Evaluation of risk factors affecting the implementation time for residential complex projects in Iraq

Tareq A. Khaleel a, Mohanad Ahmed Flayeh b

a Assistant professor, Civil engineering Department, University of Technology/Baghdad, Iraq
b Master student, Civil engineering Department, University of Technology/Baghdad, Iraqmohanadahmedflayeh@gmail.com, drtarikkhalil@gmail.com

Abstract: Residential complex projects represent one of the most important infrastructure project types in Iraq, as these plays a significant role in housing provision. In recent years, various types of risks that may occur during the implementation stage of residential complex projects have been identified. To accomplish these projects successfully, it is thus very important to manage these risks where they may affect project objectives in terms of cost, time, and quality, and risks often cause delays or cost overruns. The concept of risk management is to develop a systematic process that includes planning, identification, response planning, analysis, and assessment of both qualitative and quantitative variables, monitoring and mitigation of risks. This research thus aims to identify, assess and analyse the factors related to risks that may affect the implementation time for residential complexes projects by means of conducting statistical analysis using IBM SPSS v22 and Microsoft Excel to determine the severity risk for such project risks based on a relative importance index. This data for this was gathered by means of a questionnaire, field survey, and personal interviews. The questionnaire consisted of three parts, with the first part including general information about the sample; the second part included 17 queries about applications of risk management systems as a methodology; and the third part discussed the probability of occurrence and impact of risks, with 57 factors considered. The results of the statistical analysis showed that only four out of the 17 items in section 2 were applied; further, by analysing responses to the 57 factors, only 25 factors were found to have high impacts on risk occurrence in residential complex projects in Iraq. This suggests that only 44% of time overruns in residential complex projects may occur due to risk factors. The most important factors in terms of high impact are executing works that do not conform to specifications, which leads to rejecting and returning works, inaccuracy of schedule, and delayed payment of advances in accordance with the contract.

Key words: risk management, evaluation, complexes, severity risk.

1. Introduction:

All projects are risky, as each is a unique undertaking with its own degree of complexity [1]. Residential complex projects in Iraq are particularly dynamic and complex environments resulting from the conditions of uncertainty and danger, in addition to the need to complete the work to the specified time, cost, and quality requirements. Recently, the country has seen the establishment of several new residential complexes, which have been accompanied by multiple uncertainty events and risks during their implementation that have led to time delays and other schedule issues, highlighting the effect of such matters on important projects. Work is thus required to call the attention of project stakeholders to the seriousness of this subject. Risk can be defined as any uncertain event or condition that, if it does occur, has a positive or negative effect on one or more project objectives [1]. Project risk management aims to exploit or enhance positive effects...
(opportunities) while avoiding or mitigating negative risks (threats), as unmanaged threats may result in serious problems such as delays or cost overruns [1]. Risk can also be defined as the exposure to loss/gain, or the probability of occurrence of loss/gain multiplied by the respective magnitude of such a change [2]. Risk management is an essential part of the project management process which aims to prevent, mitigate, and control risks using a systematic approach that allows organisations to deal with unknown events [3]. Risk management thus includes the identification of influencing factors which could negatively impact project objectives [4]. The main procedures for establishing systematic risk management are identification, assessment and analysis, and response [5], and the key effects of risks can be summarised as follows [6]:

1. Failure to complete the project within a specified time.
2. Failure to keep within the cost estimate and estimated revenues.
3. Failure to achieve the operational and quality requirements.

The objectives of this research are thus to identify and investigate the significant risk factors affecting the implementation duration of residential complex projects in Iraq and to evaluate the severity of such risks to identify the most significant factors responsible for time overruns.

2. Literature Review

To reduce business risk (particularly time delays and cost overruns) in a construction project accurate identification and evaluation of management of risk by using questionnaire and interviews was performed in previous research. The significant factors examined were inadequate construction planning, poor estimation, project changes during construction, poor contract management, and finance and payment problems. Improving communication between multiple construction parties on the same site is particularly significant for any construction cost and time controls [7]. Evaluation of the probability of risks’ occurrence and their impacts on the construction project objectives in Erbil city was done using a questionnaire; and the findings showed a total of 50 risks detected, which were divided into seven risk factors based on risk index scores, the greatest risk factors were the inability of the owner to finance the project; the awarding the design to unqualified designers; poor qualifications, skill and experience among contractors and technical staff; design errors or defective designs; poor qualifications and supervision among project engineers; and long delays for approval of tests and inspection. The risks with the most important effects on the duration of a project were deemed to be suspension of work; poor planning and scheduling of the project by the contractor; slow decision-making processes by the owner; the inability of the owner to finance the project and delays in progress payments made by the owner [8]. An investigation into the severity and the allocation of each identified risk from the perspectives of contractors and owners was done to evaluate the top risk factors in the construction industry in Gaza using interviews and a questionnaire. The most severe risks from the owners' perspective were awarding the design to unqualified designers, defective design, occurrence of accidents because of poor safety procedures, difficulty accessing the site, inaccurate quantities, lack of consistency between bills of quantities, drawings and specifications, work in dangerous areas, the financial failure of the contractor, closure, and high competition in bids, while contractors identified the severe risks from delayed payments on contract, unstable security circumstances, and poor communication between involved parties [9]. Identifying the major risks associated with the Malaysian construction industry to evaluate the practical measures required to mitigate such risks identified time risk and financial risk as the major risks, as these risks have a considerable effect on project performance. Many organisations in the Malaysian construction industry do not practice formal risk management, although the highest level of risk occurs in the construction phase; this lack of proper risk management practices is most likely a reasons why construction projects there tend to experience schedule and time overruns [10]. Investigating the significance of each risk in construction projects in Iraq from the contractors’ perspective led to the conclusion that of 36 risk factors presented in a questionnaire, corruption, war, military operations and terrorism, financial failure, and delay of payment on contracts were the most significant risk factors. In addition, traditional risk
management represented by depending on the expert judgment is the most commonly used in the construction industry in Iraq\[^{11}\]. These risks were also analysed using quantitative and qualitative assessment techniques in terms of mathematical probability of occurrence and associated consequences \[^{12}\].

A review of previous studies over the past three decades on identification and assessment of risk factors in construction project considered almost 1,000 international projects from various countries, including UK, US, Australia, China, and Turkey. It mainly focused on the development of models to assess the risk factors relevant to construction projects. The critical risk factors identified were scope and design changes, technology implementation, site conditions and unknown geological conditions. Unavailability of funds, financial failure, inadequate managerial skills, improper coordination between teams, lack of availability of resources, and construction delays \[^{13}\]. It can be concluded from previous studies there is a lack in knowledge of risk management in construction projects; however, the most important risk factors affecting the execution time of the projects include inadequate planning and scheduling, finance and payment problems, poor communication between construction parties, and changes during the construction phase. The current research focuses on the fact that residential complex projects in Iraq face various challenges and risks of this type during their execution time, as with other types of construction projects. Thus, it seeks to clarify the most important items to develop a methodology for managing risks in the housing and construction sector in Iraq.

3. Research Methodology

The research methodology used can be summarised as follows: Fifty-seven risk factors were identified and categorized into seven risk sources based on personal interviews, a literature review and a field survey. These were visualised using the Ishikawa (cause and effect or fishbone) diagram, a tool used for presenting all the possible causes of a particular problem in a graphical form as shown in figure (1). A questionnaire form was then designed and distributed to the housing and construction sector, and the resultant the collected data were analysed using a reliability test, and a relative importance index technique to determine the severity risk of the identified factors. This depended both on the likelihood of risk occurrence and its impact (consequence). A qualitative evaluation of the severity of risk and ranking of the risk factors was also done according to the influence level of the RII intervals. The findings thus revealed the most significant factors causing time overruns during the implementation time of residential complex projects in Iraq.

![Figure (1): Cause and Effect diagram (Ishikawa diagram)](image-url)
4. Questionnaire Design

The questionnaire form used for the survey listed multiple of identified risk factors that might affect the implementation duration of residential complex projects from an owner's perspective based on the information obtained from the literature review, personal interviews with a number of engineers and managers working in the housing and construction sector and field observations. The questionnaire form consisted of three parts: the first sought general information about the research sample and the second featured 17 questions about whether risk management methodology was applied in the respondents' residential complexes. The third part of the questionnaire form included 57 risk factors and asked respondents to identify the degree of impact and the probability of occurrence of these risks in terms of their effects on residential complexes during the implementation phase. Finally, the questionnaire ended with an open question about other risks. Each factor was measured on a five-point Likert scale of five points as very low, low, medium, high, very high. Based on the purpose of the study, engineers in the housing and construction sector formed the study population. Before the questionnaire form was generally distributed, committee of seven arbitrators was formed to assess how the questionnaire performed (see table (1)).

Table (1): Demographic Data for Arbitrators

| NO. | Functional Grade                          | Experience Years | Work Place                  |
|-----|------------------------------------------|------------------|-----------------------------|
| 1   | Head of Studies and Population Planning  | 39               | Directorate of Housing      |
| 2   | Head of Investment                       | 28               | Directorate of Housing      |
| 3   | Head of Monitoring and Statistics        | 20               | Directorate of Buildings    |
| 4   | Head of Projects                         | 31               | Alrasheed general state     |
|     |                                          |                  | constructional             |
| 5   | Lecturer/Ph.D.                           | 38               | University of Technology    |
| 6   | Lecturer/Ph.D.                           | 25               | University of Technology    |
| 7   | Lecturer/M.sc                            | 18               | University of Technology    |

5. Data Collection

The required data for the study was gathered by distributing questionnaires in the housing and construction sector to collect a minimum sample size of 30 respondents [14]. Overall, 92 questionnaire forms were distributed to different engineers with various levels of experience in the construction field. The responses used in the final analysis in the analysis were (numbered 81), however, some forms received were incomplete. Table (2) shows the distribution of the questionnaire forms and illustrates the number distributed and received for each directorate and project covered by the research sample. The overall response rate was 88%.

Table (2) Distribution of the Questionnaire form

| No. | Work Place                             | Distributed | Received | % of Response |
|-----|----------------------------------------|-------------|----------|---------------|
| 1   | Directorate of Building                | 5           | 5        | 100           |
| 2   | Ayadi Complex                          | 13          | 12       | 93            |
| 3   | Alrasheed General State Constructional | 20          | 17       | 85            |
| 4   | Directorate of Housing                 | 24          | 19       | 80            |
| 5   | Basmayh Complex                        | 30          | 28       | 94            |
|     | Total                                  | 92          | 81       | 88            |

6. Statistical Analysis

Analysis was performed using IBM SPSS V22 and Microsoft Excel software.

6.1 Reliability Test
To ensure the reliability and the internal consistency of each factor included in the questionnaire, Cronbach’s coefficient alphas (Cα) were calculated. The value of Cα is always between 0 and 1, and the closer the value is to one, the higher the stability and vice versa. Table (3) shows the values for each category in the questionnaire, which indicate that the Cronbach’s alpha values for this research are in the range 0.771 to 0.953, offering a good indicator of the validity and reliability of the questionnaire according to Cronbach’s coefficient must exceed 0.715.

Table (3): Cronbach’s Alphas for Questionnaire

| No. | Category                                      | No. of Item | Cronbach’s Alpha |
|-----|----------------------------------------------|-------------|------------------|
| 1   | Application of risk management as a methodology | 17          | 0.899            |
| 2   | Probability of occurrence & impact of the risk factors: | 57 Impact  | Probability      |
| 2.1 | Design & Planning                            | 9           | 0.858 0.915      |
| 2.2 | Resource Management                          | 12          | 0.913 0.912      |
| 2.3 | Financial                                    | 5           | 0.892 0.912      |
| 2.4 | Contracts                                    | 5           | 0.850 0.875      |
| 2.5 | Change Orders & Disputes and Claims          | 14          | 0.940 0.953      |
| 2.6 | Management                                  | 5           | 0.771 0.853      |
| 2.7 | External Risks                               | 7           | 0.815 0.841      |
|     | Total (all items of questionnaire)           | 74          |                  |

6.2 Relative Importance Index Technique

This is used to determine the relative importance of identifying and ranking the various risk factors affecting the execution duration of residential complex projects. The Relative Importance Index (RII) was calculated using equation (1)16.

\[
\text{RII} = \frac{\sum W \times (\leq \leq)}{A \times N} \hspace{1cm} (1)
\]

Where:
- \( W \): is the attached score of each factor and mainly ranges between (1 to 5), (where “1” is “Very Low” and “5” is “Very High”); or (where “1” is “No” and “5” is “Always”);
- \( A \): is the highest score (5 in this study) and;
- \( N \): is the sample size of the questionnaire (81 in this study).

6.3 Severity Risk

This is used to determine the severity risk of factors causing time overrun of residential complex projects- by adopting a relative importance index (RII) for both the probability of risk occurrence and the impact of risk for the factors in the questionnaire 8. The severity of risk can thus be calculated using equation (2)8.

\[
\text{Severity Risk} = \text{Probability} \times \text{Impact} \hspace{1cm} (2)
\]

To identify the influence level of the severity risk- based on RII intervals, the difference- \( D \) between the highest risk value and the smallest value is calculated as shown in table (6)17:

\[
D = 0.534 - 0.227 = 0.307
\]
Table (4): Influence level of RII intervals

| Influence Level | RII Intervals | Minimum limit | Maximum limit |
|-----------------|--------------|---------------|---------------|
| Very Low        | 0.227-0.258  | 0.227         | 0.277+10% *D= 0.258 |
| Low             | 0.259-0.328  | 0.259         | 0.259+22.5% *D= 0.328  |
| Medium          | 0.329-0.398  | 0.329         | 0.399+22.5% *D= 0.398  |
| High            | 0.399-0.468  | 0.399         | 0.469+22.5% *D= 0.538  |
| Very High       | 0.469-0.538  | 0.469         | 0.469+22.5% *D= 0.538  |

Table (4) shows the influence level of RII intervals -for evaluation of the- risk severity/score based on the minimum and maximum limits of the severity of risk.

7. Analysis and Discussion of data

7.1 Questionnaire Findings

In order to simplify the results of the questionnaire form, the statistical analysis process consisted of three-main parts.

7.1.1 Part One: General information

Figure (2) illustrates the percentage of responses from each workplace. Basmayh residential complex had the highest percentage at 35%, followed by the directorate of housing at 23% and then Alrasheed general state constructional at 21%. The percentage from Ayadi residential complex was 15%, while the lowest percentage 6% came from the directorate of buildings.

![Figure (2): Workplace responses](image)

Figure (3) shows the percentage of public sector versus private sector; 85% are respondents work for the public sector while 15% work for the private sector.

![Figure (3): Work sector](image)
Figure (4) shows the percentage of the engineers in various fields within the research sample. The highest percentage was in civil engineering at 63%, while mechanical engineers were 14%, architect represented 12%, and the smallest number worked as electrical engineers at 11%.

Figure (4) : Engineering Specialisations

Figure (5) illustrates the academic level of the respondents, the highest percentage of engineers hold a B.SC degree at 86%, while those with M.SC degrees represent 10%. Engineers with Ph.D. degrees formed 3% of the sample, while the remaining 1% had some form of postdoctoral status.

Figure (5) : Academic degree

Figure (6) shows the experience in years of the respondent engineers in the construction sector. The highest percentage was for engineers with 5 to 10 years’ experience at 36%, while those with over 15 years’ experience formed 25% of the sample. The proportion of engineers with 10 to 15 years’ experience was equal to 22%, while only 17% of engineers had less than 5 years’ experience.

Figure (6): Years of Experience
Figure (7) describes the current job-position of engineers in the research sample. The highest proportion, 36% were engineer, while 25% were senior chief engineers, 22% were senior engineers. The remaining 17% were assistant engineers.

![Current Job Position](image)

**Figure (7):** Current Job-position

Figure (8) illustrates the work fields of the engineers who completed the questionnaires. About half are supervisor engineers.

![Work Field](image)

**Figure (8):** Work Field

7.1.2 *Part Two: Application of risk management as a methodology*

This part investigated the possibility of applying a system or methodology to managing risks, based on an observed lack in knowledge about risk management concepts and project parties thus dealing with risk informally in most instances. Table (5) shows the ranking of items adopted to determine whether risk management is employed in the housing and construction sector. The findings identified the most important items by RII value with a range of 0 to 1; where the higher value is better. The most important item was "risk was taken into consideration for previous residential complex projects and precautionary measures are taken to avoid these risks" with an RII of 0.733, while the least important item was "modern programmes and technologies are used for risk analysis" with an RII of 0.427, most likely because of a lack of staff specialising in managing risk.

| Cat. | No. | Item                                                                 | RII   | Rank |
|------|-----|----------------------------------------------------------------------|-------|------|
| Ap   | 1   | Risk was taken into consideration for previous residential complex projects and precautionary measures are taken to avoid these risks | 0.733 | 1    |
| li   | 2   | Do you think project managers are at the level of responsibility for decision making risk management | 0.723 | 2    |
| cat  | 3   | Relying on the practical expertise in the work of the executable work program as a way to remedy the effects of risks | 0.706 | 3    |

**Table (5):** Items of the Application of risk management as a methodology
7.1.3 Part Three: The probability of risk occurrence and the degree of risk impact

Table (6) shows an evaluation of the severity and ranking of the risk factors, selected that reveals the critical factors to be executing works that do not conform to specifications and thus lead to rejecting and returning works, inaccuracy of schedule, delay payment of advances in accordance with the contract, failure in finance the project. The final six factors appear to have little impact the implementation time for the residential complex projects, however.

| Risk factor                                                                 | Degree of Impact | Probability of Occurrence | Severity Risk | Influence Level | Rank |
|------------------------------------------------------------------------------|------------------|---------------------------|---------------|-----------------|------|
| Executing works that do not conform to specifications and thus rejecting and returning works | 0.778            | 0.686                     | 0.534         | Very high       | 1    |
| Inaccuracy of schedule                                                       | 0.8              | 0.659                     | 0.527         | Very high       | 2    |
| Delayed payment of advances in accordance with the contract                  | 0.756            | 0.659                     | 0.498         | Very high       | 3    |
| Failure in financing the project                                              | 0.785            | 0.62                      | 0.487         | Very high       | 4    |
| There is no correspondence between the bill of quantities and drawings       | 0.731            | 0.635                     | 0.464         | High            | 5    |
| Multiple additional works (new works) and modifications during execution     | 0.684            | 0.672                     | 0.46          | High            | 6    |
| Supplying of invalid materials or conform to specifications                  | 0.785            | 0.585                     | 0.459         | High            | 7    |
| Incorrect planning for the execution method                                  | 0.753            | 0.595                     | 0.448         | High            | 8    |
| Lack of follow-up work progress with schedule continuously and processing problems | 0.738            | 0.605                     | 0.446         | High            | 9    |
| Risk factor                                                                 | Degree of Impact | Probability of Occurrence | Severity Risk | Influence Level | Rank |
|---------------------------------------------------------------------------|-----------------|---------------------------|---------------|-----------------|------|
| Difficulty getting the necessary permits to work                           | 0.714           | 0.625                     | 0.446         | High            | 10   |
| Delay fulfilment of works for reasons belonging to the owner or any other authority authorized by law or for reasons of other contractors employed by the owner | 0.743           | 0.598                     | 0.444         | High            | 11   |
| Risk caused by subcontractors (qualifications, financial status, delays, technical problems with subcontractors | 0.691           | 0.64                      | 0.442         | High            | 12   |
| Non-compliance with the determinants of the contract by one of the parties | 0.704           | 0.627                     | 0.441         | High            | 13   |
| Poor experience in subcontractor and technical staff                       | 0.711           | 0.612                     | 0.435         | High            | 14   |
| Poor communication and coordination between project parties                | 0.743           | 0.585                     | 0.435         | High            | 14   |
| Absence of coordination among staff                                       | 0.677           | 0.642                     | 0.435         | High            | 14   |
| Abandonment of contract by one of the parties                             | 0.726           | 0.595                     | 0.432         | High            | 15   |
| Errors or decreases in items in construction contracts                     | 0.662           | 0.637                     | 0.422         | High            | 16   |
| Legal disputes arising during the implementation phase between the project parties | 0.677           | 0.622                     | 0.421         | High            | 17   |
| Exceptional risk (unexpected circumstances by both parties of the contract) | 0.686           | 0.607                     | 0.416         | High            | 18   |
| The amount of change orders higher than the reserve amount                 | 0.696           | 0.59                      | 0.411         | High            | 19   |
| Increased time period for event within the project                        | 0.652           | 0.627                     | 0.409         | High            | 20   |
| Unpredictable obstacles to the project                                    | 0.686           | 0.595                     | 0.408         | High            | 21   |
| Urgent referrals for bids                                                 | 0.664           | 0.61                      | 0.405         | High            | 22   |
| Laxity in imposing delay penalties on the contractor in case of delay     | 0.662           | 0.61                      | 0.404         | High            | 23   |
| Changes in designs during the implementation phase                        | 0.627           | 0.61                      | 0.382         | Medium          | 24   |
| Fluctuation of work productivity (equipment and labour)                   | 0.667           | 0.595                     | 0.397         | Medium          | 25   |
| Change orders not documented on time and upon change                      | 0.679           | 0.585                     | 0.397         | Medium          | 25   |
| Delay in ordering purchase materials                                      | 0.719           | 0.551                     | 0.396         | Medium          | 26   |
| Low quality of works due to the time limitation available for implementation | 0.642           | 0.605                     | 0.388         | Medium          | 27   |
| Select the appropriate contract type for the nature of the project        | 0.625           | 0.617                     | 0.386         | Medium          | 28   |
| Delay in delivery of materials and tools according to schedule            | 0.664           | 0.565                     | 0.378         | Medium          | 29   |
| Lack of skilled labours                                                  | 0.664           | 0.565                     | 0.375         | Medium          | 30   |
| Lack of necessary machinery and equipment                                 | 0.681           | 0.543                     | 0.37          | Medium          | 31   |
| Absence of arbitrators specialised in resolving engineering disputes      | 0.62            | 0.593                     | 0.368         | Medium          | 32   |
| Absence of periodic maintenance of equipment and machinery                | 0.637           | 0.575                     | 0.366         | Medium          | 33   |
| Delay in disputes resolution                                              | 0.635           | 0.575                     | 0.365         | Medium          | 35   |
| Delay in resolving the conflict between the project parties               | 0.64            | 0.56                      | 0.358         | Medium          | 36   |
| New government regulations or laws that affect work progress               | 0.627           | 0.57                      | 0.357         | Medium          | 37   |
Absence of quality control over materials and skill of implementation 0.664 0.536 0.356 Medium 38
Disagreement over change orders duration 0.63 0.565 0.356 Medium 38
Inflation and change in prices and currencies 0.644 0.546 0.352 Medium 39
Lack of agreement on the project’s cash flow schedule 0.644 0.543 0.35 Medium 40
Difficulty to accessing the site (raw materials and labour and machinery, etc.) 0.627 0.556 0.349 Medium 41
Not using modern methods and software in decision making and project procedures 0.59 0.39 0.348 Medium 42
Executive problems with some entities 0.622 0.56 0.348 Medium 42
Poor storage of raw materials 0.61 0.568 0.346 Medium 43
Accidents due to lack of safety procedures 0.602 0.575 0.346 Medium 43
Executing the engineer’s orders in conducting additional tests not included in the contract 0.61 0.543 0.331 Medium 44
Owner's requirements are unclear 0.593 0.528 0.313 Low 45
Storage of materials - away from the work site and wastage during - transportation 0.595 0.499 0.297 Low 46
Complexity of designs 0.546 0.526 0.287 Low 47
Improper and harsh weather conditions 0.558 0.514 0.287 Low 47
Scope of work is unclear 0.533 0.531 0.283 Low 48
Supply of foreign labours 0.437 0.519 0.227 Very low 49

7.2 Most Significant Risks

By categorising the risk factors into five different intervals according to Likert scale scores and severity risk, 25 risk factors can be identified as the most significant factors with the largest influence as shown in table (7). These include executing works that are not conforming to specifications and then rejecting and returning works factor related to change orders & disputes and claims category with severity risk (0.534) and the last factor is laxity in imposing delay penalties on the contractor in cause of delay related to change orders & disputes and claims category with severity risk (0.404). These significant risks are responsible for multiple time overruns, around 44% of those seen in the residential complex projects in Iraq.

| Rank | Risk factor | Severity Risk | Category |
|------|-------------|----------------|----------|
| 1    | Executing works that do not conform to specifications and thus rejecting and returning works | 0.534 | Change Orders & Disputes and Claims |
| 2    | Inaccuracy of schedule | 0.527 | Design & Planning |
| 3    | Delayed payment of advances in accordance with the contract | 0.498 | Financial |
| 4    | Failure in financing the project | 0.487 | Financial |
| 5    | There is no correspondence between the bill of quantities and drawings | 0.464 | Design & Planning |
| 6    | Multiple additional works (new works ) and modifications during execution | 0.46 | Change Orders & Disputes and Claims |
| 7    | Supplying of invalid materials or conform to specifications | 0.459 | Resource Management |
| 8    | Incorrect planning for the execution method | 0.448 | Design & Planning |
| 9    | Lack of follow-up work progress with schedule continuously and processing problems | 0.446 | Design & Planning |
| 10   | Difficulty getting the necessary permits to work | 0.446 | Management |
Delay fulfilment of works for reasons belonging to the owner or any other authority authorized by law or for reasons of other contractors employed by the owner 0.444 Change Orders & Disputes and Claims

Risk caused by subcontractors (qualifications, financial status, delays, technical problems with subcontractors) 0.442 Contracts

Non-compliance with the determinants of the contract by one of the parties 0.441 Contracts

Absence of coordination between staff 0.435 Resource Management

Poor experience in subcontractor and technical staff 0.435 Contracts

Poor communication and coordination between project parties 0.435 Management

Abandonment of contract by one of the parties 0.432 Contracts

Errors or decreases in items of construction contracts 0.422 Contracts

Legal disputes arising during the implementation phase between the project's parties 0.421 Change Orders & Disputes and Claims

Exceptional risk (unexpected circumstances by both parties of the contract) 0.416 External risks

The amount of change orders higher than the reserve amount 0.411 Financial

Increased time period for an event within the project 0.409 Design & Planning

Unpredictable obstacles to the project 0.408 External risks

Urgent referrals for bids 0.405 Contracts

Laxity in imposing delay penalties on the contractor in case of delay 0.404 Change Orders & Disputes and Claims

7.3 Group Rankings

The 57 identified factors were grouped into seven risk sources; table (8) shows these in ranking order with the total weight of the risk sources, and the number of factors included in each. It indicates that the main risk sources affecting the execution duration of residential complex projects in Iraq is change orders, disputes and claims, resource management, design and planning, contracts, financial, management, and external risks respectively.

Table (8): Group Rankings

| Risk source                          | No. of factors | Total RII | Weight | Rank |
|--------------------------------------|----------------|-----------|--------|------|
| Change Orders, Disputes and Claims   | 14             | 5.12      | 24%    | 1    |
| Resource Management                  | 12             | 4.4       | 20.6%  | 2    |
| Design and Planning                  | 9              | 3.03      | 14.2%  | 3    |
| Contracts                            | 7              | 2.96      | 13.9%  | 4    |
| Financial                            | 5              | 2.1       | 9.8%   | 5    |
| Management                           | 5              | 1.93      | 9%     | 6    |
| External risks                       | 5              | 1.81      | 8.5%   | 7    |

8. Conclusion and Results

In this paper, the findings from the questionnaire were presented and discussed. A total of 17 items were used to investigate the application of risk management as a systematic methodology in residential complex projects and a total of 57 risk factors were categorised into 7 risk sources-based on their risk–index/score, which included both the probability of risk occurrence and the
13

degree of impact on execution duration of residential complex projects. The results revealed the top significant -risk factors- that should be considered when managing risks.

1- Risk management methodologies were not generally used by the participants or stakeholders in the residential complex projects in Iraq; the stakeholders or participants generally dealt with risks using an informal approach.

2- Four main significant items should be considered in any proposed management systems for risk management based on relative importance index: "Risk was taken into consideration for previous residential complex projects and precautionary measures are being taken to avoid these risks (RII 73.3%); "Do you think project managers are at the level of responsibility for decision making risk management?" (RII 72.3%); "Relying on the practical expertise in the work of the executable work program as a way to remedy the effects of risks" (RII70.6%); "Do periodic meetings and workshops between parties and project staff to raise awareness of the risk management plan" (RII70.4%).

3- The less significant items included: "Modern programmes and technologies are used for risk analysis" (RII 42.7%); "A time reserve for the period is added as a precautionary measure of against the effects of risks" (RII 54.6%); "Lack of attention to risk management causes lack of experience in adopting assessment and risk response strategy" (RII 58.3%); "The company/project management uses an effective approach to identify risks related to stated objectives (RII 58.3%); and "Training courses are open for staff about risk management" (RII 59.5%).

4- Evaluation of the severity risk and ranking of overall risk factors and results identified 25 factors were considered the most significant risk factors and identified as causing 44% of time overruns in residential complex projects in Iraq.

5- The least severe risk factors included supply of foreign labours, storage of materials away from the work site and wastage during transportation, owner requirements being unclear, scope of work being unclear, and the complexity of designs.

6- The ranking of overall risk sources were factors belonging to change orders, disputes and claims; resource management; design and planning; contracts; financial; management; and only then external risks.

9. References

1. Project Management Institute Standard Committee 2017 A guide to the project management body of knowledge Sixth edition - Newtown Square Pennsylvania USA PA, p. 397.
2. Jaafari A - 2001 Management of risks, uncertainties and opportunities on projects: time for a fundamental shift - Int.Journal of Project Management Vol.19 pp-89-101.
3. Sharma S and Swain N 2011 - Risk management in construction projects - Asia Pacific Asia-Pacific Journal of Management Research and Innovation Vol. 7 No 3 pp.107-120.
4. Ehsan N, Mirza E, Alam M and Ishaque A 2010 Risk management in construction industry - 3rd IEEE Int. Conf. on computer science and information technology (ICCSIT) Vol. 9 pp.16-21.
5. Sheen S , Priyan R and Sugumar S 2017 A review on risk management in residential projects Int. Journal of Engineering Research & Technology (IJERT) Vol. 6 No.11.
6. Merna A - 2003 Management and corporate risk - In: Smith N. J. (Ed.) Appraisal Risk and Uncertainty - Thomas Telford London.
7. Saeed Y S 2018 Cost and time risk management in construction projects Tikrit Journal of Engineering Sciences Vol.25 No. 1 pp: 42 - 48.
8. Mohammed A J 2016 - A study for significant risks and their effects on construction projects in Erbil city - *Journal of Engineering and Sustainable Development* Vol. 20 No. 4.

9. Abu Mousa - J. H 2005 Master thesis - Risk management in construction projects from contractors and owners” perspectives The Islamic University of Gaza – Palestine.

10. Goh C and Abdul-Rahman H 2013 The identification and management of major risks in the Malaysian construction industry *Journal of Construction in Developing Countries* Vol.18 No1 pp:19–32.

11. Hussein H and Shibaani A 2016 Risk management in construction projects in Iraq: contractors’ perspective *Int. Journal of Engineering Research-Online* Vol.4 No.3.

12. Chapman R J 2001 The controlling influences on effective risk identification and assessment for construction design management *Int. Journal of Project Management*, Vol.19 pp:147-160.

13. Renuka S , Umarani C and Kamal S - 2014 A Review on critical risk factors in the life cycle of construction projects *Journal of Civil Engineering Research* Vol.4 No.2A - pp: 31-36.

14. Hogg - R V, Tanis E A and - Zimmerman D - 2014 *Probability and Statistical Inference*. Ninth edition - USA P.303.

15. Li X and Wang R 2007 Survey research on relationship among service failure, service recovery and customer satisfaction - *Proc. of the Int. Conf. on Management Science and Engineering* Harbin China pp:20-22.

16. Sambasivan M and Soon Y W 2007 Causes and effects of delays in Malaysian construction industry *International Journal of Project Management* Vol.25 pp:517–526.

17. Hamada M, Amoudi O and Nsifah M 2012 - Management of construction phase risks for construction projects in Syria - *Damascus University Journal for Engineering Sciences* Vol. 28 No.1.