

RESEARCH ARTICLE

ANALYSIS OF THE IMPACT OF REWORK ON PUBLIC AND PRIVATE PROJECTS IN NIGERIA

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Abstract

..... Manuscript History The aim of this research was to investigate the impacts of and assess Received: 25 April 2020 preventive strategies for rework on public and private projectsin Final Accepted: 30 May 2020 Nigeria. Questionnaires were used to collect data from professionals Published: June 2020 involved in public and private projects. Using the Kruskal Wallis Rank sum Test, the result indicated a significant variation in the impact of rework for public and private projects. The impact of rework was more Rework, Cost-overrun, Time-Overrun., significant with time overrun for public projects whileit has more impact on cost overrun for private projects among other factors. The study concluded that rework has more impact on completion time for public projects while it affects the final cost more for private projects. It was recommended that managers of public and private projects should

adopt preventive strategies such asminimizing changes made at the request of the client, allocation of fund for site investigations, prevention of errors in the contract documentation and validity of needed tests to minimize rework on construction projects.

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Introduction:-

The construction industry is an important industry that plays vital role in the growth of a country. It improves the quality of life by providing the necessary infrastructure through construction projects such as buildings, civil and heavy engineering works. However, problems of time and cost overrun are often encountered in the execution of these works, both in private and public projects. As a result, this industry has been criticized extensively for its inability to deliver work at the initial stated time and cost. In line with this, it has been deduced that rework is the major factor contributing to the delay and extra cost incurred (Meshksar, 2012). Rework represents the activity of redoing a process that was done incorrectly in the first time. Hence, rework becomes necessary when an element of construction works does not meet client's requirement or when the completed work is not in line with the contract documentation.

Rework is a significant factor that directly contributes to cost and schedule overruns in construction works though the changes may be deemed as inevitable sometimes. Its occurrence adversely impact other project performance indices such as stakeholder satisfaction (Ade-Ojo et al., 2016). Rework has become a cankerworm within the Nigerian construction industry today as well as poor quality of its end product which do not provide many of the clients' value for money. Many researchers have studied, in depth, rework in construction projects both in Nigeria and in other advanced countries across the globe(AbdelRahim.2014; Ade-Oio et al., 2016), However, nothing has been said about comparing the impacts of rework in public projects with that of private projects, although some researchers have worked on rework on residential projects. The objective of the study is to investigate the impacts of

Corresponding Author:- Ade-Ojo, Comfort Olubunmi Address:- Department of Quantity Surveying, Federal University of Technology, Akure, Nigeria. rework on public projects compared to private projects and assess rework preventive strategies on public and private projects in the study area.

Literature Review:-

Rework are activities in the field which after completion were required to be repeated or undertaken again as a result of some impeding correction that was necessary to be carried out during the project (Anil & Danielraj, 2016). In the same vein, Mcdonald and Leed (2015) defined rework as work that is made to conform to the original requirements by completion or correction at least one extra time due to non-conformance with requirements. Rework is defined as the unnecessary effort of redoing the activity that was implemented incorrectly for the first time or activity which is to be done more than once caused by lack of design coordination and integration on the part of design deficiencies (Maheshkumar&Purva, 2016). However, it is believed that rework refers to non-achievement of quality standards which is common in the construction industry. It is one of the crucial problems that affect performance in construction projects (Dahanayake, Ramachandra, & Thurairajah, 2016; Mahamid, 2016).

Muralidharan & Thiyagarajan (2016)described rework as waste. Waste in this context was classified into materials, labour and machinery waste. Therefore, any effort in terms of labour, materials and machinery which is directed towards redoing a part or element of a building construction due to non-conformity to the design constitutes a waste.

Various studies have considered the different causes of rework with varying conclusions. Such studies indicated that shortage of materials, poor coordination between design team and members, and poor communication with the design team are the main causes of rework in educational buildings (Ade-Ojo *et al.*, 2016). On the other hand causes of rework were classified from consultant's related factors and contractor's related factors (Mahamid, 2016). Unarguably, rework generally arises from errors, changes and omissions during the design and/or construction stages. The various sources of rework are discussed as follows.

Sources of Rework in Construction Projects:

Rework arises from different sources.;

Rework arising from errors:

Ahmed andNaik (2016)defined errors as unintended deviations from correct and acceptable practices and lead to project cost and schedule overruns, which are both unnecessary and avoidable. Errors made during the early stages of a project are often detected during the later stages of the project, after what appears to be an "error free-undetected period." Design errors from architectural and engineering professionals that go undetected may lead to Structural, Geotechnical and Civil Engineering or Mechanical failures that can have catastrophic consequences (Mcdonald, 2015). Errors made during the design process appear downstream in the procurement process. The longer an error goes undetected, the greater the possibility of rework occurring that significantly impacts cost and schedule(Ahmed & Naik, 2016). The extent of rework required, then, depends on how long the error has remained unnoticed. It was added that a dimensional error or spatial conflict contained within design credentials may not arise until the project is being physically constructed on site.

Rework arising from changes:

Change is a directed action that alters current established requirements. Changes can have an effect on the aesthetics and well-designed aspects of the building, the scope as well as the nature of work, or its working aspects. Tatari andKucukvar, 2011;Muralidharan and Thiyagarajan, 2016 stated that changes that are related to the construction phase of the project consist of those activities and tasks that take place at the project site during the construction interface. A change could be in the method of construction while construction changes are usually made to enhance the constructability of the project. Design related rework in the form of change orders is the major source of rework in construction projects.

Rework from omissions:

Construction omissions are those deviations that occur due to the omission of some construction activity or task which could be due to time pressure, understaffing, fatigue and inexperience(Muralidharan & Thiyagarajan, 2016).

Impacts of Rework on Construction Projects:

Rework has varying degrees of effects on both cost and time performance of construction projects. It leads to different levels of increment in the cost of different work categories and caused delays in different work

categories(Ade-Ojo et al., 2016). The severity of these delays is judged by the category of the work (Zaiter & Enshassi, 2014). Rework can cause inter-organizational conflict which could lead further into decrease in supervision, result in de-motivation of workers and then reduced profit for contractors (Anil & Danielraj, 2016). The impact of rework on cost and time are briefly discussed as follows.

Cost is one of the key drivers for construction projects while cost overruns are considered a major concern within this industry. Alwi et al. (2001) indicated that rework costs range from 2.01% to 3.21% of the total project costs and that the direct costs alone often tally to 5% of the total construction costs. Form another study, the average rework for project was revealed to be 4.7% increase in the total cost of project, (Alzanati, 2014). Furthermore, the impact of rework is dependent on the total project completion duration. Small, medium- or long-term projects face varying amount of rework. By implication, short and medium duration projects experience low impact rework while projects with long duration experience higher impact from rework (Adnan & Naqvi, 2015). The impact of change to the project design discovered prior to the start of work may not directly or immediately affect construction productivity. However, this may create unforeseen delays or disruptions to the progress of the work. This is referred to as cumulative impact or cumulative effect (Hwang et al., 2009)

Anil and Danielraj (2016) concluded that rework is a major contributor to time wastage and schedule overruns which eventually impact on cost, resources and quality. Adding that the adverse consequences of rework include reduced profit, loss of market share, worker injuries, damaged reputation, increased turnover of management and workforce, lower productivity, higher costs, and finally, costly litigation between participants over responsibility for overruns and delays. In the long term, rework can also affect a construction company's reputation and its ability to attract new business.

Failure to deliver project needs on time and on budget has been the downfall of governments and public entities around the world (Mcdonald, 2015). Where delays in projects occur, the Project Manager is usually forced to consider three possible situations: decline in quality, additional costs and possible rework. A decline in quality will usually lead to rework, while introducing additional resources to meet project schedule constraints significantly increases project costs. Likewise, loss of productivity may occur due to longer periods of overtime if project acceleration is required to resolve delays. Where this approach is adopted, fatigue will invariably increase leading to substandard performance that may also generate rework. If extra resources are implemented, the outcome may lead to labor overcrowding and stacking of subcontract trades, which also has a potential to reduce work effectiveness, which in turn can lead to non-conformance. Table 1 consists of the summary of impacts of rework on construction projects as contained in literature.

	Author	Type of Work	Cost	TimeOverru
			Overrun	n
1	Simpeh (2012)	Construction Project	5.12%	
2	Meshksar (2012)	ReinforcedConcrete	1.85%-2.1%	4.1%-5.18%
		Structure		
3	Alwi, Hampson, & Mohamed (2001)	Construction Project	2.01%-	
		_	3.21%	
4	(Alzanati, 2014)	Pipeline Project	4.70%	
5	(Zaiter & Enshassi, 2014)	Different Categories of	3%-10%	20% to 77%.
		Works		
6	Taggart, Koskela, & Rooke (2014)	Building Construction	5%	
7	Mcdonald & Leed(2015)	All types	5%	
		Commercial Industrial	2%-6%	
		Residential	3.15%	
		Highway	5%	
		Heavy Eng./Industrial	12.40%	
		Railway	10%	
8	Dahanayake, Ramachandra, & Thurairajah (2016)	Housing Construction		0.5%-3.7%

Table 1:- Rework Cost and Time Overrun.

9	Mahamid (2016)	Residential	Building	10%-15%	
		Projects			

Source: Authors compilation (2017).

Public and Private Construction projects:

Construction projects are classified as public and private depending on the type of client- either government or private individual(s). In other words, construction projects are not categorized under public projects or private project based on the type of work but rather the type of client(s). If owned by government, it is a public project but if owned by an individual(s), then it becomes a private project.

A public project is any project that is funded by a government and is meant to be owned or operated by that government. Public projects are government owned; federal, state or local government(Prasser, 2015). Most public projects relate to work a government does to fulfill a public purpose. In most cases, city managers or administrators at any level of government follow a certain process when implementing a public project. These projects are subject to more open procedures than many other projects. For example, public projects are required to publish requirements and request bids for construction projects. The bids are opened at a public place and then considered publicly. In order for a contractor to win in a bid for a public project, it may need to meet certain criteria. Often, the company must be bonded and submit a bid bond with the project. Typical government projects include construction of environmental remediation, institutional buildings (courthouses, prisons schools etc.), infrastructure projects (subway systems, massive water tunnels, road repair and construction, public building construction, and even public parks. (Joe, 2015). A public project can be owned by any level of government- Federal government, State government or Local government.

Some of the major characteristics of public projects is that there is a clear line of accountability and access to expertise which is usually not available in the private projects and development risk is minimized. Public project also has better compliance with environmental regulation as it is owned by government(Prasser, 2015). In this type of project, there is right to terminate contract and to apportion penalties for poor performance and the fear of these help to improve cost effectiveness and with flexible concession period (Johnson et al., 2013). Some of the limitations to public projects include the bidding process as few contractors bid due to pre-qualification requirements which make some contractors unfit to tender. Others include high transaction cost that is, cost to financial advisor/lawyer which increases the transaction amount. There is also reduction of bargaining position with civil works companies.

However, Private projects are projects of every type that are owned, controlled or commissioned by a private party. Private parties include individuals, homeowners, corporations, other business entities, non-profit associations. The individual funds the project all alone without any direct financial intervention from government. The products of private construction project are privately funded schools, hospitals, publicly traded companies, and any other construction project in other words that is not the government (Johnson et al., 2013). Private construction projects come in different shapes and sizes. Private sector investment in construction projects have become the dominant method for building in cities today. High population growth rate and associated demand for development in the absence of major public sector investments in building and construction has encouraged the private sector to invest extensively in city.

Management of Rework in Construction Projects:

Rework has been identified as a significant factor that negatively impacts project performance. Construction projects, both public and private, often experience cost and schedule overruns Although changes may be deemed as inevitable in some perspectives, uncontrolled occurrences of rework and wastages should be effectively controlled to improve targeted objectives of construction project with respect to timeliness, cost targets and product/ service quality. This is important to give good value for client's money.

The study by Zaiter and Enshassi(2014) indicated that sufficient and capable human resources were the most effective measure for reducing rework. The study revealed that teamwork effectiveness, strong qualified supervision, continuous evaluation before and during work and supplier prequalification were very effective measures for reducing rework. Another study indicated that the cost of rework may be reduced considerably at the end of the project by: ensuring effective communication among the staff; improving the training of the staff; increasing the amount of supervision; usage of right materials and ensuring the usability and functionalities of the

machinery and equipment (Alzanati, 2014). In order to improve project performance by reducing rework costs and effects, Mahamid (2016) suggested thatthere is need todeveloped a workable mechanism to bring together the client, the design consultant, the consultant and the contractor to minimize change orders and the introduction of additional work during the construction phase. It was also suggested that offer examination commissions should be instructed to comply with bid taking into account the required quality degree, the possibility of execution within the specified period and the contractor ability to perform the required work according to the conditions and specifications. In addition, project consultants should develop quality control and quality assurance plans to review and revise contractor submittals such as material submittals. Lastly, that site managerial skills of contractors and subcontractors should be improved by conducting management courses and workshops. According to Maheshkumar and Purva (2016) the success of supervision is more likely to depend on the experience of the supervisors rather than increasing the number of supervisors involved in a particular project. Quality of site supervision and the supervisor's level of experience help to minimize the rework cost.

To reduce rework, firms should implement quality operations such as pre-project planning, benchmarking processes, project change management and constructability and design effectiveness(Mcdonald, 2015). Furthermore, firms should improve management of design and documentation processes and communication among owner, designers and constructors to create a guiding coalition, and a shared objective and mutual trust. Overall change requires leadership and management; the larger the change the more leadership is required. Project Managers should analyze, think ahead and change by taking the lead to develop and implement systems for tracking and controlling constructor error and omission for owners, design change for contractors, owner change, and design error for both contractors and owners to try to reduce rework by these sources. The owners are recommended to revise the design documents of the projects to minimize the change orders during the implementation; moreover, the owner should choose the qualified contractor and not the lowest price offer (Sweis et al., 2013).

Ahmed andNaik (2016) suggested the following factors for reducing rework in construction project.

Rework can be reduced by developing adequate awareness about the root causes and what constitutes rework and implementing systematic approach to measure rework. A fulltime supervisor is to be placed in site- who is well trained to avoid mistakes made by the unskilled laboures. The employment of unskilled labour should be limited and if employed they should be given proper training so that the errors are minimized. Inspections must be conducted on a daily or weekly basis by the senior managers or senior staffs so as to avoid the errors in the early stage. Proper inspection of the materials being supplied should be made compulsory so that defective materials can be identified Improvement and total commitment to quality management would render and assure reduction in rework Site documentation should be carried out as early as possible and at every stage to check work done and highlight rework. Formal training must be given to supervisors to improve supervisor's skills like planning work, communication, leadership, motivation.

Methodology:-

The methodology adopted for the study consists of a cross-sectional survey of public and private projects in Tertiary Educational Institutions in Ondo State Nigeria with a population public and private building projects completed from 2013-2017. The information on the completed projects were obtained from the Physical Planning Division of the respective institutions with a total of 22 public projects and 11 private projects completed within the study period. Census was adopted while questionnaire survey was used for the purpose of data collection. The questionnaires consisted of structured close-ended questions on the effects and preventive strategies for rework in public and private projects. A nominal scale on a five (5) point Likert's scale with five as the highest and 1 the lowest scores was used. Thirty-three (33) printed copies of questionnaires were distributed to the professionals while thirty (30) were recovered (91%). The Importance Index Rate (IIR) was used to analyze the data for impacts and strategies for reducing rework in public and private projects. The Kruskal Wallis Test was used at 95% confidence interval to establish the significant difference in the impacts of rework on public and private projects.

Table 1 shows that 27% of the respondents were Architects, 23% Quantity Surveyors, 33% are Engineers and 17% are builders.

 Table 1:- Profession of the Respondents.

Profession	Frequency	Percentage

Architecture	8	27	
Quantity Surveying	7	23	
Engineering	10	33	
Building	5	17	
Total	30	100.0	

Table 2 shows the profile of respondents in terms of their years of experience in the construction industry. Majority of the respondents for both private and public institutions had served the industry for more than 10 years. This suggest that majority of the respondents have been in the industry for a considerable number of years. Thus, information gathered is considered reliable enough to meet the needs of this research. They are also ideally suited to provide comments and answers on the objectives of this study while their opinions are expected to reflect the real industry's situation.

Table 2:- Years of Experience of the Respondents.

Years of Experience	Frequency	Percentage	
0-5	5	16.7	
6-10	13	43.3	
11-15	7	23.3	
16-20	4	13.4	
21 & above	1	3.3	
Total	30	100.0	

As shown in Table 3, Time overrun with an IIR of 96%, is the highest impact of rework on public projects closely followed by cost overrun with an IIR of 92%, contractual claims and end-user/client dissatisfaction with an IRR of 82% and 67% were ranked as third and fourth impact respectively. However, on private construction projects, cost overrun was ranked first with an IIR of 97%, time overrun was ranked second with an IRR of 85% while end-user/client dissatisfaction with an IIR of 43% has the least impact.

Table 3:- Impact of Rework in Public and Private Projects.

S/n	Impact	Public		Private	
		IIR (%)	Rank	IIR (%)	Rank
1	Cost overrun	92	2	97	1
2	Time overrun	96	1	85	2
3	Contractual claims	82	3	57	4
4	Quality degradation	66	5	60	3
5	End-user/client dissatisfaction	67	4	43	7
6	Contractor's dissatisfaction	43	7	52	6
7	Design team's dissatisfaction	47	6	57	4

Table 3 shows the analysis of variance of the impact of rework in public and private projects. The significant probability 0.023 is less than the alpha level 0.05, therefore, there is statistical reason to reject the null hypothesis that there is no significant difference in the impact of rework on both public and private projects. Hence, this analysis shows that there is statistically significant difference in the impact of rework on public and private projects at 98% variation.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	24.07129	1	24.07129	6.515236	0.023006	4.60011
Within Groups	51.72461	14	3.694615			
Total	75.7959	15				

Table 3:- Analysis of Variance of Impact of Rework on Public and Private Projects.

Table 4 shows the preventive strategies for rework on public and private projects. After ranking the importance index rate of the respondents, minimizing changes made at the request of the client was ranked as the best preventive strategy for reducing the impact of rework in public construction projects with IIR value of 80%, followed by setting of reasonable completion time with IIR of 79%, allocation of fund for site investigations with IIR 74%, prevention of errors in the contract documentation and validity of needed tests has the same IIR of 72% each. On the other hand, good communication with design consultants was ranked the best strategy in minimizing rework in private construction projects with an IIR of 87%, closely followed by allocation of fund for site investigations with an IIR of 85%, prevention of errors in the contract documentation was ranked as the least strategy with an IIR of 63%.

S/n	Strategies	Public	Public		Private	
		IIR (%)	Rank	IIR	Rank	
				(%)		
1	Allocation of fund for site investigations	74	3	85	2	
2	Client involvement in the project	59	10	65	10	
3	Sufficient time spent on the briefing process	68	6	75	6	
4	Sufficient money spent on the briefing Process	66	8	72	8	
5	Good communication with design consultants	67	7	87	1	
6	Payment of necessary fees for preparing contract	64	9	63	11	
	documentation					
7	Minimizing changes made at the request of the client	80	1	82	4	
8	Prevention of errors in the contract documentation	72	4	83	3	
9	Adequate project documentation	56	11	78	5	
10	Validity of needed tests	72	4	67	9	
11	Set reasonable completion time	79	2	73	7	

Table 4:- Preventive Strategies for Rework in Public and Private Projects.

Findings and Discussions: -

Evaluating the impact of rework in public projects, the study identified time overrun, cost overrun, contractual claim and End-user/client dissatisfaction respectively for public projects. However, for private construction projects, Cost overrun was ranked first while Time overrun was ranked second. From this result, it is can be deduced that the top two impacts of rework are the same in both public projects and private projects. This result is also in line with previous findings that the main impacts of rework in construction projects are additional time and additional costs(Mahamid, 2016;Anil & Danielraj, 2016).

Additionally, the result also revealed preventive strategies such as, minimizing changes made at the request of the client, allocation of fund for site investigations, prevention of errors in the contract documentation and validity of needed tests as means of minimizing rework in construction projects.

Conclusion and Recommendations:-

As a result of the analysis made, the study concludes that cost and time overrun are the major impacts of rework in public and private projects. Time overrun is more prominent for public projects while cost overrun is more prominent for private projects. Preventive strategies such asminimizing changes made at the request of the client, allocation of fund for site investigations, prevention of errors in the contract documentation and validity of needed tests are means of minimizing rework in public and private projects.

The study recommended that the management of public and private projects should be concerned with minimizing cost and time overrun as major impacts of rework. The study also recommends that management of public and private projects should adopt preventive strategies earlier identified tominimize rework.

References:-

 Ade-Ojo, C. O., Adewumi, B. O., & Akinola, J. A. (2016). Susceptibility of building elements to rework in selected higher hducational buildings in Nigeria. In F. K. Ebohon, O. J., Ayeni, D. A, Egbu, C. O, and Omole (Ed.), Joint International Conference (JIC) on 21st Century Human Habitat: Issues, Sustainability and Developmen (Issue 1145, pp. 21–24). JIC.

- 2. Adnan, F., & Naqvi, I. H. (2015). Effect of rework on project success. Science International (Lahore), 27(1), 575–580.
- Ahmed, S. A., & Naik, B. H. (2016). Rework Management in Construction Projects and Comparision with Time and Cost. International Journal of Innovative Research in Science, Engineering and Technology, 5(10), 17973–17980. https://doi.org/10.15680/IJIRSET.2016.0510102
- 4. Alwi, S., Hampson, K., & Mohamed, S. (2001). Effect of qualith supervision on rework in the Indonesian context. Asia Pacific Building and Construction Management Journal, 6(January 2014), 2–6.
- 5. Alzanati, A. (2014). Project Management : An Analysis of Causes and Effects of Rework on Construction Project. The British University in Dubai.
- 6. Anil, A., & Danielraj, R. C. (2016). Analyze the Causes and Minimize the Occurrence of Rework in Construction Project. 5(4), 6464–6467. https://doi.org/10.15680/IJIRSET.2016.0504253
- Dahanayake, B., Ramachandra, T., & Thurairajah, N. (2016). Assessment on Rework Costs Probability of Housing Projects In Sri Lanka. In P. W. Chan & C. J. Neilson (Eds.), 32nd Annual ARCOM Conference (Vol. 2, Issue September, pp. 1265–1273). Association of Researchers in Construction Management.
- 8. Hwang, B., Thomas, S. R., Asce, M., Haas, C. T., Asce, M., Caldas, C. H., & Asce, M. (2009). Measuring the Impact of Rework on Construction Cost Performance. March.
- Johnson, C., Adelekan, I. O., Bosher, L., & Marome, W. (2013). Private sector investment decisions in building and construction: increasing, managing and transferring risks (Background Paper Prepared for the Global Assessment Report on Disaster Risk Reduction 2013 Private, Issue April). https://doi.org/10.13140/RG.2.1.3479.2084
- Mahamid, I. (2016). Analysis of Rework in Residential Building Projects in Palestine. Jordan Journal of Civil Engineering, 10(2), 1–13. https://doi.org/10.14525/JJCE.10.1.3536
- 11. Maheshkumar, R. S., & Purva, S. K. (2016). Impact of Supervision on Rework in Construction In. International Journal on Recent and Innovation Trends in Computing and Communication, 4(1), 1–7.
- 12. Mcdonald, R. (2015). Root Causes & Consequential Cost of Rework North America Construction.
- 13. Meshksar, S. (2012). Cost and Time Impacts of Reworks in Building a Reinforced Concrete Structure (Issue June). Eastern Mediterranean University.
- 14. Muralidharan, S., & Thiyagarajan, S. (2016). Factors Affecting Rework in Construction Project. International Journal of Engineering Sciences and Research Technology, 5(1), 623–629.
- 15. Prasser, S. (2015). Overcoming the 'White Elephant' Syndrome in Big and Iconic Projects in Public and Private Sectors (Issue January 2007). University of Sunshine Coast.
- 16. Simpeh, E. K. (2012). An Analysis of the Causes and Impact of Rework in Construction Projects.
- 17. Sweis, G. J., Sweis, R., Rumman, M. A., Hussein, R. A., & Dahiyat, S. E. (2013). Cost Overruns in Public Construction Projects: The Case of Jordan. Journal of American Science, 9(7), 134–141. https://doi.org/http://www.jofamericanscience.org.
- Taggart, M. ., Koskela, L. K., & Rooke, J. . (2014). An Improvement Strategy for the Defects and Rework Management Process Within an SME: An Action Research Approach. In A. B. Raiden & E. Aboagye- Nimo (Eds.), 30th Annual ARCOM Conference (Issue September, pp. 1059–1068). Association of Researchers in Construction Management,.
- 19. Tatari, O., & Kucukvar, M. (2011). Cost premium prediction of certi fi ed green buildings : A neural network approach. Building and Environment, 46(5), 1081–1086. https://doi.org/10.1016/j.buildenv.2010.11.009
- 20. Zaiter, M. M. A., & Enshassi, A. (2014). Causes and Effects Of Rework on Construction Projects In. The Islamic University of Gaz.