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Technical Research

EVALUATION OF THE PROCUREMENT MANAGEMENT SYSTEM FOR RESIDENTIAL COMPLEX PROJECTS IN ERBIL GOVERNORATE

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Abstract: This study aims to evaluate the procurement management system of residential complex projects in Erbil Governorate by adopting a case study for (20) constructed projects during 2007-2019, to calculate the percentage of procurement management practice and the risks that have a significant impact on cost, time, and quality. Based on a literature review and discussion with experienced construction managers and procurement officers, a questionnaire has been designed which represents a successful plan for a procurement management system that consists of ten phases, each of five items, and the risk results associated with the improper practice. The questionnaire was delivered to stakeholders working on residential complex projects to calculate the average practice of procurement management. It is revealed that 70% of residential complex projects practiced procurement management process with a percentage below 50%. Which is considered below the acceptable rate. The average practice of procurement management phases ranges between 33% for procurement risk management and 58.5% for forecasting. The study reviled that the practice of procurement management affects the cost and time mostly. There are 26 risks that range between high and significant categories for cost and 22 risks range between high and significant categories for time.

The most significant factors for procurement management are creating an appropriate risk response plan, integrating the procurement plan with the budgeting, scheduling procurement due to dates and quantities, using the tendering procedure, and procurement quality assurance. This study may contribute to solving problems for future projects by improving the current system.

Keywords: *Procurement process; project management; risk management; purchase orders; vendor management*

1. Introduction

Procurement is a means to satisfy a business requirement, and establishing a business need is one of the key drivers of the entire procurement process. Strategic Procurement Planning Guidance described procurement as a succession of logically related actions occurring or performed in a definite manner and which culminate in the completion of a major deliverable or the attainment of a milestone [1]. Choosing the most appropriate procurement method for a project is critical to achieving the project's objectives in terms that represent value for money. An effective and efficient materials procurement system should be created for all construction projects. Construction phases and engineering procurement is considered complex due to transactions that involve a series of construction tasks for the completion of a specific asset within a certain time [2]. According

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to the strategic procurement planning guide, the complexity, risk, value of the project, and procurement contracts will drive the level of research and analysis undertaken to ensure the procurement approaches are proportional and relevant [3]. The success of the development objectives of a project and its contracts can be improved with a greater focus on strategic procurement planning [4]. Public procurement has become an issue of public attention and debate worldwide. It has been subjected to restructuring, reform, rules, and regulations [5]. The project manager must be familiar with all the technical details of the proposed system's design and the related costs. Procurement management addresses everything associated with procuring both contracting and purchasing, despite its main focus on contracting and performed work. [6]. The procurement process of the material needs to be well implemented by improving the procurement process to avoid supply delay [7]. It is necessary to put an appropriate strategy for contract procurement those best addresses project objectives and particular needs. An inappropriate procurement system would result in time overruns, excessive project cost, low project quality, and the dissatisfaction of involved construction stakeholders [8]. Scope, time, and cost are considered the triple leading factors in defining the project performance and the constraints of a project [9].

Over the past 15 years, lots of residential complex projects have been constructed in Erbil Governorate (Kurdistan Region of Iraq) by the private sector exceeding the contract sum, schedule, or general gross inefficiency. As long as the procurement process consumes a major portion of a construction project budget, the weaknesses and the factors influencing them must be identified to eliminate their negative effect on cost, time, and quality.

2. Literature Review

Timothy Adu Gyamfia et al. [10], studied the selection of an appropriate procurement strategy. They reviewed two components, analysis, and choice. They stated that analysis is referring to assessing and establishing priorities for the project objectives and the client's attitude to risk, while choice is related to considering possible options, evaluating them, and selecting the most appropriate option. They noted that schedules are an important factor in construction activities as it provides an overview of the time-related work required to complete the project. They stated that procurement evolved through four successive stages that have greatly influenced the procurement services which are cost, quality, time, and satisfaction of customers. The authors emphasized the importance of these phases as being the most critical phases of the construction project and related to project success. Tirth Patel at el. [11], noted that many construction projects have been delayed due to no proper predefined schedule for procurement of materials and which ultimately led to an increase in the cost and time of the project.

Masithembe Kafile at el. [12], characterized the main causes of poor procurement processes on project implementation into the low quality of goods delivered by suppliers, lead time variability, internal factors, poor time management, and system breakdown of online data capturing software to track supplies. Depaoli [13], in his research, indicated that procurement management is one of the most critical fields in project management that incorporates widely the administrative elements of planning, communicating organizing, staffing, leading, and controlling. T. Subramani at el. [14], indicated that resource availability and work availability are the construction's major common constrain and limitations. A.S. Shehu [15], stated that the

framework conceptualized the construction procurement management knowledge as a conglomerate of knowledge (system) that is made up of units of knowledge aligned to accomplish a construction project. Ogunsanmi O, E [16], evaluated the effects of procurement-related factors on project performance by using the snowballing sampling technique for 40 selected construction organizations. The results of the study indicated that procurement selection criteria, project characteristics, time, cost, quality, and external environmental factors have effects on project performance. He concluded that tendering methods should be competitive, open, and selective because they have a high impact on project performance. Tomas and Jana [17], analyzed municipal procurement practices and regulations of public procurement of construction works focusing on small-scale public contracts in the Czech Republic. They concluded that practical experience shows that internal directives are especially necessary for small-scale public contracts. Owiti Jacob at el. [5], studied the effects of procurement control regulations, and procurement quality assurance process on the successful completion of construction projects in Usain Gishu County. They found that the procurement process is positively correlated to the successful completion of construction projects. They revealed that procurement control regulations and procurement quality assurance have a significant impact on the completion of construction successfully. Nana Shonia al el. [18], their study concluded that using an electronic system will simplify the implementation of procurement for both suppliers and self-governing purchasing organizations to save time and human resources and combat corruption. Such a system will practically exclude the possibility of a biased assessment by the members of the tender commission of the procuring entity. They also noted that using price criteria only is risky because there is a risk of quality deterioration. Maksum Tanubrata at el. [19], stated that the fault of project schedule creation can make project completion longer which impacts the budget spike like overhead cost.

3. Data Collection

The research methodology consists of designing a questionnaire for a procurement management system based on the criteria carried from interviews, site visiting, and discussions with management, experienced construction teams, and procurement officers in addition to the literature.

The study has been guided by the following objectives:

1. Evaluating the validity of the designed procurement management and control proposed phases.
2. Identifying the problems and risks associated with the proposed phases of the procurement management system.
3. Calculating the average practice of the procurement management process.
4. Adopting a case study for 20 constructed residential complex projects to calculate the degree of practicing procurement management and the average practice of the proposed phases.
5. Evaluating the impact of the procurement management process on cost, time, and quality.

4. Methods and Materials

The questionnaire was distributed to a random sample of 170 persons working on residential complex projects. 144 of them have been returned. The target groups were project managers, procurement officers, engineers, and contractors.

The questionnaire is divided into 3 parts. Part 1 contains general information about respondents as shown in table (1).

Table 1. Respondent's experience in construction projects

Years of experience	Project manager	Engineer	Procurement officer	Contractor	No
1 – 5	0	4	2	2	8
6 - 10	2	8	4	4	18
11 -15	5	12	9	8	34
16 -2	8	14	7	15	44
> 20	10	15	5	10	40
Total	25	53	27	39	**144**

In part 2 an extensive checklist for a procurement management system was prepared including 50 items of 10 proposed phases for a procurement management plan. Each phase consists of 5 items as shown in table (2).

Table 2. The ten proposed phases of the procurement management system

	Forecasting phase
1	Defining procurement requirements during the design phase
2	Having a feasibility study for available materials
3	Ensuring the availability of alternative materials
4	Having a financial and technical evaluation for suggested materials
5	Determining a timeframe for implementation
	Planning phase
6	Plan for the method of making sure of the real need for material is developed
7	Developing a method of making sure of the quantity of material
8	Assessing the capacity of implementation
9	Identifying items to be procured
10	Creating an appropriate risk response plan
	Developing the procurement work plan phase
11	Defining a process for acquiring needed items
12	Developing procurement plan
13	Integrating procurement plan with the budgeting
14	Setting a clear & reasonable timeline for delivery implementation
15	Developing technical specifications and/or scope of work for certain requirements
	Procurement plan overview phase
16	Having records with descriptions of goods
17	Prioritizing the procurement/work plan
18	Obtaining authorization to proceed from authorities
19	Considering specifications based on value for money
20	Scheduling procurement due to dates and quantities
	Procurement controlling phase
21	Testing samples
22	Identifying all significant materials that the contractor should provide
23	Developing evaluation criteria, weighting, and an evaluation methodology
24	Estimating the schedule for providing services or works
25	Monitoring and controlling procurement administration

Table 2. Continued

	Preparing a statement of work phase
26	Making feedback study to minimize procurement cost
27	Identifying method of transporting materials
28	Setting completion criteria for the work to be performed
29	Having suitable stores for materials
30	Developing a method for the disposal of damaged materials
	Request or proposal phase
31	Undertaking market research
32	Estimating cost for goods or services
33	Using the tendering procedure for procurement
34	Using quotations for each material
35	Considering specifications as the basis for the value of money
	Establishing evaluation criteria phase
36	Specifications do not restrict competition
37	Using a competitive selection procedure
38	Having proficient procurement staff vet and evaluate contractors
39	Developing a detailed, mathematically sound scoring plan
40	Assigning weightings (a range that specifies a minimum and maximum weighting).
	Tendering procedure phase
41	Ensuring the compatibility of materials with contract specifications
42	setting procedure for placing persons and contractors under procurement restrictions
43	Having an electronic database for entering tenderers that satisfy prescribed criteria
44	Having appropriate procedures in place for a fair/equitable quotation process

45	Getting conflict of interest documents from all evaluation committee members
	Procurement risk management phase
46	Defining major risks
47	Investigating risk reduction options
48	Putting policies to deal with the potential conflicts of interest
49	Setting requirements for managing risks associated with the breaching procurement system requirements
50	Using procurement quality assurance

Part 3 is related to conducting a case study for residential complex projects in Erbil Governorate.

During the first round, the respondents have been asked to rate the importance of each item of the ten proposed phases to evaluate their validity for the study.

Data were collected and statistically analyzed by using a three-dimension scale (important, average important, and not important. The respondents have been asked to give their opinions about the importance of each item of procurement management suggested phases by giving weights as follows:

important = 2
not important = zero
average important = 1

The relative importance (RII) has been calculated for each item of the questionnaire phases by using the following equation [20]:

$$RII = fi / \sum fi \quad (1)$$

Where:

fi= respondent answer for each item

∑fi = weights of the ten stages

The average relative importance has been calculated for the whole items of the questionnaire as follows:

$$X = \sum fi / n \quad (2)$$

Where: X= average relative importance, fi= the weighted responses, n= number of responses.

The average relative importance would be:

$$X = 11495 / 144 = 79.82$$

This good ratio reflects the weighted average for each item of the questionnaire, which means that the proposed items had obtained the approval sample questionnaire.

On the other hand, according to ISO standards, each practiced item has been given a full weight of 100%, zero weight for the never practiced, and 50% of weight for partially practiced.

The weights for each phase have been calculated to determine the average practice of the procurement management system depending on the degree of practicing procurement management subphases.

The full weight for each phase is supposed to be 10% to have 100% practice for the ten phases.

A second-round questionnaire was designed for a list of risk factors that have been nominated during conducting a Face-to-face interview by the author with 7 managers of large construction projects, 5 design consultants, and 6 procurement officers who were experienced in constructing residential complex projects. The purpose of the exploratory interviews was to elicit their views regarding the risk results of improper procurement management practice as listed below:

1-Forecasting
1-1 Inadequate cost estimate.
1-2 Scarcity of materials.
1-3 Cost overruns.

1-4 Product not representing value for money.
1-5 Frequent delays.

2-Planning
2-1 Purchasing unnecessary items.
2-2 Surplus or shortage of quantities.
2-3 Changing plans and scope of work.
2-4 Time and cost overruns.
2-5 Suspension of work.

3-Developing the procurement work plan.
3-1 Miss estimation of circumstances.
3-2 Priorities are not set.
3-3 Scarcity of funds and imbalanced budget.
3-4 Delay in delivery.
3-5 Improper quality.

4- Procurement plan overview
4-1 Missing some requirements.
4-2 Delays and improper financial allocation.
4-3 Suspension of work.
4-4 Cost and quality conflicts.
4-5 Poor resource allocation and scheduling.

5-Procurement controlling
5-1 Defective quality.
5-2 Disputes.
5-3 Conflicts and quality defects.
5-4 Time overrun.
5-5 Poor procurement management.

6- Preparing statement of work
6-1 Performing a project with high cost.
6-2 Facing unexpected circumstances.
6-3 Misestimating the scheduling for the following activities.
6-4 Damaged materials.
6-5 Conflict with governmental regulations.
7-Request or proposal
7-1 Scarcity of materials.
7-2 Budget problems.
7-3 Not getting the best offer.
7-4 No evaluation criteria.
7 -5 Possibility of manipulation.

8-Establishing evaluation criteria
8-1 Missing the chance of getting a suitable contract.
8-2 Not getting the best offer.
8-3 Unsuccessful choice for tenders.
8-4 Absence of scientific base for evaluation.
8-5 Conflicts and disputes.

9-Tendering procedure
9-1 Poor quality product.
9-2 Poor quality control.
9-3 Absence of reliable database.
9-4 The possibility of manipulation.
9-5 Unsuccessful non-competitive choice of suppliers.

10-Procurement risk management
10-1 Facing unforeseen conditions.
10-2 Facing risks that could be prevented.
10-3 No base for resolving conflicts.
10-4 Disputes.
10-5 Poor quality product

5. Results and Discussion

Table (3) shows the specific weight of the proposed phases, the importance, and the degree of practicing procurement management by calculating the sum of the subphase values.

Table 3. Specific weight, degree of importance, and degree of practicing procurement management for suggested phases according to respondents

	Phase	Specific weight (%)	Degree of importance (%)	Degree of practicing (%)
1	Forecasting	9.67	7.72	5.54
2	Planning	10.72	8.55	3.81
3	Developing the procurement work plan	10.90	8.70	4.26
4	Procurement plan overview	9.62	7.68	6.54
5	Procurement controlling	9.90	7.90	5.62
6	Preparing a statement of work	9.66	7.71	5.26
7	Request or proposal	10.20	8.13	5.01

8	Establishing evaluation criteria	9.60	7.66	3.75
9	Tendering procedure	9.92	7.92	2.96
10	Procurement risk management	9.81	7.83	2.95
		100	79.82	45.70

The results show that the total weight of the ten subphases ranges between 9.60 and 10.90, which means, it is a balanced value in assessing the procurement management of residential complex construction projects.

The average practice of procurement management requirements of the ten construction phases according to the respondents has been 45.70 %. Which is considered a very low percentage and below the acceptable level of measurement according to the standards (0 - 100).

The results show that the practice of procurement management phases ranges between 29.50% for procurement risk management and 65.40% for procurement plan overview.

The average practice of procurement tendering procedure and procurement risk management has been 29.60% and 29.50%, respectively. The results show that there is a significant shortage in practicing these phases. Developing the procurement work plan phase and planning phase have been sorted as the most important phases with a rate of 87% and 85.50%, respectively. Although their average practice has been 42.60% and 38.1%, respectively. The average practice of procurement plan overview has been sorted as the highest rate with a percentage of 65.40%.

6. Case Study of Residential Complex Projects

The purpose of the third round was to determine the percentage of practicing procurement management plans during the construction of residential complex projects.

During 2007-2018, about 50 residential complex projects have been constructed in Erbil Governorate. Out of 50 projects, 20 projects have been selected to conduct a case study. Which means 40% of constructed projects. This percentage is considered a very good sample size for that period. The projects have been coded from P1 to P20. As shown in Table 4.

Table 4. Cost and time duration for residential complex projects

Project No.	Volume of work	Cost $	Duration (month)
P1	1100 houses	55,000,000	24
P2	1655 houses	82,750,000	24
P3	2300 houses and 8 towers	20,000,000	48
P4	588 houses	29,400.000	24
P5	187 Villa	75,000,000	48
P6	2800 houses	126,400,000	24
P7	300 houses	18,000,000	24
P8	504 houses	26,280,000	18
P9	510 houses	42,800,000	24
P10	338 houses	23,660,000	30
P11	700 houses	70,000,000	36
P12	584 houses	35,040,000	24
P13	7 towers	25,000,000	30
P14	500 houses	37,878,000	36
P15	41 buildings of 154 flats and 40 villas	118,480,000	36
P16	340 houses	48,100,000	36
P17	2800 houses	126,400,000	24
P18	33 buildings of 396 flats	13,300,000	36
P19	400 houses	13,000,000	30
P20	238 Villa	29,750,000	24

Each practiced item of procurement management has been given the full weight of 100%, partially practiced half of the weight of 50%, and never practiced 0% weight. The degree of practicing

project management criteria for each project has been calculated by calculating the weights of each stage depending on the degree of practicing each item as shown in fig. 1.

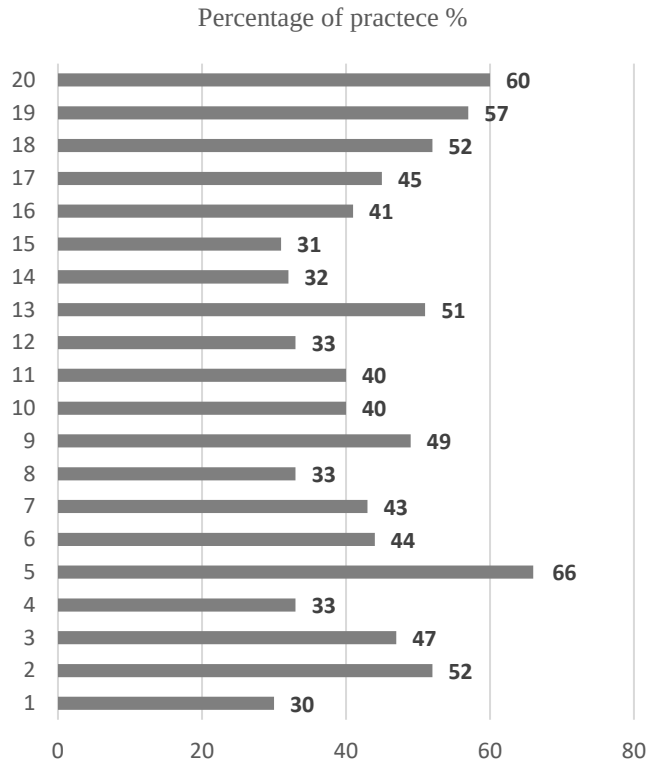

Figure 1. The practice of project management process for case study projects

Fig. 1 shows that the practice of procurement management for case study projects ranges between 30% and 66 %. This percentage is very low. The results show that 70% of residential complex projects practiced the procurement management process with a percentage below 50%. And 20% of them were practiced with a percentage below 60%. On the other hand, only 10% of projects practiced procurement management requirements with a percentage above 60%.

The average practice of procurement management process for the case study projects = (30%+66%)/2= 48%. This result is very close to the respondents' result of 45.70% in the table (3).

Fig. 2 shows that the average practice of procurement management phases for the case study projects ranges between 33% for the procurement risk management phase and 58.5% for the forecasting phase.

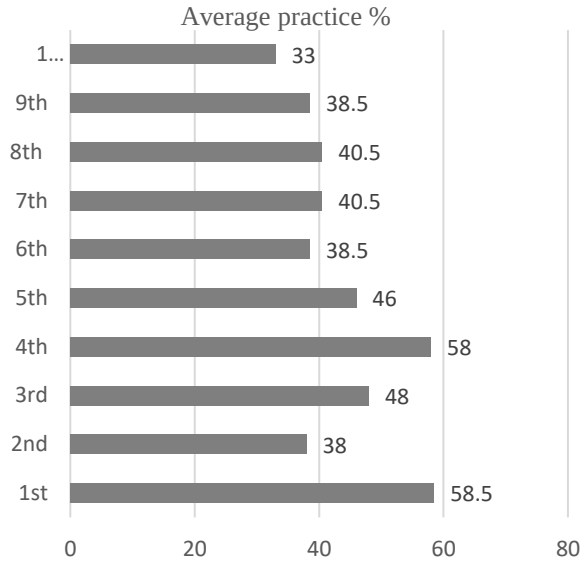

Figure 2. The average practice of procurement management in different phases according to case study projects

Depending on the obtained results from this study, it is obvious that there is a big shortage in practicing procurement management requirements in most phases of construction in Erbil Governorate residential complex projects especially for planning, developing the procurement work plan, and tendering procedure.

The purpose of the fourth round is to analyze the risks associated with the procurement management process that can present additional cost overruns, time overruns, and quality problems by using the relative importance index (RII) method for ranking the significance of risk results. The higher rating of risk means a higher influence given by the variables [21].

RII has been calculated for each item of risk result according to the following equation [22].

$$RII = \frac{\sum_{i=1}^{5} W_i X_i}{\sum_{i=1}^{5} X_i} \quad (3)$$

The weight assigned to respondent i = w
frequency of the respondent i = X_i
response category index from 1 to 5 = i

The respondents have been asked to assess the risk results associated with the procurement management process on the successive categories based on a Likert scale of 1 to 5 as follows:

very low probability or impact = 1
low probability or impact = 2
moderate probability or impact = 3
high probability or impact = 4
very high probability or impact = 5

A similar method was used in other studies [23]. The risk probability (P) and the impact (I) of the procurement management process on the time, cost and have been calculated as shown in table (5).

Table 5. Risk probability and its impact on the time, cost, and quality

Factor	P	I on cost	I on time	I on quality
1	1.22	3.88	3.67	1.11
2	3.00	2.89	4.22	2.78
3	2.89	3.00	2.33	3.67
4	3.00	4.22	3.00	4.33
5	2.89	3.33	4.56	1.11
6	2.56	4.77	2.11	1.67
7	3.55	4.44	1.00	1.22
8	2.89	4.89	4.22	2.44
9	2.59	4.11	3.00	2.22
10	4.22	4.22	4.56	3.33
11	3.00	3.22	2.44	1.11
12	3.11	3.22	2.44	1.10
13	3.67	4.78	4.44	3.89
14	3.44	2.22	3.22	1.22
15	4.00	3.33	3.67	4.00
16	3,22	2.67	3.56	1.11
17	3.33	3.89	4.00	1.22
18	3.22	3.00	3.22	1.00
19	3.00	4.22	3.00	4.22
20	4.11	3.33	4.56	1.11
21	1.33	3.78	3.89	4.11
22	3.00	2.78	3.22	1.33
23	2.89	3.00	2.33	4.00
24	2.33	1.22	3.88	1.00
25	2.44	3.67	4.11	3.67
26	3.44	4.00	1.89	1.33
27	3.44	2.78	3.00	1.33
28	2.67	3.33	3.78	2.11
29	3.33	3.67	2.78	3.56
30	1.67	1.44	3.00	2.44
31	1.44	3.22	4.11	3.67
32	3.11	3.67	3.33	2.67
33	4.00	4.44	2.33	3.89
34	2.78	3.22	2.89	3.00
35	2.44	3.44	2.89	3.77
36	3.00	3.56	1.56	3.00
37	3.78	3.67	2.11	3.00
38	3.89	3.44	2.56	2.22
39	3.11	3.11	2.67	2.88
40	3.78	3.44	2.78	3.78
41	2.78	3.33	3.89	4.11
42	3.67	4.11	2.78	4.11
43	3.89	2.33	1.44	3.56
44	3.44	3.11	2.44	2.44
45	3.44	3.44	2.33	3.56
46	4.22	4.00	4.11	3.22
47	3.78	3.78	3.78	3.44
48	3.78	3.78	3.00	3.56
49	3.78	3.22	3.22	2.89
50	4.33	3.44	2.89	4.00

Table (5) show that the highest values of probability are; poor quality product for missing quality assurance process (50), facing unforeseen conditions for not defining major risks (46), suspension of work for not creating appropriate risk response plans (10), poor resource allocation for not scheduling procurement quantities due to dates (20), improper quality for not developing technical specifications and/or scope of work for certain requirements (15), and not getting the best offer for not using the tendering procedure for procurement (33) respectively.

The least probability has been an inadequate cost estimate for not defining procurement requirements during the design phase (1).

The highest values of the impact on cost are; changing plans and scope of work for not assessing the capacity of implementation (8), scarcity of funds and imbalanced budget for not integrating the procurement plan with the budgeting (13), purchasing unnecessary items for not developing a plan for the method of making sure of the real need for material (6), surplus or shortage of quantities for not developing a methods of making sure of the quantity of material (7), not getting the best offer for not using the tendering procedure for procurement (33), product not representing value for money for not evaluating the suggested materials financially and technically (4), suspension of work for not creating appropriate risk response plans (10), cost and quality conflicts for not having the specifications based on value for money considerations (19), time and cost overruns for not identifying items that must be procured (9), poor quality control for not organizing a procedure for placing persons and contractors under the procurement restrictions (42), and facing unforeseen conditions for not defining major risks (46) respectively.

The least impact on cost has been time and cost overruns for activities for not estimating the schedule for providing services or works (24).

The highest RII values of the impact on time are; frequent delays for not determining a timeframe of implementation (5), suspension of work for not creating appropriate risk response plans (10), poor resource allocation and scheduling for not scheduling procurement quantities due to date (20), changing plans and scope of work for not assessing the capacity of an implementation (8), scarcity of materials for not having feasibility study for available materials (2), poor procurement management for not having proper monitoring and control of procurement administration (25), scarcity of materials for not undertaking market research (31), and Facing unforeseen conditions for not defining major risks (46), delays and improper financial allocation for not prioritizing the procurement/work plan (17) respectively.

The least impact on time has been the surplus or shortage of quantities for not developing a method of making sure of the quantity of material (7).

The highest values of the impact on quality are; product not representing value for money for not evaluating the suggested materials financially and technically (4), cost and quality conflicts for not making the specifications based on value for money considerations (19), defective quality for not testing samples properly (21), poor quality product for not ensuring the compatibility of materials with contract specifications (41), poor quality control for not organizing a procedure for placing contractors and persons under procurement restrictions (42), improper quality for not developing technical specifications and/or scope of work for certain requirements (15), conflicts for not defining evaluation criteria, and methodology (23), and poor quality product for missing quality assurance process (50) respectively.

The least impact on quality has been the suspension of work for not obtaining authorization from an appropriate authority (18) and time overrun for activities for not estimating the schedule for providing services or works (24).

Risk ratings for improper procurement management have been calculated by multiplying the values of the relative importance index for the probability of occurrence and the impact obtained from table (5) as follows:

$$Risk\ rating = RII\ probability\ of\ occurrence * RII\ impact$$

Risk rating may be classified into the following categories [24]:

low category = 1-5
moderate category = 5-10
significant category =10-15
high category = 15-25

The simplest method of associating the influence of procurement management risk is to associate the influence and risk probability of occurrence. Such an approach indicates measured procurement management risks to be foreseen and mitigated before they strongly impact construction projects.

Table (6) shows procurement management ratings for risk impact on time, cost, and quality of the residential complex's projects.

Table 6. Rating the significance of risks on the time, cost, and quality

Factor	Risk rating cost	Risk rating time	Risk rating quality
1	4.78	4.44	1.44
2	8.44	12.66	8.33
3	8.67	6.78	10.60
4	12.56	9.00	12.89
5	9.67	13.11	3.22
6	12.22	4.89	4.00
7	15.78	3.56	4.44
8	14.22	12.33	7.33
9	10.44	7.66	5.67
10	17.80	19.33	12.44
11	9.67	7.22	3.11
12	7.44	11.11	3.11
13	17.44	16.33	14.22
14	7.55	11.00	4.33
15	13.22	14.67	16.00
16	8.56	11.44	3.56
17	13.22	9.44	4.11
18	9.67	10.33	3.22
19	3.78	12.89	4.33
20	13.67	18.67	4.56
21	4.00	5.11	5.44
22	8.33	9.67	4.00
23	8.66	6.78	11.44
24	3.00	9.22	2.33
25	9.11	9.66	8.55
26	13.67	6.44	4.33
27	9.77	10.22	4.67
28	9.00	10	5.66
29	12.44	9.33	11.78
30	2.33	4.66	3.78
31	4.55	5.78	5
32	11.55	10.33	8.33
33	17.67	9.33	15.56
34	8.78	8.11	8.11
35	8.11	7.33	9.77
36	11.11	4.44	7.67
37	13.67	7.89	11.44
38	13.56	10.00	8.44
39	9.67	8.56	8.78
40	13.11	10.33	14.11
41	9.22	10.89	10.67
42	14.89	10.89	15.00
43	9.06	5.60	13.56
44	10.66	8.78	8.33
45	11.89	8.11	12.11
46	17.00	17.56	11.67
47	14.56	14.00	13
48	14.11	11.44	13.44
49	12.22	12.11	11.44
50	15.11	12.77	17.22

The results show that there are 6 risks within the high-risk significant category affecting the cost of construction which are; suspension of work for not creating appropriate risk response plans (10), not getting the best offer for not using the tendering procedure for procurement (33), scarcity of funds and imbalanced budget for not integrating the procurement plan with the budgeting (13), facing unforeseen conditions for not defining major risks (46), surplus or shortage of quantities for not developing methods of making sure of the quantity of material (7), and poor quality product for missing quality assurance process (50). Also, there are 21 risks in the significant category, 17 risks in the moderate category, and 6 risks in the law category.

4 risks affect the time of construction within the high-risk significant category which are; suspension of work for not creating appropriate risk response plans (10), poor resource allocation and scheduling for not scheduling procurement quantities due to date (20), scarcity of funds and imbalanced budget for not integrating the procurement plan with the budgeting (13), and facing unforeseen conditions for not defining

major risks (46). On the other hand, there are 18 risks in the significant category, 22 risks in the moderate category, and 6 risks in the law category.

4 risks affect quality within the high-risk significant category which are; not getting the best offer for not using the tendering procedure for procurement (33), poor-quality product for missing quality assurance process (50), improper quality for not developing technical specifications and/or scope of work for certain requirements (15), and poor-quality control for not organizing a procedure for placing persons and contractors under procurement restrictions (42). In addition to 16 risks in the significant category, 14 risks in the moderate category, and 17 risks in the law category.

3 risk results have a significant impact on cost and time together, which are; suspension of work for not creating appropriate risk response plans (10), scarcity of funds, and imbalanced budget for not integrating the procurement plan with the budgeting (13). Facing unforeseen conditions for not defining major risks (46). Moreover, 2 risks have a significant impact on both cost and quality which are; not getting the best offer for not using the tendering procedure for procurement (33) and poor-quality product for missing the quality assurance process (50). These risks should be considered as a record for future projects.

7. Conclusions

The obtained results show that the procurement management process in residential complex projects is below the acceptable rate. It ranges between 30% and 66%.

70% of projects practiced procurement management with a percentage below 50%. There is a big shortage in practicing procurement management requirements in most phases of construction. The average practice of procurement phases ranges between 33% for procurement risk management and 58.5% for forecasting. Also, there is a big shortage in practicing planning, preparing the statement of work, and tendering procedure phases particularly. More attention needs for planning, developing a procurement work plan, and tendering procedure phases. The study reviled that creating an appropriate risk response plan, integrating the procurement plan with the budgeting, and defining major risks are the most significant factors that impact cost and time. While using the tendering procedure for procurement is the most significant factor that impacts cost and quality. The results show that the practice of procurement management affects cost and time more than quality.

Special attention should be taken into consideration for improving the procurement management system in Erbil Governorate.

It is recommended to use computerized systems and communication technology for interring all received data and information as a database. Training courses should be held for cadres working in the construction sector and for procurement managers focusing on the benefits of the application of procurement management principles in construction projects.

Conflict of interest

The publication of this article causes no conflict of interest

Author Contribution Statement

The author conceived of the presented idea developed the theory and performed all the research work individually.

8. References

1. Mathonsi, M.D. and Thwala, W. D,(2012). *Factors influencing the selection of*

procurement systems in the South African construction industry, African Journal of Business Management Vol. 6, Issue 10, pp. 3583-3594. DOI: 10.5897/AJBM10.978

2. Nguyen, H.T. and Hadikusumo, B. (2017). *Impact of human resource development on engineering procurement and construction project success*. Built Environment Project and asses Management. Vol.7, Issue 1, pp.73-85.DOI: 10.1108/BEPAM-04-2016-0010.
3. Asian Development Bank (ADB). (2021). *Strategic Procurement Planning Guideness On Procurement*. DOI.org/10.22617/tim189672-3
4. Asian Development Bank. (2018). *Strategic Procurement Planning Guidance Note On Procurement*. Manila,Philippines.DOI.org/10.22617/tim189436-2
5. Owiti Jacob Omondi, Stephen Diang a1 Abednego Gwaya, and Robert Onyanyo Jomo. (2017). *Effects of Procurement Processes on Successful Completion of Construction Projects in Using Gishu County*. IOSR Journal of Business and Management. Vol. 10, Issue 12. Ver.7, pp. 42-50.
6. John M. Nicholas and Herman Steyn. (2020). *Project Management for Engineering Business and Technology*. 6th Edition 2020, Routledge, Taylor and Franc Group, ISBN-13:978-1000092516. DOI.org/10.4324/9780429297588
7. S. Hasim, M.A.Fauzi, I.R. Endut, and A.R.M. Radzuana. (2019). *The Material Supply Chain Management in a Construction Project: A Current Scenario in the Procurement Process. AIP Conference Proceeding. Vol. 2020*, Issue 1. Published by AIP DOI.org/10.1063/1.5062675
8. Iyola Bolumole. (2017). *Construction Procurement Strategies For Project Delivery Towards Enhanseent Of HousiHousingtanable in South africAfrica*sis Construction Management Department,Penin sula University of Technology, Bellville, South Africa. 216106605-Bolumole-Iyiola-MConst-Construction-Management-Eng-2018.pdf
9. Kamyar Kabirifar and Mohammad Mojtahedi.(2019). *The impact of Engineering, Procurement and Construction (EPC) Phases on Project Performance: A Case of Large-scale Residential Construction Project*. Faculty of Built Environment, University of New South Wales, Building MDPI Sydney 2052, Australia. DOI:10.3390/buildings9010015
10. Timothy Adu Gyamfia and, Richmond Boadaab. (2015). *The Effects of Procurement Management Practices on Risk Management in Construction Firms*. International Journal of Sciences: Basic and Applied Research (IJSBAR)ISSN 2307-4531. Vol. 24, Issue 3. Pp. 403-420. .
11. Tirth Patel , Kihan Batavia, Kush Kansagara and Hirakrag Bapat. (2019). *Vendor Evaluation System For Procurement of Material in Ahmedabad ComteContextference onAdvanvment in CmputComputingmanagement,2019.* At Jagannath University, Jaipur.

    DOI: 10.2139/ssrn.3462934
12. Masithembe Kafile & Stanley Fore.(2019). *Effects of Procurement Processes on Project Execution in A Project Management Company in Cape Town*. South Africa, International Journal of Business and Administrative Studies vol.4,

issue 4, pp.176-186. DOI:10.20469/ijbas.4.10005-4

13. Depaoli, P., Sorrentino, M., & De, M.(2013). Publicness and organizational theory building: Opening the black box. In Proceedings of the Bicentennial Conference of AIDEA", Lecce, Italy, 2013.
14. T.Subramani, and A. Prabhu. (2018). *Material Procurement in Construction Industry Problems and Solutions*. International JornaJournalngineering & Technology, Vol.7 . Issue 3.10, pp.31-35. DOI:10.14419/ijetv7i3.10.15624
15. A. S. Shehu, Y. Ibrahim, and I. I. Inuwa. (2019). *Knowledge requirement theoretical framework for construction procurement management. The 7th International Conference of Euro Asia Civil Engineering Forum, 30th Sept 2019*. University of Stuttgart, Germany. DOI.org/10.1088/1757-899x/513/1/012003
16. Ogunsanmi,O,E.(2013). *Effects of Procurement Related Factors On Construction Project Performance In Nigeria.*Vol. 6. Issue 2. DOI: 10.4314/ejesm.v6i2.12.
17. Tomas Hank & Jana Koryarova.(2019). *Procurement Management in Construction Study of Czech Munusupalitues*. journal of Open Engineering. Vol.9, pp. 151-158. DOI.org/10.1515/eng-2019-0019
18. Nana Shonia , Zurab Mushkudiani and Sulkhan Makhatadze. (2021). *Specific Local Government Procurement Management In Georgia*. European Journal of Economic and Financial Research, Vol. 5, Issue 3. Pp.56-64.
19. Maksum Tanubrata and, Ika Gunawan, (2018). *Procurement management/ material supply on construction projects. MATEK Web of Conferences Vol. 215:01031*. published by EDP Sciences 2018. DOI:10.1051/matecconf/201821501031
20. Amin, M.E.(2005). *Social Science Research: "Conception, Methodology, and Analysis*. Makerere Press, Kampala.
21. Mohammed, J. Aksana.(2016). *Quality Management of Dwelling complexes n Projects in Erbil City*. Zanco Journal of Pure and Applied Sciences, Vol.25, Issue 3. pp. 7-20.
22. Sari, D.P., Pujotomo D., Wicakson P. A.and yYunanto K. H..(2019). *An Integrated Relative Importance Index, Risk Allocation and Bow Tie Analysis for Analyzing Risks of the Amartha View Apartment Development Project. IOP Conference Series:* Materials Science and Engineering. Vol. 598, Issue 1, pp.012099,2019. DOI: 10.1088/1757-899X/598/1/012099
23. Mohammed, J. Aksana. (2021). *The Impact of Financial Crisis on Construction Projects -A case study: the Erbil Governorate in Kurdistan Region of Iraq*. International Review of Civil Engineering (IRECE), Vol 12. Issue 1. pp. 31-39. DOI: 10.15866/irece.v12i1.18722
24. Nagalla Vaishta, D.Satish Chandra, and SS.Asadi.(2018*). Analysis of Risk assessment in Construction of Highway Projects Using Relative Importance Index Method*. International Journal of Mechanic Engineering and Technology (IJMET), Vol. 9, Issue 3. Pp. 1-6. ISSN Print: 0976-6340 and ISSN Online: 0976-6359