Identification and Classification of Factors Affecting the Performance of Building Supervisor Engineers for Construction Industry

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Abstract: The construction industry is one of the main sources of economic growth and development all over the world. Thus, the success of these projects is very important. Construction projects are engaged with three main factors of time, cost, and quality. Among these three factors, quality is considered as one of the most significant competitive factors. An important factor in maintaining and controlling quality and reinforcement of buildings is continuous supervision. Building supervisor engineers play a key role in the supervision of constructions. Unfortunately, due to the significance of construction industry, the poor performance of supervisor engineers leads to poor quality of urban constructions. In Iran, several surveys have been conducted to review the causes for undesirable performance of engineers, among which 62% pointed to supervisor engineers as the main cause of undesirable performance. This issue somehow; points to the poor performance of supervisor engineers and low quality of the construction industry in Iran. In other words, various factors affect the performance of building supervisor engineers and supervisory process. Accordingly, in this study authors are to identify factors affecting the performance of supervisor engineers through Systematic Literature Review (SLR) method. Collected data are descriptively analyzed. 18 factors affecting the performance of building supervisor engineers are identified. Using the pattern analysis, these factors are classified into 4 groups of legal, ethical, technical, and economic. We used the NVivo software to simplify the pattern analysis process. This classification provides an appropriate context for improving these factors to enhance the performance of building supervisor engineers and increasing the quality of the construction projects.

Keywords: Construction industry, quality, supervision, supervisor engineer, affecting factors.

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1. Introduction

The construction industry has direct and indirect effects on national economy (Chang et al., 2018). Unfortunately, despite its importance, with the dawn of the 21st century, this industry has shown an unsatisfing picture of itself. One of its factors contributing to the lack of satisfaction is poor supervision in this industry (ILO, 2001). So it can be stated that one of the most significant and fundamental factors that result in decreasing quality in construction projects is poor supervision (Wang et al., 2013). Continuous supervision over the projects is a significant factor for maintaining quality and reinforcement of buildings (Javad, 2017). Thus, projects with proper continuous supervision are nearly twice as satisfying as projects with poor supervision (Spilsbury et al., 2010). The supervisory systems play a significant role in quality,

cost, safety, and time management (Standing Committee, 1997).

Since construction projects are a national capital for each country so monitoring them is an important issue and prevents loss of quality (Wang et al., 2013). Supervisor engineers are the main factor of supervision (The role of engineering supervision over construction, 2014). Since the significance of the construction industry for other departments and industries is obvious and considering this fact that the construction industry has improved through technology and the human role has been faded, still human plays a significant role in mistakes of this industry. These mistakes result in quality loss. Consequently, supervision quality depends on supervisors, and various factors affect the performance of supervisor engineers (Mahesh et al., 2016). Several studies have been implemented to identify the reasons for

poor performance of building supervisor engineers, which point to factors such as lack of experienced supervisor engineers, lack of sufficient expertise, and inappropriate training (Alwi et al., 2001). Despite such studies and various rules carried out on building supervision and control systems, still, weakness and poor performance of the supervisory systems in the construction industry is noticeable (Hosseini and Nazari, 2014). For that purpose, this study identified and classified factors affecting the performance of a supervisory system. Next section reviews relevant literature.

2. Literature Review

2.1. Quality in the Construction Industry

The construction industry is one of the most significant and essential factors in social and economic growth (Hillebrandt, 1985), such growth and development affect the development of other industries (Okpala et al., 1988; Elinawa and Buba, 1993; Mansfield et al., 1994). Therefore, the success of construction projects is essential. A construction project is called successful, when it is completed within the time, cost, and quality specified at the beginning of the project (Lam and Gale, 2015). Among these three factors, quality is a competitive factor in constructions (Lawson, 2013), such quality maintenance and control in constructions, results in creating long-term competitions and business survival (Tan and Abdul, 2005). Accordingly, poor quality leads to duplication costs in projects (Boukamp and Akinci, 2004). Consequently, quality maintenance and control throughout the project is essential (Chandrasena, n.d.). Despite the importance of maintaining quality throughout project life cycle, unfortunately, low quality in construction projects has turned into a common problem in the world (Ali and Wen, 2011). For example, in Iran, low quality of constructions is vastly observed, for instance, the lifetime of a building in Iran is about 30 years, which is too low comparing the average 100 years' lifetime of buildings in developed countries (Qalibaf, 2007). In other words, the main factor that leads to success and quality improvement in construction projects is supervising and evaluation (Charles and Humam, 2015). Neglecting the supervision section will be accompanied by a sharp drop in quality (Asle, 2015). Supervisors are responsible for continuous supervision of all executive operations. What is observed in this regard, is a failure to take on this serious responsibility and consequently, low quality (Khajani and Shakeri, 2014).

2.2. Factors Affecting Supervision

Studies have shown that projects with good supervision are nearly twice as satisfying as projects with poor performance (Spilsbury et al., 2010). In other words, the important factor in sustaining quality and building reinforcement is continuous supervision over projects (Hendershot, 2006). According to FIDIC survey conducted in 2001, it was found that poor quality is the main problem in developing countries, and one of its main reasons is reduced proper supervision over the projects (International Federation of Consulting Engineers, FIDIC). So we can state that poor supervision over the projects is one of the significant and fundamental factors that leads to the quality loss in construction projects (Wang et al., 2013).

The main factor of supervision in the construction industry is supervisor engineers (The role of engineering supervision over construction, 2014). Unfortunately, the poor performance of supervisor engineers caused lack of sufficient quality and strength in many urban constructions (Hashemi, 2010). Unofficial statistics indicate that 99% of supervisor engineers just sign the supervision form and do not have a permanent presence in the project, and there is no system to monitor their job (Imami, 2010). Given the various rules imposed by engineering organization for the presence of supervisor engineers and quality control systems for supervision, still, we can spot many weaknesses in this system (Hosseini and Nazari, 2014). According to the surveys conducted in Tehran regarding the poor performance of engineers involved in the construction industry, 62% of statistics relate to the poor performance of supervisor engineers, which such poor performance results in quality decline. There are many factors affecting the poor performance of supervisors (Abbasi, 2007). Therefore, it is required to identify and prioritize the factors affecting the performance of supervisors. In other words, supervision is a vital element in constructions and the process of construction. Good supervision leads to saving and decreasing duplication costs and improving quality (Sugiharto et al., 1999). The responsibility of supervisor engineers is supervision over quality and monitoring the requirements and rules and regulations, and technical standards, such supervisor engineers should be responsible for any weak quality (Liu, 2004; Liu and Liu, 2007; Xie and Wang, 2005).

The construction industry is considered as the wealth of any country. Due to the strong relation of this industry with other industries, any change in it affects other industries (Negara, 2011). Therefore, the success of this industry is substantial, but in developing countries, quality of constructions is low, to the extent that lifetime of a building in Iran is about 30 years, which is very low comparing the average 100 years' lifetime of buildings in developed countries (Qalibaf, 2007).

Moreover, in Iran- as a third world country- 40 to 50 percent of buildings suffer heavy damages in the event of an earthquake, which also points to the low quality of constructions (Abbasi, 2007).

Unfortunately, the poor performance of supervisor engineers has caused many urban constructions not having the required quality and strength (Charles and Humam, 2015). Various factors such as lack of knowledge of supervisor engineers, lack of expertise, lack of formal training, have had negative effects on their performance (Alwi et al., 2001). Thus, the present study attempts to identify the factors affecting the performance of building supervisor engineers and classify them through systematic literature review. This paper also aims to provide a context for future studies and to offer effective solutions for improving the factors affecting the performance of supervisor engineers in order to improve the quality of the construction industry.

3. Research Methodology

In order to do a study, obtaining knowledge and information is essential. To help the researcher, a set of questions should be raised and answered, which in fact, research methodology is a means for testing the hypothesis and finding the answers (Sarmad et al., 2003).

This study is a qualitative study using the Systematic Literature Review (SLR) method to identify the factors affecting the performance of building supervisor engineers. In the SLR method, the researcher uses data from past studies as the basis for his/her job (Khaki, 1999). In other words, the SLR method helps the researcher to describe and interpret the accepted texts and use them as the basis for his/her job (Bailey, 1994).

3.1. Systematic Literature Review (SLR)

When researchers are faced with a question, they should have the skill of identifying constraints and qualities in the current literature, which is realized through a systematic review called "Systematic Literature Review" (Rory, 2013). In other words, the aim of this method is identifying, summarizing, and evaluating findings of all studies without any particular bias (Lindsay and Jefferies, 2013). This is a qualitative technique that is often combined with the quantitative methods (Krippendorf, 2004; Colicchia and Strozzi, 2012). The steps for implementing SLR are briefly presented in the following figure (Pearl et al., 2006).

To analyze the qualitative data obtained from SLR method, descriptive and pattern analysis methods have been applied for identifying and classifying the factors affecting the performance of building supervisor engineers. The descriptive analysis attempts to identify the available conditions and help the decision-making process. This method interprets the world as it is; in other words, it creates new insights (Ahanchian and Bazargan, 2004). However, pattern analysis finds appropriate rules and theories in data collected, and organized (Habibi et al., 2014).

To accelerate qualitative analysis of obtained data, the NVIVO software is used. In this software, all documents are collected and coded electronically (Davidson, 2003), and as a mean of communication (Davidson, 2005), facilitates data analysis. Next section illustrates the data analysis process performed using the SLR method.
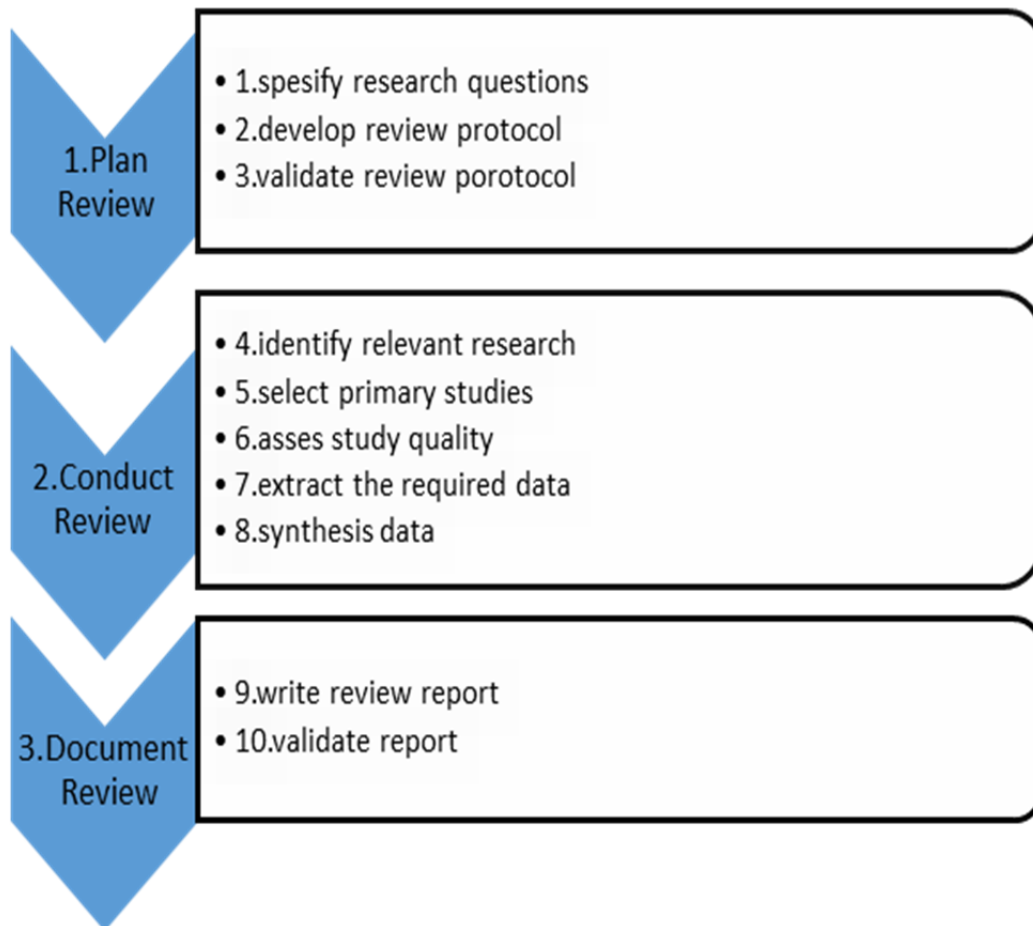

Fig. 1. Steps for SLR (Pearl et al., 2006)

4. Data Analysis

In this section, the steps of SLR technique are implemented to identify and classify the factors affecting the performance of building supervisor engineers.

• Step one: Specify research question

In the first step of SLR method, the research questions should be stated. These questions clearly define the population, interventions, and research scope (Khan et al., 2003). In other words, research scope represents research population and community, which in this study, reliable scientific articles in the field of the statistical society of supervisor engineers have been used. Research data have been collected from scientific articles from 1997 to 2017. The research question focused in this study is: 'What are the factors affecting the performance of building supervisor engineers?'.

• Step two: Develop review protocol

In fact, protocol is a design for reviewers, to enable them to complete their systematic review. In other words, a protocol includes a background specifies the purpose and benchmark of the study. In fact, a protocol is used to ensure scientific accuracy and to minimize biases and helps the researcher as a guide throughout the process (Clarke and Oxman, 2003). In this step, the criteria for entering the study are determined and the main focus is on the scientific resources, in order to prevent losing key researches (Dubois, 2012). In other words, different search engines and scientific journals and reliable databases have been used in this study, and appropriate keywords have been utilized for search, as shown in Table 1.

Table 1. List of searched bases in this study

Databases	Keywords
Science Direct	Supervisor engineer
CIVILICA	Supervisor engineer performance
SID	
IRAN DOC	Construction industry
ASCE	Supervision
Emerald	
Ieee Xplore	
Google Scholar	

• Step three: Validate review protocol

Since the protocol is a roadmap, in which the search strategy is determined (Higgin and Green, 2006), its assessment is necessary. This job is done by the researcher and colleagues to ensure there is no particular bias in it and its main objectives and subject have not been diverted (Moher et al., 2007).

• Step four: Identify relevant researches

In this step, relevant researches should be identified. Relevant articles are identified step by step through search strategy (Badampudi et al., 2015). In order to avoid any bias, all articles with different years of publication and authors are selected and evaluated several times (Boell and Cecez, 2015).

• Step five: Select primary studies

In each review, a number of these articles are removed. Removing articles depends on acceptance or rejection criteria, such as title, scope, abstract, text, and conclusion (Meho and Sugimoto, 2009). The required criteria, through which the articles are evaluated, are:

A. The language of articles is in English or Persian.

B. Year of publication: in this study, articles from 1997 to 2017 have been used.

C. The number of referrals to articles: articles with less than 50 visitors were not acceptable.

D. Validity of articles themselves and publishing them in reliable journals and books.

E. Subjective criteria of the researcher, who reviews articles in terms of title, abstract, text, and

conclusion, and accordingly some articles are removed (Petersen et al., 2015).

1) Based on the studies conducted on the desired databases and by the help of keywords. According to step 4 of SLR, 600 articles were identified.

2) According to step 5 of SLR, 351 articles were excluded due to their inappropriate title and remaining articles were 249.

3) Through reviewing the remaining 249 articles, 168 articles were excluded due to inappropriate abstract and remaining articles were 81.

4) Among 81 remaining articles, 20 ones were removed due to lack of the required information about the project, and finally, 61 articles remained. These articles were reevaluated in step 6 of SLR.

• Step six: Assess the quality of studies

In this step, quality of studies is assessed, in order that the researcher can reject unreliable data. The quality of the remaining articles in this study is assessed through (critical evaluation) CASP. This method presents a pattern with ten indices, which helps the researcher in assessing the accuracy and importance of studies. The articles are scored by 10 indices from 1 to 5, which are classified based on a 50-point scale, CASP. Scores 40-50 are excellent, 31-40 are very good, 21-30 are good, 11-20 are medium, and 0-10 are poor. Articles with score 30 or less are removed (Jensen and Allen, 1996). According to step six of systematic literature review, the remaining 61 articles were reviewed and 38 articles were removed thus 23 articles remained. A brief to the structure of steps 4 to 6 is shown in Fig. 2, as follows.

• Step seven: Extract the required data

Throughout the SLR method, the researcher reviews the final articles several times to achieve in-content and separate findings. Main studies are conducted on these findings. Given the trend of this study, 23 articles have been approved. Classifying the information of articles in this study is as follows: in the first column, the name of authors and its publication year, and in the second column, factors affecting the performance of building supervisor engineers are stated. The basis of extracting components from the selected texts is the answers to the following questions:

1) What are the factors affecting the performance of engineers?

2) What is the reason for the poor performance of supervisor engineers?

3) What factors improve the performance of supervisor engineers?

4) What are the reasons for the qualitative weakness of the construction industry?

• Step eight: Synthesis data

In this step, in order to synthesize data, NVIVO software has been used, and pattern data analysis and coding were performed. In the present study, at first the factors affecting the performance of supervisor engineers were extracted, then these factors were considered as one code,

and overlapping codes were specified then codes with common content were determined and a common code was specified through NVIVO software. The result of data extraction is shown in Table 2.

• Step nine: Presenting findings (Write review report)

After reviewing literature through SLR and descriptive analysis, the identified factors affecting the performance of building supervisor engineers from 23 approved articles, 25 factors were extracted, some of which overlapped with others, and had the same meaning and concept. Finally, 18 factors were identified as effective factors on the performance of building supervisor engineers. These 18 factors were classified by NVIVO software using the pattern analysis method. Factors were

categorized into four groups of legal; technical and skillful; economic; ethical. Results are presented in Table 3.

• Step ten: Validate report (Quality control)

In this study, articles are selected from reliable journals and databases. Invalid articles were excluded from the process of SLR. For qualitative evaluation of these articles based on what was explained, CASP tool was used. Finally, extracting factors affecting the performance of building supervisor engineers from texts, combining information, and the method of coding and classifying them were reviewed several times. These stages and measures significantly confirm the quality of findings of this study.
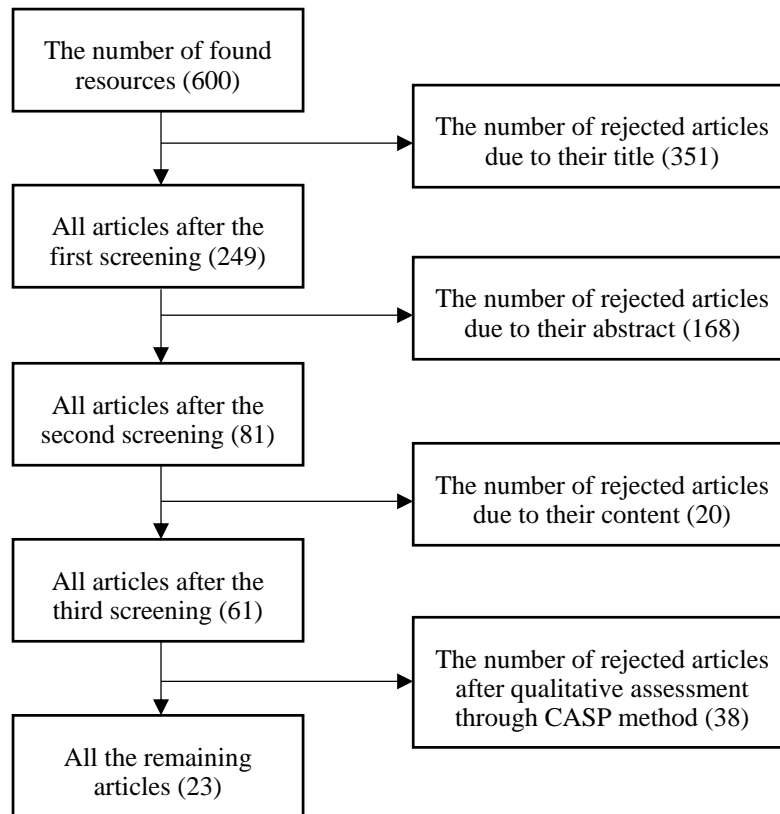

Fig. 2. Steps for SLR (Pearl et al., 2006)

Table 2. Factors affecting the performance of supervisors

Factors affecting the performance of supervisors	References
1. Supervisor skills (leadership, management, and communication skills)	Betts (1989). Sugiharto et al. (2001). Mian (1999). Magondu (2013). Wang (2000). Jiang (1998).
2. Lack of appropriate and formal training (knowledge)	Alwi et al. (2001). Mahesh and Purva (2016). Najat et al. (2007). Liu (1997). Jiang (1998). Hasnul and Kohilavaani (n.d.). Wang et al. (2009). Sheng et al. (2010). Aslshirin Sajad (2015). Khanjani and Shakeri (2014). Abbasi (2007). Hashemi (2010).
3. Lack of sufficient experience in supervisor engineer	Najat et al. (2007). Liu (1997). Jiang (1998). Khanjani and Shakeri (2014).
4. The supervisor engineer has no understanding of the project and how to monitor it.	Spilsbury et al. (2010). Sheng et al. (2010). Wang et al. (2009). Mahesh and Purva (2016).
5. Maybe the supervisor engineer is not responsible.	Spilsbury et al. (2010). Sheng et al. (2010).
6. Availability of appropriate supervisory tools	Spilsbury et al. (2010). Khanjani and Shakeri (2014). Aslshirin Sajad (2015). Wang (2000). Wang et al. (2009).
7. Financial adequacy	Spilsbury et al. (2010). Khanjani and Shakeri (2014). Hashemi (2010). Magondu (2013). Wang et al. (2009). Aslshirin Sajad (2015).
8. There is no complete standards and guidance for supervision.	Spilsbury et al. (2010). Khanjani and Shakeri (2014). Li (2004). Tang (2005). Xu (2005). Liu and Liu (2007).
9. Technical documentation and access to documents may not work well	Spilsbury et al. (2010).
10. Having self-confidence and decisiveness	Mian (1999). Hasnul and Kohilavaani (n.d.).
11. The ability to use modern techniques in supervision	Najat et al. (2007).
12. Being committed and conscientious	Najat et al. (2007).
13. Having motivation and energy (being active)	Najat et al. (2007). Liu (1997).
14. Lack of a relationship between the compilation reference of the Ministry of Roads and Urban Planning and the Municipality Control Authority	Khanjani and Shakeri (2014).
15. Supervisors just play the role of supervision and defects are not prevented and corrected.	Khanjani and Shakeri (2014).

Table 2. Factors affecting the performance of supervisors (continued)

Factors affecting the performance of supervisors	References
16. Discontinuous presence of supervisor engineers	Khanjani and Shakeri (2014).
17. Promotion of supervisors based on their working years	Khanjani and Shakeri (2014).
18. Being honest	Sheng et al. (2010).
19. There is no supervision over the performance of supervisor engineers	Abbasi (2007).
20. Market inappropriate behavior	Li (2004). Tang (2005). Xu (2005).
21. Low-level physical abilities of the supervisor	Li (2004). Tang (2005). Xu (2005). Liu (1997). Jiang (1998). Khanjani and Shakeri (2014).
22. Ethical and professional stability	Wang et al. (2009). Hasnul and Kohilavaani (n.d.).
23. Being creative	Hasnul and Kohilavaani (n.d.).
24. Having discipline	Hasnul and Kohilavaani (n.d.).

Table 3. Factors classification

Classification	Factors affecting the performance of supervisor engineers
Legal	Promoting supervisors based on their working years- supervision as the second and third job of supervisor engineers (not the main job) Availability of complete standards and instructions Supervisor should not just play the role of supervision, he/she should have a preventive role, too Supervision over the performance of supervisor engineers The relationship between the compilation reference of rules and municipality Appropriate level of physical ability of the supervisor
Ethical	Self-confidence and decisiveness Having motivation and energy Being creative Having ethical and professional stability, that represents honesty in job Being committed and conscientious, that represents supervisor's responsibility Having discipline, that represents the continuous presence of the supervisor engineer
Technical and skillful	Availability of appropriate supervisory tools, that states the ability to use modern technologies Formal training Having sufficient experience Skillful supervisor engineers Technical documents circulation among supervisors, which somehow has improved the supervisor's understanding of the project
Economic	Market-appropriate behavior, which represents supervisor's financial adequacy and appropriate rights

5. Discussion

The construction industry is considered as a national capital, and quality is one of the factors affecting the success of a project. The quality is obtained through continuous supervision, and supervision is conducted by the supervisor engineer. Neglecting supervision is accompanied by a sharp drop in quality (Asle, 2015). It can be stated that supervision over the quality of projects is one the significant factors preventing failure and losing the quality of construction projects (Wang et al., 2013). It is seen that projects with poor supervision, suffer from poor quality (international federation of consulting engineers, the global voice of consulting engineers,

FIDIC). Unfortunately, the poor performance of supervisor engineers has made many urban constructions not to have the required quality and strength (Hashemi, 2010). In fact, 99% of supervisor engineers just sign the supervision form and do not have a continuous presence in the project. There is no system based on supervision over the job of supervisors, to control their job (Imami, 2010). Various factors affect the performance of supervisors, so it is necessary to identify and classify them. In this study, 18 factors affecting the performance of supervisor engineers were identified and classified into four groups. Focusing on these four groups, we can present effective solutions that can enhance the quality of

the construction industry. This is achievable through improved supervision of supervisor engineers.

6. Conclusions and Suggestions

In this study, at first, we addressed the significance of the construction industry and its quality, which is achieved through supervision of supervisor engineers. Moreover, it is mentioned that poor performance of building supervisor engineers has caused reduced supervision and weak quality in the construction industry. Given the great responsibility of building supervisor engineers and their poor performance, various factors can cause this weakness. In this study, we have tried to identify these factors through systematic literature review and library studies. Using descriptive analysis, 25 factors affecting the performance of building supervisor engineers were identified, some of which overlapped with others. In this way, 18 final factors were identified. Finally, these identified factors were coded through NVIVO software and pattern analysis was performed on them, then they were classified in four ethical, legal, economic, and technical and skillful groups. Accordingly, a context was provided for future studies to present solutions to improve the performance of building supervisor engineers that lead to quality improvement and progress of the construction industry in Iran and all over the world.

Since this study addresses the reasons for poor performance of building supervisor engineers, these factors were identified and classified. In order to improve these factors and present them to the engineering organization, we should focus on their improvements. So, we can cover a part of these factors through cooperation with this organization, for example; through improving the performance of supervisor engineers, we can reduce qualitative costs and enhance construction. Also, as some of the factors affecting the performance of supervisor engineers point to their areas of competence, we can consider educational classes or courses based on the needs of the construction industry and supervisor engineers, in order to improve their performance. Or because the factor affecting the performance of supervisor engineers is the relationship between Municipality and compilation references of National Building Regulations, so in order to improve this relationship and its effectiveness on the performance of building supervisor engineers, we can point to the more presence of engineers and their better cooperation with Municipality. This issue results in improvement of relations. Moreover, for better supervision of building supervisor engineers, modern techniques and supervisory tools are provided for supervisors to improve their performance.

In this study, we have tried to identify and classify the factors affecting the performance of supervisor engineers, to be able to prioritize them. Given the significance of these factors, appropriate and effective solutions are presented to improve the performance of building supervisor engineers.

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