aubry, 2010). The decision making power of PMO stabilizes its organizational position, and enables it to execute necessary functions (Rajendra et al, 2009). Therefore, it is considered as an enabling factor giving PMO the power to direct project managers, allot resources, and determine priorities toward becoming a more active and effective organizational unit (Hobbs & Aubry, 2008).

## **4- Conducting interviews with experts for initial adjustment of factors**

### **4-1- Target population**

The target population includes Iranian construction companies having some form of project management office for up to 2 years. Gathering information from databases of Iran Project Management Association, Iranian construction engineers organization (ICEO) and other relevant sources, the number of organizations with some form of PMO was proved to be 180 organizations. Toward meeting the objective of this research, the PMOs which performance implication is traceable

should be studied. Therefore, target population is limited to organizations having some form of PMO for more than 2 years. Accordingly, 63 organizations which have these characteristic were considered for the survey. The questionnaires were submitted to the PMO managers of these 63 organizations. The demographic analysis of the case organizations is illustrated in figure 2.



**Figure2. The demographic analysis of the 63 case organizations**

#### **4-2- Data gathering**

In this study, the data gathering tools include questionnaire and interview. At first step, 10 construction industry experts were interviewed for initial adjustment of potential factors to the Iranian construction industry. Furthermore, the comments of these experts were gathered through interview for assessing the validity of questionnaires. At subsequent steps, two questionnaires were developed. The questionnaire 1, which was designed for identifying the factors, was completed by PMO managers in 63 case organizations. The questionnaire 2, which was developed for determining the interrelations among factors in the conceptual model based on Interpretive structural modeling (ISM) method, was completed by PMO managers through the Delphi process with 3 iterations. The Delphi technique has become increasingly used in qualitative researches. This technique allows researchers to reach consensus over a subject among diverse set of participants.

#### **4-3- Reliability and validity of questionnaire**

The validity of the questionnaire 1 was evaluated through conducting interview with 10 academic experts. Furthermore, the Cronbach's alpha method was used to test reliability of the questionnaire 1. In this regard, SPSS software was used to analyze data from questionnaire 1, and the calculated Cronbach's alpha is 0.81. Regarding the fact that the calculated Cronbach's alpha is above 0.7, the reliability of the questionnaire1 is acceptable. The questionnaire 2 includes the structural self-Interaction matrix, and does not need test of validity.

#### **4-4- Validation of modeling procedure:**

The validity of the modeling procedure was assessed through conducting interview with 10 academic experts, who was participated in earlier steps of the research.

### **5- Results**

#### **5-1- Hypothesis testing**

**Hypotheses:** The steps of identifying effective factors include:

- Reviewing the literature and extracting general factors which can potentially affect the PMO performance (12 factors were extracted).
- Conducting interview with experts for initial adjustment of general factors to Iranian construction industry (2 out of 10 factors were modified).
- Constructing the hypotheses (general factors have to be examined in Iranian construction industry)



- Identifying the effective factors (as the result of hypothesis testing, 3 factors were rejected and 9 factors were identified as effective factors in Iranian construction industry)

The general factors identified in the literature have to be adjusted to Iranian construction industry. Therefore, 10 experts were interviewed, and adjustments were made based on their comments. As a result of the interviews, 2 factors were modified ("developing standards and methodologies" and "obtaining decision making power"). Hypothesis testing needs to be conducted to extract effective factors from general factors. These hypotheses are mentioned in table 1.

**Table1.** Hypotheses

H <sub>i</sub>	Hypothesis (H <sub>a</sub> )	Reference
H <sub>1</sub>	Is "Employing qualified project managers" a key factor in improving the PMO performance?	(Rajendra et al, 2009) (Desouza, 2006)
H <sub>2</sub>	Is "Senior management support" a key factor in improving the PMO performance?	(Bolls, 2007) (Hobbs & Aubry, 2010) (Zayyana, 2009) (Desouza, 2006)
H <sub>3</sub>	Is "Improving the project management maturity level" a key factor in improving the PMO performance?	(Hobbs & Aubry, 2010)
H <sub>4</sub>	Is "Executing the right functions" a key factor in improving the PMO performance?	(Hill, 2013) (Hobbs & Aubry, 2010)
H <sub>5</sub>	Is "Developing standards, methodologies and tools" a key factor in improving the PMO performance?	(Desouza, 2006) And Expert Judgment
H <sub>6</sub>	Is "Developing competencies of project managers" a key factor in improving the PMO performance?	(Desouza, 2006) (Englund & Graham, 2003)
H <sub>7</sub>	Is "Supporting projects" a key factor in improving the PMO performance?	(Pelleggerlli, 2009) (Zayyana, 2009)
H <sub>8</sub>	Is "Acquiring necessary resources" a key factor in improving the PMO performance?	(Zayyana, 2009)
H <sub>9</sub>	Is "Realizing the mission and objectives of PMO" a key factor in improving the PMO performance?	(Rad & Levin, 2002) (Zayyana, 2009) (Hobbs & Aubry, 2010) (Desouza, 2006)
H <sub>10</sub>	Is "Developing knowledge management" a key factor in improving the PMO performance?	(Zayyana, 2010) (Rajendra et al, 2009) (Desouza, 2006)
H <sub>11</sub>	Is "Obtaining organizational companionship" a key factor in improving the PMO performance?	(Aubry, 2010) (Desouza, 2006) (Hobbs & Aubry, 2010) (Hobbs & Aubry, 2008)
H <sub>12</sub>	Is "Authorizing the PMO" a key factor in improving the PMO performance?	(Hobbs & Aubry, 2010) (Hobbs & Aubry, 2008) (Rajendra et al, 2009) And Expert Judgment

**Method of statistical analysis:** At first, it is necessary to make certain from the normality of data before selecting the right statistical test. In this regard, we performed Kolmogorov-Smirnov test. Regarding the fact that the volume of the sample is more than 30, and the distribution is normal, the parametric T-test can be used to examine the hypotheses. Furthermore, SPSS software was used for statistical analysis.

Regarding the fact that hypotheses of the research are interval, Kolmogorov-Smirnov test was used to test the normality of variables. The results of this test indicate that the calculated alpha is less than 0.05, and all of the variables are normal (table2).

**Table2.** The results of Kolmogorov-Smirnov Test

		H <sub>1</sub>	H <sub>2</sub>	H <sub>3</sub>	H <sub>4</sub>	H <sub>5</sub>	H <sub>6</sub>	H <sub>7</sub>	H <sub>8</sub>	H <sub>9</sub>	H <sub>10</sub>	H <sub>11</sub>	H <sub>12</sub>
N		63	63	63	63	63	63	63	63	63	63	63	63
Normal Parameters <sup>a</sup>	Mean	2.778	3.460	3.524	2.730	3.492	3.571	3.539	3.460	3.460	2.762	3.428	3.349
	Std. Deviation	1.038	1.175	1.203	1.050	1.243	1.103	1.147	1.202	1.255	1.088	1.241	1.166
Most Extreme Differences	Absolute	.235	.217	.209	.236	.214	.223	.211	.213	.206	.222	.185	.220
	Positive	.130	.117	.113	.129	.112	.127	.125	.126	.110	.128	.127	.130
	Negative	-.235	-.217	-.209	-.236	-.214	-.223	-.211	-.213	-.206	-.222	-.185	-.220
Kolmogorov-Smirnov Z		1.869	1.719	1.662	1.875	1.700	1.767	1.678	1.690	1.636	1.758	1.472	1.743
Asymp. Sig. (2-tailed)		.002	.005	.008	.002	.006	.004	.007	.007	.009	.004	.026	.005
a. Test distribution is Normal.													

Regarding the normality of hypotheses, the t- test was used for statistical analysis. The mean of expert opinions' scores (based on Likert 5 point scale) for H<sub>0</sub> to H<sub>12</sub> is calculated and the t- test is used to examine and generalize the results. If the mean for H<sub>a</sub> is more than 3 then the hypothesis is acceptable, and the related factor is selected as a key factor.

$$Test: \begin{cases} H_0: \mu \geq 3 \\ H_1: \mu < 3 \end{cases}$$

In each statistical test, if the significance is more than 0.05, the H<sub>0</sub> hypothesis is rejected (table3). Therefore, the hypothesis1 (employing experienced project managers), hypothesis 4 (executing the right functions) and hypothesis 10 (developing knowledge management) were rejected with confidence level of 95%, and the key factors are as below:

1. Senior management support
2. Improving the project management maturity level
3. Developing standards, methodologies and tools
4. Developing competencies of project managers
5. Supporting projects
6. Acquiring necessary resources
7. Realizing the mission and objectives of PMO
8. Obtaining organizational companionship
9. Authorizing the PMO

**Table 3.** The result of student's T- test

Variables	Test Value = 3					
	t	df	Sig. (2-tailed)	Mean Difference	95% confidence interval of the difference	
					Lower	Upper
VAR00001	-1.698	62	0.094	-0.22222	-0.4838	0.0394
VAR00002	3.109	62	0.003	0.46032	0.1643	0.7563
VAR00003	3.456	62	0.001	0.52381	0.2209	0.8268
VAR00004	-2.039	62	0.046	-0.26984	-0.5344	-0.0053
VAR00005	3.143	62	0.003	0.49206	0.1791	0.8050
VAR00006	4.112	62	0.000	0.57143	0.2936	0.8492
VAR00007	3.733	62	0.000	0.53968	0.2507	0.8287
VAR00008	3.038	62	0.003	0.46032	0.1575	0.7632
VAR00009	2.911	62	0.005	0.46032	0.1443	0.7764
VAR000010	-1.737	62	0.087	-0.23810	-0.5122	0.0360
VAR000011	2.742	62	0.008	0.42857	0.1161	0.7410
VAR000012	2.377	62	0.021	0.34921	0.0555	0.6429

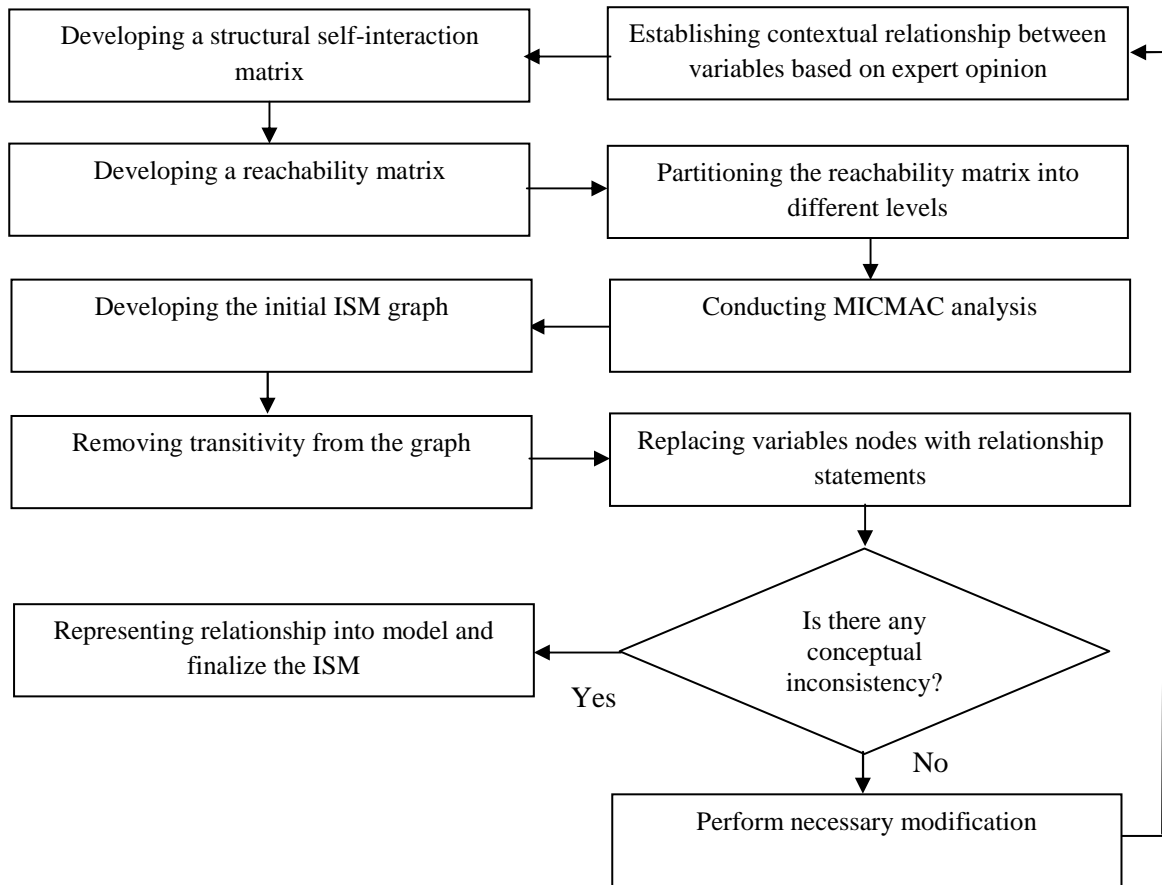
## 6- Interpretive Structural Modeling

After identifying the key factors contributing to the improvement of PMO performance, the relations between them should be determined. Therefore, the interpretive structural modeling method was used. The concept of interpretive structural modeling (ISM) was primary introduced by Warfield in 1973 to evaluate the complex systems. This approach facilitates to compel classification and direction on the complex relationships among components of a complexity of relations among elements of a system (Sage, 1977). In this modeling approach the final relationship is illustrated in a directed graphical model and the final structure is exploited from complex set of variables. There are some steps to develop ISM approach (Singh & Kant, 2008), and these steps were followed to model the PMO performance problem.

The steps in developing the interpretive structural model are as follow (Singh & Kant, 2008):

1. Creating the Structural Self-Interaction Matrix (SSIM)
2. Creating reachability matrix (RM)
3. Evaluating the transitive relation between digits in the reachability matrix
4. Deriving the reachability set and antecedent set for each factor
5. Determining the level of variables in ISM model
6. Depicting the graph

The flow diagram of ISM modelling is presented in figure 3.



**Figure 3.** Flow diagram of ISM modeling

**Step1: The Structural Self-Interaction Matrix**

In the first step, the Structural Self-Interaction Matrix should be completed to determine the relations among factors. The structural self-interaction matrix represents the relationships among variables using following four symbols (Singh & Kant, 2008):

- V: Factor i will assist to reach Factor j;
- A: Factor j will assist to reach Factor i;
- X: Factor i and j will assist to reach each other; and
- O: Factor j and i are unrelated.

The overall opinions of interviewees, who had participated in the last step of the research, were gathered through Delphi method. The questionnaire 2 was developed to determine the relations between 9 variables through the structural self-interaction matrix. The questionnaire 2 was sent to 63 PMO managers in case organizations. The results are shown in table 4.

**Table4. The Structural Self-Interaction Matrix**

Symbol	Factor	F9	F8	F7	F6	F5	F4	F3	F2	F1
F <sub>1</sub>	Senior management support	V	V	V	V	V	V	V	V	V
F <sub>2</sub>	Improving the project management maturity level	A	A	A	A	A	A	A	A	
F <sub>3</sub>	Developing standards, methodologies and tools	V	A	A	A	V	V			
F <sub>4</sub>	Developing competencies of project managers	V	A	A	A	O				
F <sub>5</sub>	Supporting projects	V	A	A	A					
F <sub>6</sub>	Acquiring necessary resources	V	A	X						
F <sub>7</sub>	Realizing the mission and objective of PMO	V	X							
F <sub>8</sub>	Obtaining organizational companionship	V								
F <sub>9</sub>	Authorizing the PMO									

### Step2: The reachability matrix

A converted SSIM matrix into binary matrix (elements are 0 or 1) provides the reachability matrix (Singh & Kant, 2008). In order to convert the structural self-Interaction matrix to the reachability matrix below rules were followed, and the matrix in table 5 was drawn.

If the relation  $C_i$  to  $C_j = V$  then element  $C_{ij}=1$  and  $C_{ji}=0$  in the reachability matrix.

If the relation  $C_i$  to  $C_j = A$  then element  $C_{ij}=0$  and  $C_{ji}=1$  in the reachability matrix.

If the relation  $C_i$  to  $C_j = X$  then element  $C_{ij}=1$  and  $C_{ji}=1$  in the reachability matrix.

If the relation  $C_i$  to  $C_j = O$  then element  $C_{ij}=0$  and  $C_{ji}=0$  in the reachability matrix.

**Table5.** The Initial reachability Matrix

Symbol	Factor	F1	F2	F3	F4	F5	F6	F7	F8	F9
F <sub>1</sub>	Senior management support	1	1	1	1	1	1	1	1	1
F <sub>2</sub>	Improving the project management maturity level	0	1	0	0	0	0	0	0	0
F <sub>3</sub>	Developing standards, methodologies and tools	0	1	1	1	1	0	0	0	1
F <sub>4</sub>	Developing competencies of project managers	0	1	0	1	0	0	0	0	1
F <sub>5</sub>	Supporting projects	0	1	0	0	1	0	0	0	1
F <sub>6</sub>	Acquiring necessary resources	0	1	1	1	1	1	1	0	1
F <sub>7</sub>	Realizing the mission and objective of PMO	0	1	1	1	1	1	1	1	1
F <sub>8</sub>	Obtaining organizational companionship	0	1	1	1	1	1	1	1	1
F <sub>9</sub>	Authorizing the PMO	0	1	0	0	0	0	0	0	1

In the next step, the transitive relation among digits in the matrix was evaluated. In the final matrix driving power and dependence power were calculated for each factor based on reachability matrix (table6). The driving power for each factor is the total number of factors involves itself that it may assist reach and the dependence power for each factor is the total number of factors involves itself that may assist reach it (Singh & Kant, 2008).

**Table6.** The final reachability matrix

Symbol	Factor	F1	F2	F3	F4	F5	F6	F7	F8	F9	Driving Power
F <sub>1</sub>	Senior management support	1	1	1	1	1	1	1	1	1	9
F <sub>2</sub>	Improving the project management maturity level	0	1	0	0	0	0	0	0	0	1
F <sub>3</sub>	Developing standards, methodologies and tools	0	1	1	1	1	0	0	0	1	5
F <sub>4</sub>	Developing competencies of project managers	0	1	0	1	0	0	0	0	1	3
F <sub>5</sub>	Supporting projects	0	1	0	0	1	0	0	0	1	3
F <sub>6</sub>	Acquiring necessary resources	0	1	1	1	1	1	1	1	1	8
F <sub>7</sub>	Realizing the mission and objective of PMO	0	1	1	1	1	1	1	1	1	8
F <sub>8</sub>	Obtaining organizational companionship	0	1	1	1	1	1	1	1	1	8
F <sub>9</sub>	Authorizing the PMO	0	1	0	0	0	0	0	0	1	2
Dependence Power		1	9	5	6	6	4	4	4	8	

### Step3: Determining the level of variables

The reachability set and antecedent set for each factor were derived from initial reachability matrix. The reachability set consists of factor itself and other factors that it may help reach whereas antecedent set consists of factor itself and other factors that may help in reaching it. Afterward, the intersections of these sets were exploited for all factors. If elements of which reachability and intersection sets are similar then those are level I elements (table 7). Once the level I is determined, it is removed and then next same process is reiterated to discover next level elements (Singh & Kant, 2008).

**Table7.** The level of variables

Symbol	Factor	Antecedent Set	Reachability Set	Intersection	Level
F <sub>1</sub>	Senior management support	1	1,2,3,4,5,6,7,8,9	1	VI
F <sub>2</sub>	Improving the project management maturity level	1,2,3,4,5,6,7,8,9	2	2	I
F <sub>3</sub>	Developing standards, methodologies and tools	1,3,6,7,8	2,3,4,5,9	3	IV
F <sub>4</sub>	Developing competencies of project managers	1,3,4,6,7,8	2,4,9	4	III
F <sub>5</sub>	Supporting projects	1,3,5,6,7,8	2,5,9	5	III
F <sub>6</sub>	Acquiring necessary resources	1,6,7,8	2,3,4,5,6,7,8,9	6,7,8	V
F <sub>7</sub>	Realizing the mission and objective of PMO	1,6,7,8	2,3,4,5,6,7,8,9	6,7,8	V
F <sub>8</sub>	Obtaining organizational companionship	1,6,7,8	2,3,4,5,6,7,8,9	6,7,8	V
F <sub>9</sub>	Authorizing the PMO	1,3,4,5,6,7,8,9	2,9	9	II

**Step4: MICMAC analysis**

The MICMAC analysis was conducted to categorize variables based on their driving and dependence power (figure 4). The clusters I, II, III and IV are defined as below:

- **Autonomous Variables:** The driving and dependence power of variables is low. These variables are weakly connected to the system and their effects on other variables are very low. In this study, none of the 9 key factors was positioned within this area.
- **Dependent Variables:** The driving power of variables is low, but the dependence power is high. These variables are highly influenced by the variables in the lower level. The factors F<sub>2</sub>, F<sub>4</sub>, F<sub>5</sub> and F<sub>9</sub> are positioned within this area.
- **Linkage Variables:** The driving and dependence power of variables is high, and any stimulate on these variables can affect the whole system. The factor F<sub>3</sub> is positioned within this area.
- **Driver Variables:** The driving power of variables is high, but the dependence power is low. Driver variables highly affect other variables, and constitute the base of the ISM model. The factors F<sub>1</sub>, F<sub>6</sub>, F<sub>7</sub> and F<sub>8</sub> are positioned within this area.

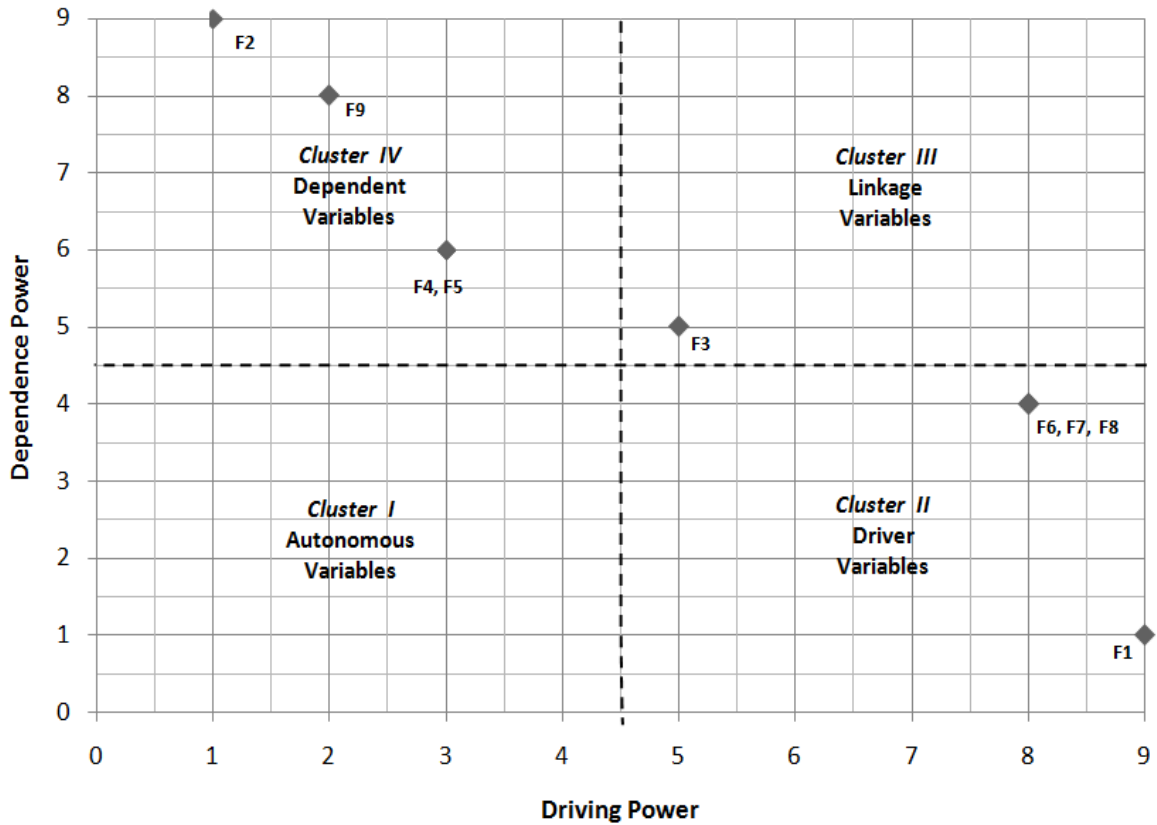
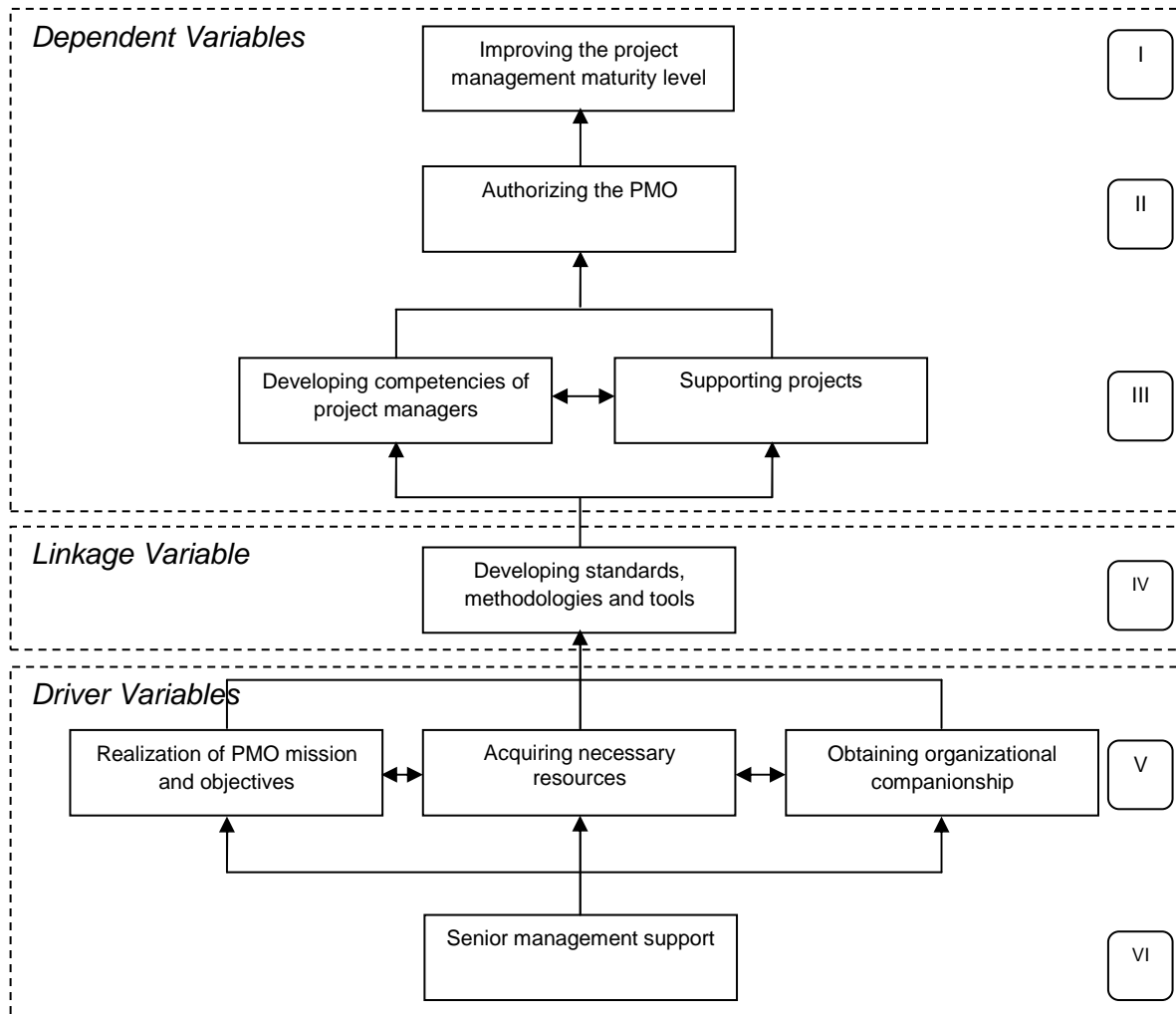


Figure 4. MICMAC analysis diagram

**Step5: Depicting the ISM model**

The interpretive structural model of factors improving the PMO performance is offered in 6 levels. The ISM is created from initial reachability matrix. If there is a relationship between factors i and j, then the relationship is shown with an arrow that points from i to j. Following graph showing factors improving the PMO performance, and was generated to portray visually both the direct and the indirect relationships between factors (figure 5).



**Figure 5.** The ISM model of factors improving the PMO performance in Iranian construction companies

The driver variables in the ISM model include "senior management support", "realization of PMO mission and objectives", "obtaining organizational companionship", and "acquiring necessary resources". These independent factors are considered as the fundamentals of PMO performance, and Iranian construction organizations have to make sure of their fulfillment. Senior management support is the most basic factor in order of its low dependence power and high driving power among all factors. This factor plays an essential role in achieving system's result, and it directly provides appropriate condition for realization of the other three driver variables. It means that obtaining the organizational companionship and necessary resources as well as realizing the PMO objectives are not applicable without gaining upper management support. The interrelations among factors positioned at the fifth level of the model indicate that these factors are dependent on each other, and provide the essential basis for "developing standards, methodologies and tools" which, in turn, is a linkage variable positioned at the fourth level of the model. This variable have high dependence and diving power, and largely affects the whole model. Organizations have to pay special attention to this factor because it plays an important role as a leverage variable in improving the PMO performance.

The realization of dependent variables positioned at the first three levels of the ISM model depends on the lower level variables. The relations among dependent variables in the second and third level of the model indicate that PMOs can gain necessary authority and decision making power if they show their ability in supporting projects and developing competencies of project managers, and consequently build confidence in upper management. Authorizing the PMO is considered as a key factor which enables this organizational unit to run its functions more effectively, and enhance the project management maturity level. The factor "Improving the project management maturity level" has the highest dependence power, and is positioned at the top of the ISM model.



## 7- Conclusion

**Findings:** This study was conducted to identify the factors improving the project management office performance in Iranian construction industry. In this regard, an extensive research was conducted to extract potential factors through the literature review, and then a comprehensive survey in 63 Iranian construction organizations was carried out to identify key factors. In this regard, two questionnaires were used as the data gathering tools, and student's t-test was applied for hypothesis testing. Accordingly, the result of the hypothesis testing revealed that 9 out of 12 factors are key factors which interrelations were determined based on the interpretative structural modeling.

**Contribution:** This paper contributes to the academic literature through extending the concept of project management office performance, as well as introducing the first model of factors positively influencing the PMO performance in Iranian construction industry. The findings are presented in an ISM model illustrating 9 interrelated factors grouped in 3 categories (dependent, linkage and driver variables). Four factors were identified as "driver variables" which are considered the fundamentals of PMO performance. These factors include "senior management support", "acquiring necessary resources", "obtaining organizational companionship" and "realizing the mission and objectives of PMO". Furthermore, the factor "developing standards, methodologies and tools" was introduced as a linkage variable connecting the fundamentals of PMO performance to the dependent variables "improving the project management maturity level", "developing competencies of project managers", "supporting projects" and "authorizing the PMO". Organizations should, at First priority, develop the driver factors, and then focus on linkage factor. If these factors are met appropriately, this organizational unit will be able to fulfill the dependent variables which enhance the overall PMO performance.

**Implication for management studies:** The results of this research provide project-based organizations with guidelines and common understanding to develop and manage their project management offices more effectively toward success. Furthermore, this paper focused on the transparency of PMO performance concepts. Practitioners may benefit from the findings through following the guidelines, and meeting the requirements of enhancing the PMO performance. The implications of this study are mainly tied to the understanding of PMO performance constructs which condition its success and threshold of action in the construction Industry. This research, especially, provide the Iranian construction companies with a practical roadmap for improving their PMOs.

**Limitations:** Some limitations need to be addressed. Gathering information from Iranian construction organizations was time-consuming, and there were a few sources. Furthermore, the lack of prior research into the PMO performance was a limitation. No research offered a framework or model of factors affecting the PMO performance.

**Future research:** Future research should follow up on the effort to make sense of the quantitative impact of PMO performance constructs on its success. This impact can be illustrated applying the system dynamics approach which is an efficient tool for considering dynamic relations. The theme of this research may be extended to further research into a typology of PMOs based on their performance. Furthermore, the ISM model does not presents the intensity of interrelations among variables. Therefore, it can be done through applying structural equation modeling.

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