



Improving communication management in construction projects using Building Information Modelling (BIM)

Samereh Jadidoleslami¹, Ehsan Saghatforoush*², Narges Ghanbari³

1. PhD student in Project Management and Construction, Tarbiat Modares University
J_samereh@modares.ac.ir
2. School of Construction Economics and Management, University of the Witwatersrand, Johannesburg, South Africa.
ehsan.saghatforoush@wits.ac.za
3. M.A. student in Project Management in MehreAlborz University, Tehran, Iran
n.ghanbari96@mehralborz.ac.ir

Abstract:

Communication management as one of the principles of project management knowledge, is very important in project life cycle. Nowadays, communication is one of the main aspects of human life. However, despite creation of various technologies in communication, the construction projects suffer from problems such as, delays, increased changes and reworks, and decreased quality and coordination, which are all due to lack of proper communication among project stakeholders and the CEOs. This study aims to improve communication using Building Information Modelling (BIM). Lack of effective communication management leads to disruptions in message delivery, problems in timely and correct transmission of information and incomplete communication with stakeholders, and their misunderstanding of the transmitted message. this study is a descriptive and survey and cross-sectional study in terms of data collection. In this study, at first, the authors review the literature, and investigate different ways of communication between stakeholders and the CEO. Then, 85 questionnaires are distributed among employers as of main project stakeholders, construction contractors, CEOs, and consultants for architects, structures, and facilities. The effect of BIM on effective communications in construction projects are investigates. In most studies on communication management, the role of BIM was not significant in the early phases of the project. In addition, the role of BIM has not been considered seriously, whereas the solutions presented in BIM can create a group work and effective communication between stakeholders, and reduce conflicts, and establish communication policies between them. This issue has been studied due to the necessity of understanding the role of facilitators of communication management, such as BIM. the outcome of this study can be a good framework for improving communication management in projects.



Keywords: Communication Management; Project Stakeholders; Building Information Modelling, Construction

1- Introduction

Unfortunately, there are very few projects that communication between organizations, companies, organs, stakeholders, managers, and people involved in the project are studied in their initial stages. In the meantime, many scholars believe that basic problems of construction projects are caused by their poor communication [1-5]. The success of construction projects is highly dependent on the communication among individuals involved in the project [1]. Communication management can be an effective factor in integrating stakeholders and enhancing quality of construction projects. In the field of project management, PMI's International Standard Organization for Project Management considers the ability to communicate effectively as one of the main capabilities of project managers [2].

Communication is one of the key elements of group activities. In the field of construction, the uniqueness of projects and the large number of stakeholders from the initial stages of idea and design to the operation and maintenance of the project, make communication more significant. In domestic projects, managers consider various aspects of management in terms of scope and size of the projects. Usually, small projects start with just deciding and determining the approximate cost and time, and then during the implementation phases, depending on project needs, everything changes. In large projects, preliminary studies are more carefully considered. Cost, time, and quality management is evaluated by experts and if the project is justified, they decide to conduct it and the project progresses according to the schedule. Moreover, if necessary, the plans are revised at different stages of the project. The aim of this study is to improve effective communications among CEO and key stakeholders at the initial stages of the project. In the following, research background is addressed to clarify the study gap.

2. Literature Review

In this section, considering the main purpose of this study and the significance of effective communication between CEO and key stakeholders at the initial stages of the project, the status of stakeholders, executives, communications and strategies available in this field are evaluated, as follows.

2-1 Stakeholders

Often, many stakeholders are involved in construction projects, who can be good sponsors for the project, if they are managed effectively [6]. There is no doubt that no project will survive without the presence and support of all key stakeholders [7]. Considering the interests of stakeholders helps to establish stronger relationships in the project and reduce conflicts. In summary, the definition and characteristics of stakeholders can be formally stated as: all of the individuals, groups, and organizations



involved in the project that create opportunities or threats for the project, and influence the project implementation and finally the project output^[^]. The larger the project and the more the number of stakeholders, the greater the means of communication and the more ambiguous the layering of communication and the choice of communication model, which require proper management [9].

Studies show that behavioral, structural, and environmental factors influence the way of communicating with stakeholders. The role of the first factor, the behavioral factor, is more important than others [10]. Managers of construction projects should be able to identify all project stakeholders, estimate their demands, and classify them into layers of interest, commitment, and power, in order to solve their problems effectively [11]. Considering stakeholders' management, some indicators have been evaluated and summarized in the Table 1.

Table 1: Indicators affecting formation of appropriate relationships with stakeholders [12]

Rank	Index
1	Forming appropriate relationships with stakeholder
2	Recognition of stakeholders
3	Recognition of stakeholders' interest
4	Recognition of project boundaries and stakeholders' demands
5	Applying effective communication methods, and assurance of its achievement
6	Accepting social roles

Among these indicators, the index of forming appropriate relationships with stakeholders is on the first rank, indicating the significance and necessity of effective communication with stakeholders in achieving project goals. Establishing effective communication among all stakeholders and project managers can be one of the key responsibilities of CEO; however, it does not mean that other individuals in this area are not responsible, because successful communication is achieved by the motivation and effort of all individuals involved in the project.

2-2 Executives

Implementation, monitoring, and control measures are conducted during project implementation. Executives or CEO guarantee the criteria and cost and time based on the schedule. CEO spend most of their time coordinating between various teams. They are required to meet the demands of stakeholders correctly, in order to align them with the project and its goals. The responsibility of CEO is more critical in times of crisis. In crisis, creating a favorable environment requires a higher level of energy [13]. Moreover, CEO are more willing to communicate and receive information than other project managers [14]. It is essential for managers to be honest, because it is a key element in receiving and transmitting information in the project implementation process [15]. Mid-management teams, under the supervision



of CEO, should provide them accurate and truthful information, so that CEO can mutually share this information with stakeholders [16]. Communication between stakeholders and CEO has a significant effect on reducing claims and subsequently time and cost of the project and enhancing its quality. In the following, we evaluate the concept of communication and its management in construction projects.

2-3 Communications and the consequences of not communicating

Determining the path of communication in a project will make decisions to be taken based on the collected data and to be reasonable. In addition, it will reduce claims and conflicts, and determine the level of expectations, and improve relationships [17]. Scott and Michel have determined four goals for communicating between individuals: Influencing others, revealing emotions, transmitting and receiving information, strengthening the organizational structure [18]. There are several factors that influence how a communication is selected in a project. Culture can be considered as an influential factor in the communication between individuals [19]. In a project with several stakeholders and CEO and different cultures, CEO or employers should develop negotiation skills [20]. Material culture, language, linguistics, education, region, beliefs and attitudes, social organizations, and political life are considered as effective cultural elements [21]. The diversity of stakeholders highlights the impact of the role of culture on communication. There are many different ways of communicating between individuals. In the meantime, negotiations are among the traditional ways of communication [22]. Negotiations can be considered as a solution for conflicts. The outcome of negotiation can lead to peace, cooperation, and sometimes achieving the common goals and even a combination of these results [20].

Some other methods can be short-term partnerships. In these methods, partnerships and communication between individuals and groups are created solely in relation to a project, and may sometimes be created at different stages of the project and by the end of that part of the project, that partnership and communication between the individuals and teams will be stopped [23, 24]. Another type of communication is long-term or strategic communication. This type of communication can start from the idea, study, and design phases, and continues to the operation and maintenance phase of the project. The impact of this type of communication will be on reducing project time and costs in addition to improving relationships and project performance [22]. Many studies have shown that strategic communication increases cost effectiveness [25, 26]. Commitment and trust are integral to strategic participation [27, 28]. Undoubtedly, there are some obstacles to any relationship. Judging, inappropriate transfer of concepts in negotiations, inappropriate ways of expressing solutions, and insisting on defending personal interests against common interests can be considered as obstacles to effective communication. Louise refers to other obstacles to communication, such as communicating at inappropriate times, incomplete information, inappropriate communicating ways, inaccurate estimation, emotions, anxiety, and false beliefs [29]. Of course, there are some weaknesses in construction projects due to insufficient attention to the issue of communication, which is addressed

below. Generally, conflicts arise when the parties have failed to reach the necessary agreement by failing to communicate properly [30]. Chart 2 shows the failure chain due to unpredictable communication.



Chart 2: Chain of failure due to unpredictable communication [31]

Proper management at the time of conflicts, analysis of the raised conflicts, their causes, and finally the solution to solve them are critical in construction projects. Because just these solutions can reduce tension in projects and create peace in them [32]. Knowing the consequences of lack of communication in construction projects shows the necessity of expressing communication solutions.

2-4 Available solutions for effective communication

Some solutions are provided to communicate between the executives of construction projects and stakeholders based on available resources. Table 2 summarizes these solutions.

Table 2: Available Solutions for Effective Communication

Reference (s)	solution
[33]	Increase the knowledge of senior executives and stakeholders
[34]	Preparation of checklists at the design stage
[33, 35]	Share information about each team with other teams
	Not applying traditional methods such as bidding
[36]	Holding face-to-face meetings
	Stakeholder justification for the benefits of communication
	Using communication techniques
[37]	Increasing employer awareness
	Increasing people's awareness of the benefits of communication
	Equal importance of the different phases of the project to the stakeholders
	Choosing the right people for resolving disputes
	Emphasis on increased costs in non-communication
[38]	Sharing experiences and knowledge
	Develop supportive plans for stakeholders and executives to build relationships



[39]	Standardization
[40]	Identifying ** cultural problems in communication
	Establish coordination groups for each team to establish communication
	Accept feedback
	Increased motivation in communication
	Use the instructions
[41]	Employers' power to communicate
	Examine different forms of communication
[41]	Allocating financial resources to coordination
[42]	Communication workshops
[43]	Being aware of a culture of improvement and creating a relaxed environment
[44]	Setting goals and defining long-term and short-term goals of the project
	Develop a system of stakeholder and manager motivated advice and guidance
[45]	Face-to-face negotiations*
	Introducing a person or group as coordinator
[46]	Teamwork Culture
[47]	Implementing transparent communications
[47]	Updating and implementing feedback in relationships
[48]	Correct and managed communications at different stages of the project life cycle
[44]	Changes in communication styles

As it is observed in Table 2, there are several solutions for communication. Among these solutions, negotiation is recognized as the simplest and most basic way of communication between all human beings and in all working and non-working relationships. There are different intellectual frameworks in negotiations between individuals and groups, the most important of which are the frameworks of personality, identity, outcome, interests, legal, power, and process. Various factors influence negotiations.

Considering the variety of communication tools, especially negotiation, stakeholder diversity, cultural exchange between them, and the factors influencing communication, this study is going to examine the role of BIM as a facilitator of communication and conflict reduction between stakeholders. In the following, we will introduce BIM.

2-5 Building Information Modeling (BIM)

BIM is a 3-D representation of information and structure of the building. BIM can be easily accessible and available to all stakeholders, managers, organizations, etc. The main objective of BIM is making a file of all building data, which can be shared with designers, builders, stakeholders, and finally customers throughout the project life cycle [49]. BIM applications can be divided into four categories in the construction industry: feasibility phase (pre-construction), design and drawing 2-D maps phase

(design), construction phase (equipment, machinery, and manpower...), operation and maintenance phase (post-construction) [50]. Considering the subject of the present study, we will state the benefits of using BIM in the design phase. In this phase, BIM can be used for preparing maps, standards, consumption patterns, required materials, volume and type of materials, the location of using equipment, assembly of equipment, machinery required for each department, and most importantly, skilled manpower necessary for different stages of implementation. Because specifying the priority and delay of implementation time while designing, can help reducing costs, proper timing, and accurate project implementation and enhancing project quality. Using BIM can display all the above mentioned items before beginning the project implementation, thereby reduces trial and error during implementation of the project. Moreover, using BIM we can examine several implementation methods before beginning any operation. Chart 3 shows BIM applications in construction projects.

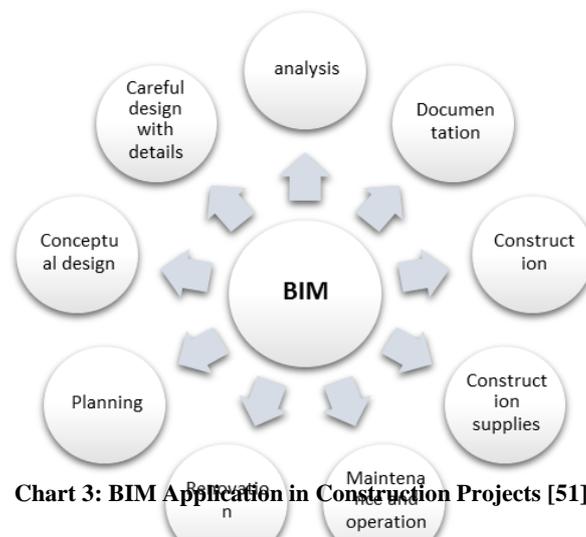
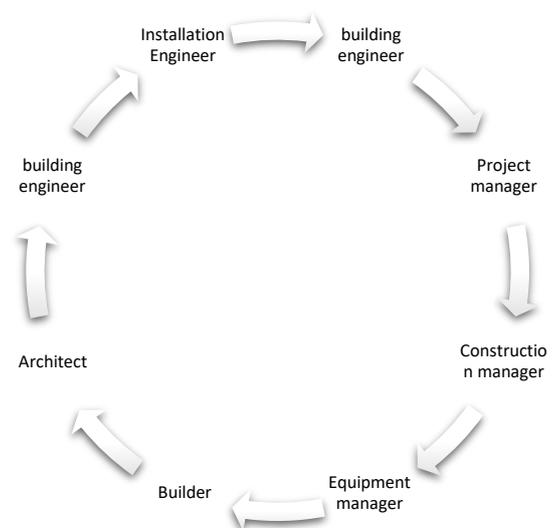
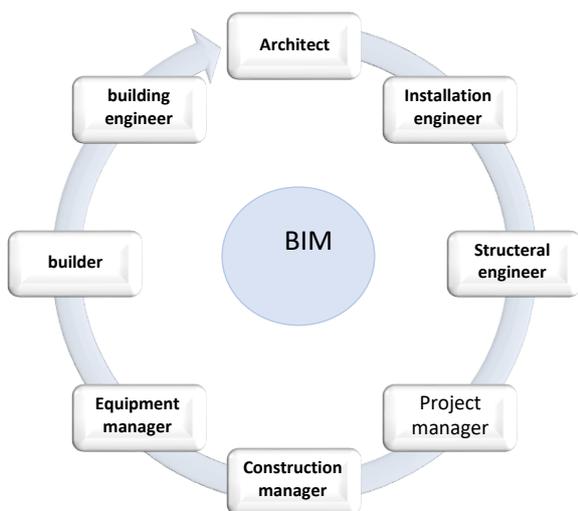


Chart 3: BIM Application in Construction Projects [51]

According to Federal Government statistics, using BIM in building construction reduces 3% of costs during construction, and executives can provide designers and employers with the final result before it is completed [52]. Moreover, every construction project, in its implementation phase, is faced with a

large volume of executive contracts, such as self-executing, conventional three-factor, four-factor or implementation management, design and two-factor construction, construction, operation and maintenance, etc., which can be easily accomplished using BIM in the process of completing the required documentation and accurate estimates [50].

It should be noted here that one of the most important goals of construction projects is meeting the stakeholders' demands, which should be considered in the design and implementation phase more than any other thing. BIM provides stakeholders with a digital image of the physical and functional properties of the building. It provides stakeholders with an opportunity to obtain a general view of their expectations of the project before conducting any operations. In addition, it offers a reliable data file, which can be used throughout the project life cycle for any decision making [53, 54]. The difference between traditional approaches and BIM is that in traditional approaches, designing and preparing construction maps are considered as two independent processes that increase project costs and make design maps to be inefficient. Whereas using BIM technology creates an effective communication between the design and construction maps. It is exactly the opposite of traditional methods. Because this communication links the design and construction maps, removes duplications, provides early presence of CEO, stakeholders, and meets their demands [55]. If the software required for BIM implementation and skilled staff are ready, the cost of using BIM in construction projects is estimated to be 0.5 to 1% of the project cost [56]. The communication in the traditional approach and using BIM are presented in Charts 4 and 5.





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Chart 4: Traditional communications in construction projects and throughout the project life cycle [57]

Chart 5: BIM communication [57]

In the following, the research methodology of this study is described, in order to achieve its goal of providing a model for facilitating communication management focusing on the selected BIM approach.

3. Research Methodology

In this study, library studies have been done to identify the ways of communicating between the construction projects' executives and stakeholders. Due to the nature of the subject and the goals of this study, we are examining and explaining a qualitative study. Most of the qualitative studies are conducted with the aim of evaluating phenomena, explaining and formulating hypotheses, and specifying the relationship between processes and phenomena. Most of the studies that are library based and theoretically, their data is obtained through studying reliable scientific sources, such as articles, related books, theses, etc. and often are of qualitative ones. In order to collect data in this study, in addition to the information obtained from library and archival studies, a questionnaire was developed based on the criteria and findings of library studies, and was distributed among the target population. Thus, this study is a descriptive and survey and cross-sectional study in terms of data collection [58].

It was attempted to introduce communication management based on the project management principles and standards. The importance of stakeholders' influence was studied, and according to the conducted studies, stakeholders' communication was recognized as the solution for many conflicts and problems. The studies were conducted qualitatively, and finally, the role of BIM in communication management was evaluated by distributing a questionnaire among employers, construction contractors and design consultants. In order to achieve efficient results, a number of factors were considered positive and some others were fixed and unchanged. The hypotheses were considered as follows:

- The first hypothesis: There is no disagreement from large project employers for the presence of other stakeholders in the think tank meetings.
- The second hypothesis: Factors such as cost and time of the project, progress according to the project schedule, and it is simply the communication factor that can change the project implementation process and influence the project.
- The third hypothesis: There is no obstacle to communicating between individuals, teams, and sections of the project.

4. Data Analysis

The questionnaires were provided to the employers as the main stakeholders, construction contractors as CEO, and architect, structures, and facilities design consultants as the first designers present in the projects (statistical population of this article). The questionnaires were prepared as survey forms and distributed among about 85 persons. At the end of the deadline, about 50 persons completed the

questionnaires. Since the questions were qualitative, the results of the study were analyzed by qualitative methods. The characteristics of the respondents are as described in Table 3.

Table 3: Demographic characteristics of the respondents

Over 30 years	21 to 30 years	11 to 20 years	1 to 10 years	Weight distribution experience
13.72	26.47	41.17	17.64	
Ph.D.	MSc	BSc	As	Distribution of questionnaires ' education level
5.77	52.94	38.35	2.94	
Over 60 years	50 year to 60 years	40 year to 50 years	Up to 40 years	Age distribution of questionnaires
3	8	28	11	
13	Female	27	Male	Gender

The quantitative nature of the outputs of the questionnaires is shown in terms of participant construction groups (Chart 6), organizational distribution (Chart 7), education level (Chart 8) and age distribution of respondents (Chart 9).

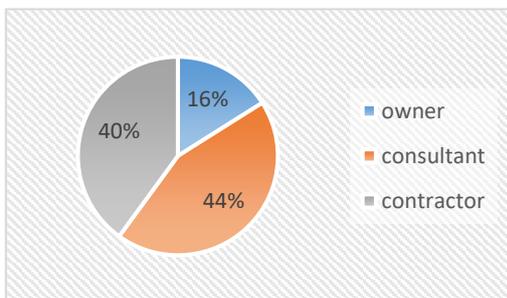


Chart 7: Organizational distribution of questionnaires

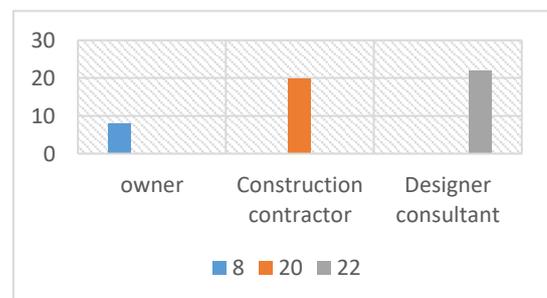


Chart 6: Number of questionnaires collected in construction groups

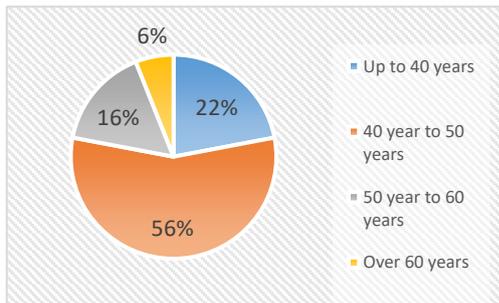


Chart 9: Age distribution of questionnaires

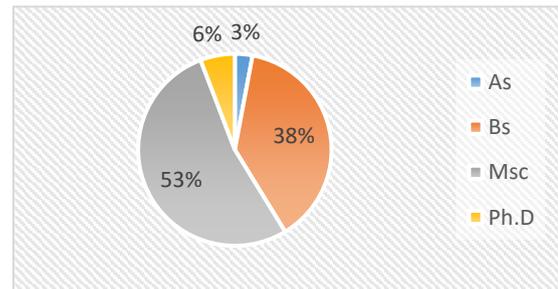


Chart 8: Distribution of questionnaires' education level

Some of the audiences knew little about BIM. Accordingly, a brochure was prepared in order to introduce BIM briefly, and was offered to the individuals to answer Forms 1 and 2 easily. Form 1 was prepared to survey the statistical population about the significance of communication in construction projects. In this Form, some questions were asked from experts, and of course stakeholders, of the project. The summary of results is presented in Table 4.

Table 4: Summary of Form No. 1

Summary of Form No. 1	
Very High	The importance of communication in construction projects
In person Negotiations	The best way to communicate between individuals and groups
Owner	Person responsible for making appropriate communications
Time, cost and quality	The most effective part of not communicating
Reduce conflicts	The effect of communication on differences

According to Table 4, communication is very important in construction projects. The results show that communication had the greatest effect on reducing conflicts. It was interesting that the majority of respondents believed that the employer was responsible for providing appropriate communication. The summary indicated that the role of consultant and contractor, despite their high involvement in the project and their presence in the project, was less significant than the employer. After completing this Form, they were asked to complete Form 2 based on their knowledge about BIM. The results

obtained from Form 2 (Appendix) show that BIM has been able to attract the audiences' attention. According to these Forms, there is a tendency to know more about BIM implementation in construction



projects, regardless of the concerns about the cost of BIM implementation. The next questionnaire (Appendix- Form 3) was prepared with questions about the factors affecting communication. The output of Forms 2 and 3 indicated that:

Given the mean age distribution of those who answered the questionnaire, the best way to communicate between individuals and groups was through face-to-face negotiations. However, among the consulting community, which comprised 44% of the respondents, the role of technology was taken more seriously, because their science was relatively up-to-date. In addition, the results of the questionnaire analysis showed that the tendency to use this new approach by age 40 was more than 70% percent, indicating that older people were more resistant to change and technology, which was unexpected given their experience. On the other hand, the respondents' high level of education can be a strength for this study. According to the mean index, more than 85% of respondents with a bachelor's degree and higher, believed that there is not an integrated approach such as BIM to enhance communication management and reduce conflicts between stakeholders. Moreover, it was found that electronic communications had a positive impact on timing, decision making, and clarity of the required information. 26% of the respondents were female; however, with 91% confidence level, there was no significant difference between respondents in terms of their gender. In the next section, we will discuss the results of this study and present the outputs of this study in an applied model.

5. Discussion and Conclusion

Undoubtedly, there are many stakeholders in construction projects that meeting their demands can facilitate the project's success. Poor communication makes the management and stakeholders not only to have a complete picture of the future, but also they fail to recognize the strengths and weaknesses of the organization's past and present status. Faced with increasing volume and complexity of decision making, management today has found that the widespread, scattered, and some existing unrelated handled systems are unable to provide the information they need and to offer it timely (the right time is when the information is useful for decision making), despite their significance for information transfer cycle and communication development.

According to the questionnaires (Form 1) and as presented in Chart 1, and based on the results of this Form, most of the respondents consider employers as the main stakeholders and communication managers of the projects. It is worth noting that establishing relationships between employers [12] in large projects with more than one employer can raise new concerns in communication management.

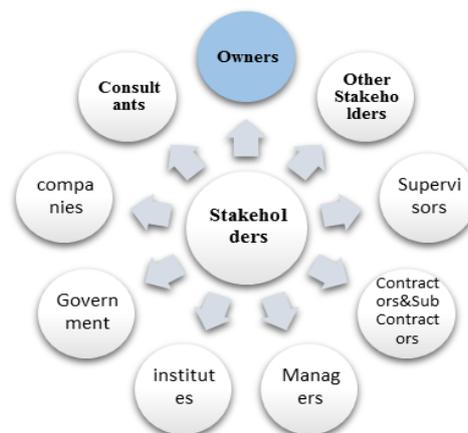


Figure 10: Identification of key stakeholders in construction projects

The permanent concern of project managers in all projects and studies, is increased time and cost of the project and reduced quality of the final product [22]. The data collected in this study demonstrates this issue clearly. Communication is not restricted to communication tools; but if one looks briefly at the studies conducted on communication in project management, a strategic approach should be considered. According to the respondents, communication management and planning for it seems possible at all stages of the project. In addition, among the various types of communications experienced by these individuals in the past, strategic communication is more successful than others (Chart 11). This type of communication is based on mutual trust and commitment [27, 28]. Moreover, among the various available intellectual frameworks, as identified in the research literature, the process framework is emphasized by most of the respondents [59] (Chart 12).

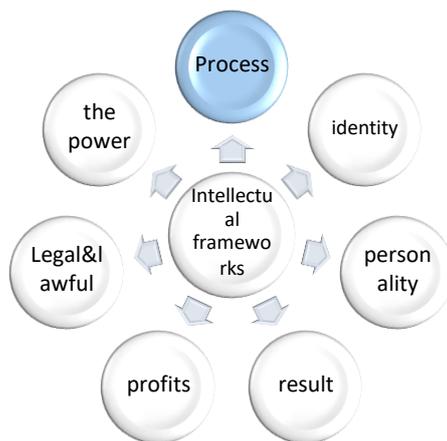


Chart 12: People's intellectual frameworks for others

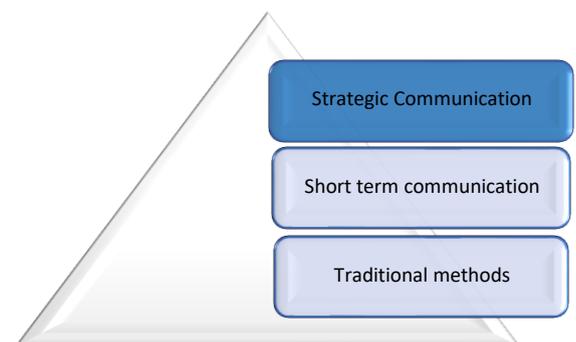
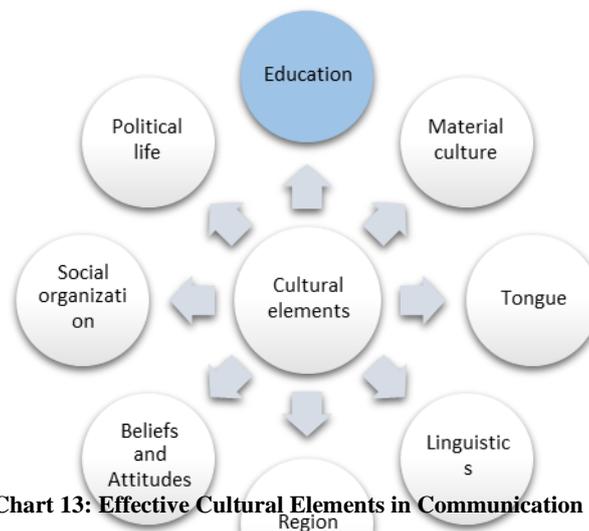


Chart 11: Types of communication

Form 3 is based on ethical indices of individuals and asks some questions about the quality of communication and teamwork. This Form indicates that most of the individuals and teams involved in construction projects are not willing to do teamwork and share their information until they are certain

of the quality of their communication with others. This issue emphasizes the significance of communication management in construction projects. The starting point to communicate between individuals is influenced by cultural factors. Due to the low usage of BIM among the statistical population of this study, attention should be paid to the element of education. Basic education helps building culture and is effective in negotiating and communicating [59](Chart 13).



Among the solutions used to communicate, holding in-person meetings [36] and face-to-face negotiations [45] are used more than other methods and has met the communicative demands of individuals. BIM allows the possibility of holding think tank meetings with the presence of all stakeholders, managers, consultants, etc. In addition, it provides access to a common language and documents meeting results and makes it possible to use content at any time and place. It can be concluded that although BIM is a new technology in the construction industry, it can find its place by overlapping the traditional methods of communication and new methods and covering the weaknesses of traditional methods.

The scientific community of the construction industry in the country is trying more than other sectors involved in this field, to introduce BIM. One can certainly state that studies have been able to prove the role of BIM in creating integration throughout the project life cycle. However, still BIM is not used practically in domestic projects. Chart 14 summarizes the role of BIM in communication management based on what has been achieved in this study.

BIM

Creation of the thinking room by the Owner

Project Success

Reduce time, cost and increase quality

Reduce conflicts

Achieving process thinking in negotiations

Teaching correct and effective communication

Preparation of strategic communication plan

Formation of project communication management team

Chart 14: The Role of Communication

of BIM in Management

In the end, as a suggested solution for communication management between stakeholders and CEO in the design phase, we believe that employers are responsible for forming a communication management team consisting of their representatives, consultants' agents, project managers' agents, and representatives of other teams in the study phase. The communication management team should plan the project communication management along with the project modeling, using BIM. As with architectural, structural, and facilities' maps, ultimately the communication model should be developed for the project. The presented solution may be one of the examples of how to achieve project development and enhance strategic communication. Of course, the scope of communication is very wide and many studies can be conducted in this regard. It is hoped that the presented solution can be applied in a case study and present its results in future studies to complete the suggested solution.

It is suggested to the researchers:

1. To identify conflicts in construction projects and examine to what extent they can prevent these conflicts by providing the necessary context for implementing communication management in projects.
2. The impact of communication management on changing the provisions of construction project contracts can be further studied to complete the present study.
3. The relationship between communication management in the study phase using BIM with the reduction of claims can be another subject to study.



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Appendix:

Form 1:

Questionnaire	
This questionnaire is developed to benefit from your experiences in construction projects. Please answer the questions carefully.	
Considering the asked dates, if you were in the stated stage of the project, but you don't know its exact date, please answer approximately; and if you were not in that stage of the project, please use the word "I don't know".	
Thank you for your cooperation.	
Part One	
	Project Name
	Your role in the project (stakeholder / CEO / consultant)
	Initial Project Proposal Date
	Date of initial studies and project scope
	Date of preparation of initial project maps
	Project start date
Part Two	
	What are the groups outside of your team in the project, you are connected with?
	What is the type of your communication?
	In your opinion, how effective is the communication in the project implementation process?



	What communication method do you suggest for better communication in the project?
	In your opinion, what is the impact of lack of communication on the project?
	What stage of the project do you recommend for communication?
	In your opinion, what is needed for communicating between principles of the project?
	How much timely communication has reduced disagreements and what is its impact on effective agreements?
	In your opinion, who can be the cause of communication in the project?
Finally, if you have any suggestions for communications in construction projects, please write down here.	
Are you familiar with BIM?	

Form 2:

Questionnaire	
Please answer the following questions after reading the brochure of Building Information Modeling (BIM). Undoubtedly, your answers will be an effective guide to conduct the present study. I appreciate your patience.	
	Have you found the information you need to know about BIM by reading the brochure?
	Can using BIM be effective in communicating in construction projects?
	Considering BIM, the role of which principles of construction projects is more important in communication?
	How effective can BIM be in communication and managing it in construction projects?
	Are you willing to use BIM in communication management in your projects?
	Can BIM be included in ongoing projects?
	Is it possible to resolve disputes and establish appropriate communication in ongoing projects with the introduction of BIM and its usage?
	Who or what group can be the main driver of using BIM in construction projects?
	Which of the BIM features do you find effective in communicating?
	Are you willing to know more about BIM?
Finally, write down your comments about BIM according to the obtained information.	

Form 3:

Please answer the questions of the final questionnaire to contribute the completion of this study.	
	Are you interested in teamwork?
	Whom do you interact with most in your work environment?
	In new projects, would you like to work with new teams or teams that you have worked with in previous projects?
	Whom do you most disagree with in your communications?
	Do you share your information and work experiences with others?
	Are you interested in holding a think-tank to share your knowledge and experience with others?
	Do you have a plan to communicate with others or you get into new job relations without any preparation?

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