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Analyzing the Major Causes of Rework in Building Construction Projects at Addis Ababa, Ethiopia

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KEY WORDS

Rework, Building construction, Cause factors, Addis Ababa, Ethiopia

ABSTRACT

The objective of the study is to examine the major causes of rework in Addis Ababa Building construction projects. To achieve the stated objective, a qualitative approach with descriptive research design is used. The building contractors' one, two and three were selected as the target population. To elicit the required data, a simple random sampling with proportional method is used. Among the distributed 118 questionnaires for the construction companies, 89 were collected. Based on the collected data, the result of the study revealed that human resource capability, project communication, project constructability, site management; and materials equipment are the major causes of rework in the Ethiopian building construction companies. Finally, the study mainly recommended for the three major participants (contractors, clients, and consultants) to develop a continuous means of communication and specifically for the contractors and consultants to have a rework event, cause and impact recording system which is going to be helpful towards reducing its occurrence. Finally, managerial implications and concluding remarks are forwarded.

1.1 Background of the Study

The construction industry is one of the significant industries that contribute to the socio-economic growth of a country. Bossink and Brouwers (1996) stated that the construction industry plays an important role that is required for the socio-economic development of a country and also directly contributes to the economic growth. In spite of its significance, the industry faced and is facing different problems like cost overrun, time overrun, poor quality, material wastage, poor performance and ineffective productivity (Abdul-Rahman, I., Memon, A., & Abd-Karim, 2013; Simpeh 2012). According to Hussin, Rahman, & Memon, (2013), the construction industry faces different problems like time overrun (70% of projects), cost overrun (average 14% of contract cost), and waste generation (approximately 10% of the material cost). The construction industry is a diverse sector of the national economy, which involves a wide range of scarce resources for a given country; therefore productivity of construction industry concerns not only the industry itself, but also other industries, which depends on its performance. This is particularly important for developing countries like Ethiopia which involves massive construction activities with these days (Ofori, 2006). According to Mckinsey Global Institute report (February, 2017), construction industry is one of the largest sectors in the world economy with $10 trillion spending, 13% of GDP contribution and 7% employment opportunity annually. However, the sector's productivity for the past two decades couldn't exceed 1% a year while the total world economy and the manufacturing sector have been grown by 2.8 and 3.6 % respectively. As a result of this, the industry loss a value of $1.6 trillion a year that would meet about half of the world's annual infrastructure needs or boost global GDP by 2 %. According to this report, Ethiopia is the last in the list of countries with poor productivity. Considering the above fact, this study examines the causes of rework in building construction projects.

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1.2 Statement of the Problem

The construction industry plays an important role in the socio-economic development of a country. Construction projects have their own processes and challenges from initiation to completion of the whole process. The challenges included but not limited to time overrun, cost overrun, and waste generation (Hussin, Rahman, & Memon, (2013). Different researchers around the globe regarded rework as a serious problem in the construction industry. For instance, Enshassi, Al-Najjar & kumaraswamy (2009) found rework as a serious problem in the construction industry and has been identified as one of the key causes for cost overrun, delay and client dissatisfaction. Similarly, Love and Edward (2004) confirmed that rework is a major contributor for time overruns which eventually impacts the cost, resources, and quality of a project. As confirmed by research which was made in Australia, the direct and indirect rework costs in building projects were 6.44% and 5.6% of contract value respectively (Love, 2002). Also, Josephson and Hammarlund (1999) on their research made in Sweden examined the causes and costs of seven building projects and found that the cost of rework ranged between 2.3% and 9.4% of the contract cost. Likewise, Oyewobi, Ibironke, Ganiyu & Ola-Awo (2011) made a study on 25 building construction projects which are located in Nigeria. According to the results, the additional cost incurred due to rework ranges up to 5% of the total estimated cost.

The construction industry in Ethiopia is the major sector where public and private sectors are investing the huge amounts of fund. However, most construction projects faced with significant problems of high cost overrun and time overrun, and rework is one of the main factors contributing to these failures (Abayneh, 2020). As it is stated by MoWUD (2006), the Ethiopian construction industry have a shortage of meeting the stated local and international quality standards and the performance demand expected from the sector. The industry suffers from many problems and complex issues related to time, cost, quality, client satisfaction, productivity and safety (Biyadglign, 2017). In addition to these problems, the study identified the cost of rework as one of the factors affecting the performance of building construction projects. Also, Asmara (2015) identified rework as one of the major causes of wastage generation in public housing projects. When it's compared to the seriousness of the consequences of rework, the attention given to the root causes is still limited (Simpeh, 2012; Ye, Jin, Xia & Skitmore, 2014; Zaiter, 2014 and; Chandrusha & Basha, 2017). Similarly, when we come to our country, as rework is a global problem in construction industry; we cannot say exhaustively available researches are carried out in this area.

Before starting this research, it was necessary to make a pilot study in order to indicate the existence and to estimate the cost that could be incurred due to reworking. The pilot study was carried out on three building projects located in Addis Ababa. According to the data collected through semi structured interview, the additional cost of rework can range up to 2.5% of the total cost of a building project. This indicated the seriousness of the issue which made this area of study worth to dig deep. As a result, the study examined the major causes of rework on building construction projects which are located in Addis Ababa.

1.3. Research Objective of the Study

To identify the major causes of rework in building construction projects which are located in Addis Ababa.

1.4. Significance of the Study

The identified top root causes are one of the results which are obtained from this study. So this result will create awareness about the causes of rework so that construction professionals can act to minimize the adverse impacts in the construction industry. In addition to that, the result would help the policy makers to develop the standard and working procedures so as to reduce the non-value adding costs that are being incurred by the rework related problems.

1.5. Scope and Limitations of the Study

The research focused on building projects focused on building contractor one (BC1), building contractor two (BC2) and building contractor three (BC3) companies that are located in Addis Ababa and registered by Addis Ababa City Construction Bureau. This study was limited to show the rework incident in construction phase in the perspective of professionals on contractor's side. But the perspective of clients and consultants need to be seen separately in detail by the next researchers. The other limitation is that, the study was carried out using descriptive research design and analyzed using descriptive statistics using RII analysis tool to identify the causes of rework. The result would be more holistic had it had a triangulated data from the client, contractor and consultant sides. Finally, regression analysis could indicate the causes more appropriately than the RII method.

2. Review of Related Literature

A rework definition opined by Construction Industry Institute CII (2001) is an activity that needs to be done repeatedly and also includes undoing the works which were

already performed. These definitions give emphasis and relate to rework with its repetition. From this, it can be understood that rework is doing an activity more than once.

2.1. Rework in Construction Industry

Rework is a significant problem in construction projects mostly in building constructions. That is because of the involvement of multiple disciplines like architects, engineers, contractors, suppliers, and clients; which leads to the existence of a complex environment that makes many activities to be carried out simultaneously. In this process, some of the activities will be reworked due to non-conformance, omission, errors, changes or misunderstandings between the involved parties (Love, Smith, & Georigiou, 2000). The construction industry accepted rework as unavoidable process. Due to this, it is perceived as part of a construction process. As a result of this, rework is one of the problems which leads a project to face time and cost overruns, degrade the quality and leads to client dissatisfaction. Even though it has these serious impacts, the parties who are involved in the industry do not realize the actual extent of its occurrence (Nihal, 2013). According to different studies which are carried out in different countries found that the cost of reworking is about 10% - 15% of the total cost of the project (Love and Li, 2000; Josephson, & Hammarlund, 2002; Palaneeswaran,Kumaraswamy,& P., L., 2005; Oyewobi, Ibironke, Ganiyu, & Ola-Awo, 2011; Enshassi, Sundermeier & Zeiter, 2017).

2.2. Categories of Rework

Rework can be categorized as error, omission and change**.** According to Love, Skitmore, and Earl (1998), an error is defined as *"any item or activity in a system that is performed incorrectly resulting in a deviation"*. As opined by Simpeh (2012), the extent of rework required depends on how long the error has remained unnoticed while according to Reason (2002), Omission errors arise when the mental process of action control is subjected to strain 2or distraction. Construction projects, in general, will rarely be built as per the original design (Smith, Currie, & Hancock, 2001). As a result of that, change orders are inevitable and undesirable events of all types of construction projects (Safapour ,& Kermanshachi, 2018). As stated by Love et al. (2004), from design-related rework causes, change orders are the major source of rework in construction projects. As opined by Habibi (2018), change orders usually include a design change or modification initiated by contractor or client during the construction phase or it could be initiated due to financial, economic, social or legal changes. The operational aspects of change affect the cost of a project, create scheduling delays, and decrease productivity (Kermanshachi, Beaty,& Anderson, 2016). The issued rework also has a potential of creating serious challenges among the project stakeholders (Habibi, 2018). According to Mastenbroek (2010), when a project is carried out, many changes will occur but all of them are not attended. But both the attended and unattended changes can influence the project negatively or positively.

2.3. Classification of Rework Causes

Three different ways of classifying the causes of rework are identified from different works of literature. First, according to Love, Wyatt, & Mohamed (1997), the causes of rework can be classified into three groups. These are people, design, and construction. They stated different sub causes on each group. In their conclusion, they confirmed that some causes are interrelated due to the complexity of construction operations. Also, they further stated that reworks that are carried out due to peoples account the majority percentage (60%). The following figure illustrates the researchers' classification.

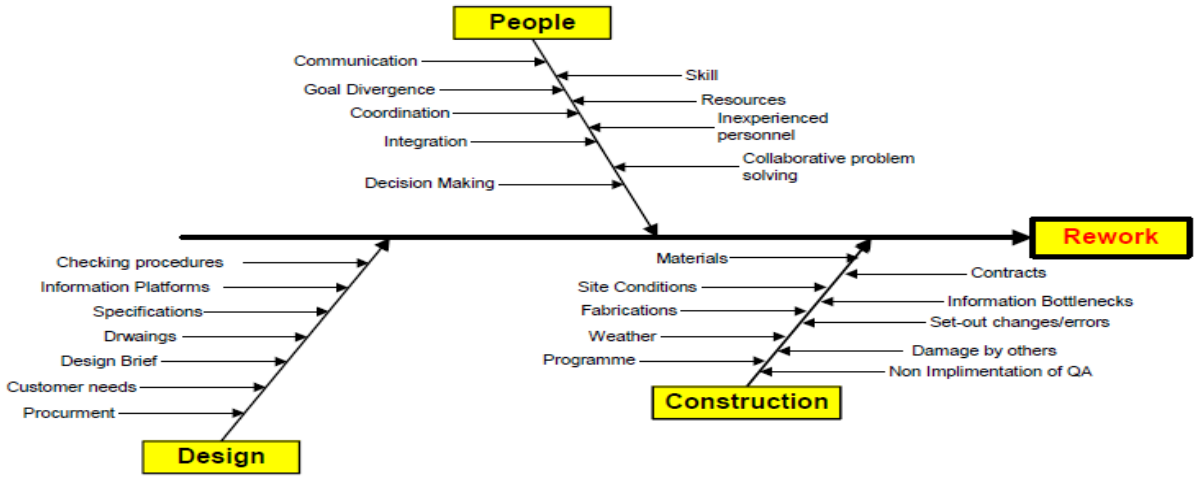

Fig1: *Classification of Causes of Rework*
Source: (Love, et al., 1997: p. 13)

The second classification of rework was proposed by Love & Edwards (2004). According to them, the root causes of rework can be classified as client related factors, design related factors and contractor related factors (includes site management and subcontractor factors). As it is stated by them, most of the time, the client related factors arise from both design and construction-related sources. The rework could come from either a design change made due to the client's requirement or construction-related changes initiated by the client. The changes might be requested after some phase of work had been undertaken on-site or it might even be after the completion of the work. The client related rework factors includes inadequate funding provided during site investigations, inadequate time and funds attributed to the briefing process, payment of low fees for preparing contract documentation, ineffective use of information technology and poor design coordination between design team members. The second root cause of rework is design-related factors. Here, the changes could be made by different parties such as clients, contractors, subcontractors, and regulatory bodies. The design-related rework factors as confined by Love and Edwards (2004) includes; redesign due to an inadequate brief, changes arising from unchecked drawing issue, redesign due to inappropriate drawing scale, accepting and changing designs due to client's requirement. The third root cause of rework is contractor related factors. This factor includes the subcontractor related factors which include low skill level, damages, defects, poor workmanship, inadequate supervision, and use of poor quality materials. The other factor is related to constructability. This includes setting out errors, failure to protect constructed works, changes in construction methods to improve constructability, errors due to inappropriate construction methods, and omission of some activity (Love & Edwards, 2004).

The third classification of rework cause is based on the categorization method proposed by the Construction Owners Association of Alberta COAA (2001). It is developed using a fishbone diagram. The diagram was further modified by Fayek,Dissanayake, & Campero (2003). The classification is based on five major causes of rework and each major causes consists of four sub causes as indicated below in the figure2.

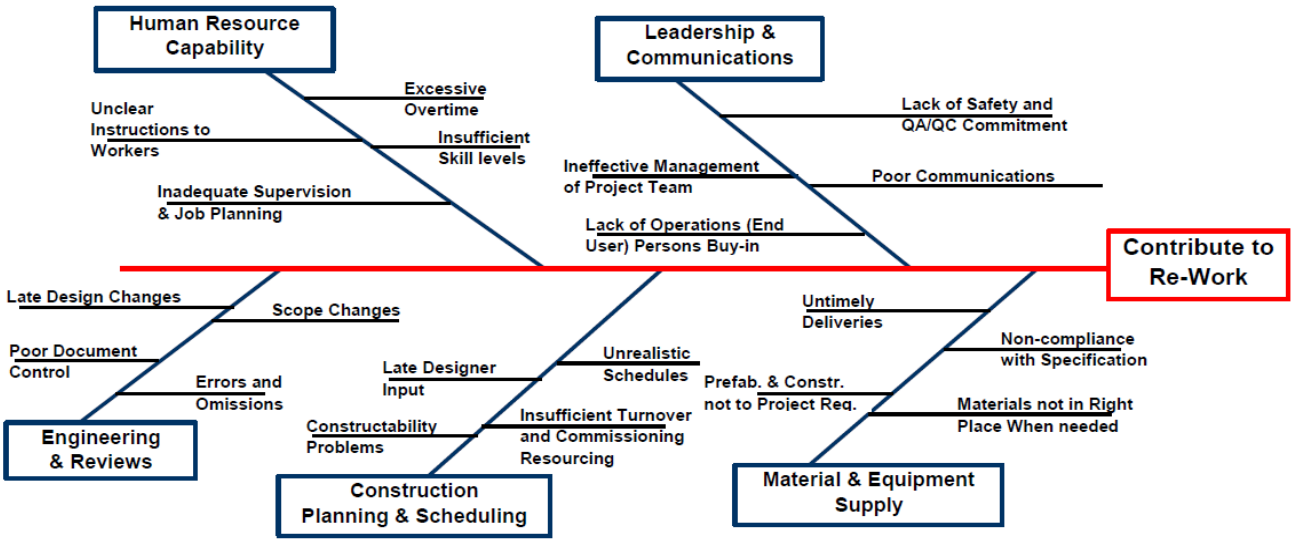

Fig2: *Fishbone Rework Cause Classification*
Source: (Fayek, et al., 2003: p.18)

According to Fayek el al. (2003) classification, leadership, and communication is the first level rework cause. As per their classification, there are four possible causes that are considered as second-level causes for this rework cause category. These are lack of safety and quality assurance or quality control commitment, ineffective management of project team, poor communication and lack of operation (End-user) person's buy-in. Alwi (2001) affirmed that one of the major problems in the construction industry is their inability to become quality focused. According to Love, Edwards, Irani, & Walker,(2009), strategic decisions taken by top management or key decision-makers who stimulate the conditions for the adoption of inappropriate structures, processes, practices, and technologies for projects are the major contributors of rework under the leadership and communication category.

According to Fayek et al. (2003) classification, human resource capability is one of the first-level rework causes. As per their classification, there are four possible causes that are considered as second-level causes for rework. Alwi (2001) identified inadequate supervision, lack of supervisors' skill and lack of skilled labors as major causes

of rework. Similarly, Palaneeswaran et al. (2005) identify a lack of managerial and supervisory skills as the main factor that causes rework. Josephson et al. (2002) found workmanship as a whole takes 20% of the total rework cost and from that group; erroneous workmanship takes 65% of the 20% rework cost. Toole (2005) suggested excessive overtime will cause fatigue to workers and through time it will reduce worker's productivity. As a result, the output of the workers will be in poor quality so the works will be needed to be reworked.

According to Fayek et al. (2003) classification, engineering and reviews is the other first-level rework cause. As per their classification, there are four possible causes that are considered as second-level causes for rework. These are late design change, scope change, poor document control, errors, and omission. According to Love and Li (2000), errors and omissions which are made in contract drawings are the major contributing factors to rework. Construction rework arose out of this incomplete and erroneous information. As opined by Love et al. (2004), poor technical knowledge and lack of experience can be the causes for the results of error and omission in design documents. According to the researchers, this has a potential of leading to rework. Similar to this, Lopez, Love, Edwards & Davis (2010) confirmed that insufficient knowledge simply masks more complicated problems inherent with design firms. Besides, Love et al. (2004) suggested that, besides the inexperience of the design team, the limited duration allocated to design tasks has an effect on the quality of contract documents and this also stated as one cause of rework. As stated by Love and Li (2000), the other cause of rework is changes. This change is direct from the architects because of their need to improve the functionality and aesthetics of the building. But these change, whether they are initiated by clients, contractors or design team members, it has a capacity of leading to rework. As confirmed by Josephson et al. (2002), one of the categories of classifying rework costs is design. This category accounts for 26% of the overall rework cost. Under the design category, lack of coordination (28%) and unsuitable design (18%) are the major causes of rework.

According to Fayek et al. (2003) classification, construction planning and schedule are the fourth first-level rework cause. There are four possible causes that are considered as second-level causes for rework. These are unrealistic schedules, late designer input, insufficient turnover and commissioning resourcing and constructability problems. As stated by Mastenbroek (2010), work preparation before both the design and construction stage is very important. In relation to this, Hwang et al. (2009) identified inadequate pre-project planning as a rework causing factor. Love (2002) in detail stated that poor planning and design are causes for rework. He further confirmed that the insufficient time allocated for design and planning before the construction is started is the major cause for rework. Josephson et al. (2002) on the other hand quantified in the contribution of the factors for the existence of rework. According to them, the production management category as a whole takes 25% of the overall rework cost. Under this category, mistakes in planning and faulty work preparation account 24% and 18% respectively. In the case of constructability problems, Alwi (2001) opined that the construction method selected might lead to rework if they are selected wrongly.

According to Fayek et al. (2003) classification, material and equipment supply is the other first-level rework cause. As per their classification, four possible causes are considered as second-level causes for rework. These are untimely deliveries, non-compliance with the specification, materials not in the right place when needed, prefabrication and construction not to project requirement. Josephson et al. (2002) in their research classified this category in to two as material and machinery. The material cause contributes 17% of the overall of categories are late deliveries (37%), faulty manufacturing (30%), material hard to work with (8%), delivery with wrong type (10%) and other causes (18%). As the result shows, late deliveries and faulty manufacturing of material are the major ones. According to the researchers, usual examples include delay in delivering doors, windows, and prefabricated components, or delivered materials that were in the wrong dimensions and quantities. The other category is machinery; which accounts 3% of the overall rework costs. Machine breakdown and machine not working satisfactorily were the major causes of rework under this category. Therefore, having considered and analyzed the above literatures in the different parts of the world, conceptual understandings are developed from the Ethiopian building construction perspectives in relation to the major causes of rework and causing categories of the project rework. From the literature reviewed and discussed, the Ethiopian construction industry major causes are analyzed from the project constructability, site management, project communication, material and equipment; and human resource capability perspectives.

3. Research Approach and Design

According to Creswell (2003), qualitative research approach measures attitude based on opinions, views and perceptions measurement. The objective of this approach is to develop understanding and to explain the phenomenon, analyses data statistically and quotes results in qualitative forms. This approach is used to find facts based on evidence or records. Due to this, qualitative research approach was adopted to grasp the opinions of respondents towards causing factors of rework. As a result, a qualitative research approach with descriptive design was adopted to rank the causes of rework. Based on

the obtained list of registered contacting companies from the Addis Ababa Construction Bureau, the total number of sampling frame from contractors one, two and three are 149. This includes project managers, site engineers, and office engineers. To determine the sample size Yamane's formula (1967) is used with 95% confidence interval. The sample size of 118 is selected using a proportional random sampling technique.

3.1. Measurement, Validity and Reliability

To obtain the needed data, a structured questionnaire was used as a data collection tool. In this research, a five-level Likert scale was used, ranging from strongly agree to strongly disagree. To ensure the face validity of the instruments, draft questionnaires were given to experienced professionals who are currently working on the construction industry and academic areas. After that, the questionnaire was modified based on the received comments and distributed to the piloted respondents. Accordingly, the following reliability results were: project constructability (0.78), human resource capability (0.78), site management (0.74), project communication (0.8), material and equipment (0.8) ensured and accepted.

3.2 Methods of Data Analysis

The RII method was implemented to determine the ranks of all factors listed in the questionnaire. The relative importance index (RII) was calculated using the following formula (Sambasivan and Soon, 2007).

$$RII = \frac{\sum PiUi}{N\,(n)}, \quad (0 \le RII \le 1)$$ Where,

RII = Relative Importance Index

Pi = respondent's rating of cause of rework

Ui = number of respondents placing identical weighting/rating on cause of rework

N = sample size

n = the highest attainable score on cause of rework (5 in this case)

4. Results and Discussion

Regarding the causal factors of reworking about 33 rework causing factors were selected and grouped in to five groups as factors related to project constructability, human resource capability, site management, project communication and; material and equipment. The respondents were given variable level items to show their level of agreement about the causes of rework. However, to shorten the table within a page, only the aggregate results are presented. Accordingly, the data are analyzed using Relative Importance Index (RII) value and ranked as shown below in the table.

Table 4. 1: Rework Cause Categories

Cause Categories	N	Mean	SD	RII	Rank
Human Resource Capability	89	3.8587	0.65	0.77	1st
Project Communication	89	3.8067	0.69	0.76	2nd
Project Constructability	89	3.7000	0.50	0.74	3rd
Site Management	89	3.6404	0.71	0.73	4th
Material and Equipment	89	3.5712	0.73	0.71	5th

Source: Survey (2022)

Factors Related to Human Resource Capability

From the selected five rework causing categories, human resource capability was ranked first with mean value of 3.8 and RII value of 0.77 which lies high to medium level of importance. Construction as a whole is a team work which needs most of human's participation. As a result, the output will mainly be depends up on the performance of the human force used. Most of the reviewed studies indicated that the capability of the human resource used is the major rework causing factor that determines the probability of facing reworking; a skilled human resource will decrease the probability of rework occurrence (Fayek et. al., 2003; Josephson et al., 2002; Hwang, et al., 2009; Simpeh, 2012; Enshassi et al., 2017). The result of Fayek et al. (2003) and Enshassi et al. (2017) ranked human resource capability as the second major cause for the occurrence of rework, whereas Josephson et al. (2002) ranked this rework category as first rework causing factor in construction phase of a building projects; which is the same as this study.

Factors Related to Project Communication

This rework causes related to project communication was ranked second with mean value of 3.8 and RII value of 0.76 which lies high to medium level of importance. This rework cause factor indicates any information flows, communications and instructions given and received among the client, contractor, and consultant of the building project during construction phase. The communication between clients, consultants and contractors was raised first by Love (2004) in his rework cause classification study. Simpeh (2012), Mahamid (2016) and Hussein (2014) gave focus for this rework cause factor and ranked it. Both Simpeh (2012) and Hussein (2014) ranked this factor first from the category and Mahamid (2016) ranked this factor as 1st both in its own category. This category includes poor communication path of project instruction.

Factors Related to Project Constructability

This category indicates the rework causing factors which might come from problems exactly during the construction process. Errors due to incomplete/faulty design as the first rework causing factor. It is consistent with the study of Love et al. (2010); Zaiter (2014); Josephson et al. (2002) and Simpeh (2012). The other rework cause is insufficient construction methods and non-conformance of work with specification requirements. According to Alwi (2001) wrong selection of construction method might lead to reworking. The study of Ye et al. (2014), Simpeh (2012) and Zaiter (2014) indicated that the non-conformance of the executed construction activity is one of the major rework causes in construction. Different assumptions can be given for this factor. For instance it might be due to unclear specifications given from the consultant or the contractor might attempt to fraud and execute the work with low quality or different reasons can be raised. According to the result of Simpeh (2012) and Hussein (2014), this factor was ranked first from its category, whereas Zaiter (2014) ranked this factor 4th.

Factors Related to Site Management

This cause indicates the site management practices of the contractor which includes construction activities, labor and resources usage. Of the total of five selected cause factors attributed to site management categories were identified, inadequate supervision is the first cause. Inadequate supervision in general has an impact on the performance of a construction project in terms of time and cost, Meshksarr (2012). So when it comes to rework, even though the workers have insufficient skill, a continuous and adequate supervision has a probability of decreasing the occurrence of rework (Alwi, et al., 2001). Simpeh (2012), Hussein (2014), Mahmid (2016), Fayek et al. (2003) and Josephson et al. (2002) included inadequate supervision as one of the rework cause factors. But majorly Alwi (2001) identified it as major rework causing factor in accordance with lack of supervisors' skill and lack of skilled labors. Ineffective use of quality management practices and poor planning and coordination of resources are the second and third causes of rework. Fayek et al. (2003) and Alwi et al. (2001) gave more emphasis on quality management practices on their study. According to the study of Fayek et al. (2003) this factor ranked first from its category and named the factor as lack of quality assurance and quality control practices. The same way, Alwi et al. (2001) and Palaneeswaran et al. (2005) stated lack of quality management as the major rework causing factor. Hwang et al. (2009), Simpeh (2012), Mahmid (2016) and Hussein (2014) identified poor planning and coordination of resource factor as one of the major rework causing factors in the construction industry. In addition Palaneeswaran et al. (2005) stated that poor coordination of resources and ineffective use of quality management practices as the most frequent rework causing factors in the category of site management.

Factors Related to Material and Equipment

Respondents ranked the rework cause category material and equipment as fifth factor. Fayek et al. (2003) illustrated this category first on their fishbone rework cause classification. In addition, Josephson et al. (2002) classified this category independently as material and equipment. Using poor quality of material might be one of the results of poor site supervision. That is because supervision includes checking the quality of material before it is used. The other reason might be attempt to fraud. The contractor might construct the building with low quality material to get a large amount of profit. Studies related to rework included this factor as the major cause of rework. For instance, according to the study of Mahamid (2016) this cause factor was ranked 2nd in its own category. In addition to this, Ye et al. (2014) ranked this factor as 1st in its group the same as this study. Use of insufficient equipment/machinery and non-compliance of materials with specification were ranked 2nd and 3rd respectively. Josephson et al. (2002) gave more emphasis for rework cause factors related to machinery and separate it from material category. The study identified machine breakdown and machine not working satisfactorily as major causes of rework under this category In addition to them Ye et al., (2014) and Mahamid (2016) also identified this group and ranked the cause factor. According to the study of Mahamid (2016) and Mastenbroek (2010) the causing factor use of insufficient equipment ranked fourth in its own group; whereas Josephson et al., (2002) and Ye et al. (2014) ranked it as second in its own category the same as this study. According to the study of Josephson et al. (2002), this rework factor accounts 10% of the additional rework cost of material.

5. Conclusion and Managerial Implications

The study identified the major rework causing factors that needs a serious intervention by the construction professionals. According to the identified causes, the top rework causing factors in the Ethiopian building construction industry mainly lies in the category project communication and Human resource capability. In the communication category, continuous change instructions made by the client were the major cause factor for the occurrence of rework. It has been frequently stated that communication is vital for the success of a project especially for a construction project which needs teamwork. So, the practical implication of this research is that reduction of rework requires the collaboration and sufficient communication between the 3 C's (client, consultant, and contractor) and needs using a capable human resource from the beginning to the end of the project. The other point of this research was that as different researchers indicated, the degree of attention given to the consequences of rework is insufficient. Let alone the measures taken to reduce rework, the researcher find out that the rework incidences are not even recorded sufficiently as rework event.

Therefore, in the design phase of the project, the consultant and the client need to communicate exhaustively towards the scope of work based on the client's interest. They need to make a scheduled meeting program with a specific time interval like at the beginning of the design, after the completion of 20% of the design, after the completion of the 60% of the design and after the final completion. Whenever the contractor is not responsible for the design work, the design work needs to be discussed in detail about its constructability and completeness issues with the consultant prior to the commencement of the construction phase. This can be achieved by taking some time (depending on the project type) by the contractor's professional (could be site engineers) to make a detailed review of the design. If there are any problems, it needs to be corrected by the consultant before the construction phase is started. That way the rework incidents happening due the faultiness and incompleteness of designs can be reduced. The construction industry by itself is a labor-intensive industry in the Ethiopian context. As a result, working on making an effective and efficient human resource can reduce a lot of problems in the industry. Here also, two out of the three major rework causes came with the capability of human resources. Due to this, both the contractor and consultant should use capable human resources in doing both the design and supervision works. Their efficiency can be increased by giving training regarding project planning and scheduling methods, quality management, project communication and the like depending on the identified gaps.

Finally, a continuous rework recording system should be developed by both the consultant and the contractor side based on the responsible body for that rework incident. To do that, a sheet can be developed to record the rework events happened, the major causes and every additional cost and time incurred due to the rework. This will be helpful to increase the consciousness of the project parities about the magnitude of rework and its impact on the performance of their project. As a result, the professionals will gradually come up with rework reduction solutions. In addition, the collected data can also be used as a lesson learned not to be repeated in other projects; in relation to this effective supervision should be carried out by the contractor's side. The labor force which is used in the construction industry doesn't have detailed knowledge about the construction methods. So, closer supervision needs to be carried out to decrease the poor workmanship, which is identified as one of the major rework cause factors. In this regard, the supervision work shouldn't be the only assignment of the consultant; the contractor should also give attention towards supervising the labor force.

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