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EFFECTS OF CONSTRUCTION PHASE ERRORS ON MAINTENANCE OF SCHOOL BUILDINGS IN GAZA STRIP

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ABSTRACT

The aim of this paper is to identify and rank the construction phase faults/errors affecting the maintenance of the United Nations Relief and Works Agency (UNRWA)'s schools buildings in Gaza Strip, and to propose recommendations for minimizing and preventing the reoccurrence of such problems. A survey was conducted to collect the required data and then used to identify the important factors leading to the identified defects noticed to have emanated during the project initiation and construction stages. These include awarding the contract to the lowest bidder at the expense of performance indicator, excessive and repetitive usage of old formworks, lack of adequate qualitative control in painting, water supply and sewage network, speedy construction to obviate delay. This research recommends that a strict quality assurance and quality control (QA/QC) program should be implemented by the parties to construction to insure that project execution complies with the latest economical and practical specifications. The project execution could be increased through effective project management during the procurement, execution while developing the quality control strategies to ensure that the service life of the project is long without compromising the stability, safety and reducing the overall maintenance cost.

KEYWORDS: Construction Industry, Construction Problems, Construction Phase**,** Faults/Errors**,** Gaza Strip**,** Maintenance, Palestine**,** Schools Buildings, UNRWA Schools

INTRODUCTION

Due to the fast developing in Gaza Strip and the increasing in the population every year, many building construction project have been built to overcome the demand of both the public and private sectors. Meeting this high demand in both the public and private sectors in new building constructions requires speedy construction and not given enough time for adequate planning and risk identification. This will unavoidably result in poor project output and high cost of maintenance. Further, UNRWA schools afford the Palestine refugee student's free education. Due to population growth and increased rate of transfers from Palestinian Authority schools, where the quality of education and infrastructure suffers significantly damage and closure, many UNRWA school buildings have been built to alleviate people's condition. Increase and transfer of students from another region within a short space of time, have secondary effect on the construction project and management which causes indirect effect on the increase in the high maintenance costs (UNRWA, 2014).

Maintenance issue often arises when the building performance is not meeting the standards and quality designed (A. Ali, Keong, Zakaria, Zolkafli, & Akashah, 2013). In the light of lack of building standards, more maintenance, rehabilitation, and renovation work have become necessary to ensure the serviceability and safety of the buildings under

construction. In addition, the existing schools need to be sustained as long as possible. Maintenance costs of a building during their functional lifetime could easily exceed the initial outlay of a new building. Therefore, it's important to consider maintenance aspects at the very outset of the life cycle of a building because decisions made at planning, design and construction stages have a large effect on the maintenance costs to be expended on the project life cycle. Aged building does not necessary have to be associated with high maintenance cost if the building is well properly managed at the outset (Hoe, 2009). Taking adequate precautions during construction could be quite helpful considering the proximity of Gaza to coastal area, which could increase the propensity of untimely deterioration and durability challenges due to corrosion or sulfate attack (Abu Hamam, 2008). Many concrete structures in Gaza Strip suffer from serious defects/errors that increase maintenance costs and decrease the life span of the structure. Therefore, ways must be found to reduce the maintenance cost works due to ageing of the buildings while keeping the same quality.

Abu Hamam (2008) stated that structures in the Gaza strip may face several durability challenges in their life cycle – from design to the service stage. These include faults in design, and construction process, defects in materials, and environmental (chemical) attacks. Therefore any design or construction errors may negatively affect impair the maintenance performance of the academic and residential buildings. Therefore, buildings should be designed, constructed and made to meet higher service life and in tune with the recognized and established standards. The aim of this research is to identify the main types of defects/errors in construction stage that affecting maintenance of UNRWA schools buildings in Gaza Strip. This will minimize the defects in construction phase and will have subsequent increase the lifespan of UNRWA schools buildings.

MAINTENANCE DEFINITION

Oxford Dictionary defined the verb maintain' as cause to continue. Maintenance, therefore, is ensuring that physical assets continue to fulfill their intended functions (Lam, 2007). Maintenance includes the costs of regular custodial care and repair, annual maintenance contracts, and salaries of facility staff performing maintenance tasks. Replacement items of minor value or having a life of less than five years are included as a part of maintenance i.e. replacing light bulbs and repainting are normally included under the maintenance category (Kirk & Dell'Isola, 1995). Various definitions of maintenance exist among maintenance managers, as defined by various authors and institutions, some of this definition are summarized below at Table 1.

Table 1: Definition of Maintenance Building

Term	Definition	Quoted Source
Maintenance	Work undertaken in order to keep, restore or improve every facility, i.e. every part of the building, its services and surrounds, to a currently acceptable standard and to sustain the utility and value of the facility	(Chanter & Swallow, 2008)
Maintenance	the combination of technical and administrative actions to ensure the items and elements of a building in an acceptable standard to perform its required foundation	(A. Ali et al., 2013)
Maintenance of a building	The process of reservation and restoration activity of the structure and components of a building. It covers the whole building which includes toilets, rooms, walls, roofs, drains, doors, windows, floors and also the fix furniture	Zainol, Woon, Ramli, &) (Mohammad, 2013
Building maintenance	Work undertaken in order to keep, restore, or improve every part of the building, its services and surrounds, to currently accepted standards, and to sustain the utility and value of the building.	(BSI, 1993)

Building maintenance	effort undertaken so as to keep, refurbish or improve every element that is every part of a building, its services and surroundings to a currently acceptable condition and to maintain the utility and value of the facility.	(Hoe, 2009)
Maintenance	the work that is carried out to preserve an asset in order to enable its continuous use and function, above a minimum acceptable level of performance, over its design service life, without unforeseen renewal or major repair activities.	(Mohamed, 2013)
Maintenance	Actions undertaken in order to reduce the adverse effects of breakdown and maximize the facility at minimum cost.	(Löfsten, 2000)

The issue of building maintenance is a universal issue and is highly considered in the early process of the construction (design) to assure the quality of the building (David Arditi & Manop Nawakorawit, 1999). Maintenance issue often arises when the building performance is not meeting the standards and quality designed (A. Ali et al., 2013). Building maintenance follows a specific set of objectives including repair, replacement, renewals, modification, protection that protects the basic materials (i. e external painting and thin coating), decoration that protects of the internal surface of the building (i.e. painting and etc.), and cleaning for maintaining the internal face of the building (Amani, Nasly, Mohamed, & Samat, 2012).

The other's objectives of building maintenance were summarized by (Alner and Fellows, 1990) (Alner & Fellows, 1990), among these were to ensure that the buildings and their associated services are safe and fit for use to ensure that the condition of the building meets all statutory requirements. In summary, building maintenance is to ensure the building and its services are in a safe condition, fit for use and meets all statutory requirements (Zainol et al., 2013).

LITERATURE REVIEW

Buildings cannot remain new throughout their entire life. All buildings start to deteriorate from the moment they are completed, and at that time the need for maintenance begins. A newly completed building also requires maintenance. Moreover, it is not possible to replace or rebuild all buildings at one time. The value of a building decreases unless maintenance is carried out on the building (A. S. Ali, Kamaruzzaman, Sulaiman, & Cheong Peng, 2010; Lateef, Khamidi, & Idrus, 2011). Further, building maintenance and the performance of the building constantly affect people’s comfort and productivity. Maintenance works are the only way to maintain and increase the value of the property.

With the increasing costs of new construction, the effective maintenance of the existing building stock has become even more important. Increasingly, building owners are beginning to accept that it is not in their best interest to carry out maintenance in a purely reactive manner, but that it should be planned and managed as efficiently as any other corporate activity (D. Arditi & M. Nawakorawit, 1999). Knowing that, it is impossible to produce buildings that are maintenance free, yet maintenance work can be minimized by good design and proper workmanship carried out by skilled experts or competent craftsmen using suitable codes of installation and requisite building materials and methods (Adenuga & Iyagba, 2005).

Defective construction works can be defined as works that fall short of complying with the express descriptions or requirements of the contract. The majority of modern buildings and civil structures are complex and involve the use of a great variety of engineering methods and processes. Therefore, most projects face the possibility of defects and defective work, which generally result in structures that cannot perform their originally intended roles (Ojo, 2010). Defective

construction contributes to both the final cost of a project and the cost of maintenance, which can be substantial.

Construction defects usually include any deficiency in the performing of the design, planning, supervision, inspection, construction, or observation of construction of any new home or building. The building is deficient if there is a failure during construction in other words, if the building does not perform in a manner that was intended by the buyer (FindLaw, 2011).

Construction defaults are another source of the high cost of maintenance which happens during the construction stage and because of construction performance or material used. Faulty construction is one of the most common causes of early deterioration. Common construction faults include inadequate compaction and failure to position the reinforcement, so that it has adequate concrete cover. Under almost any exposure conditions these faults will eventually reduce the service life of the structure as a result of reinforcement rusting after the concrete has become carbonated (Seeley, 1987).

As known, the environment of construction is constantly changing and the authorities' actions continuously give new conditions. At the same time, competition between companies may become stronger factor that leads the contractor accept the bid with low margin of profit. Studies show that the cost of defects in construction is in the range of 5-10% of the production cost. Therefore, knowledge of the causes of these defects is necessary for choosing adequate measures. Also, (Grosskopf & Lucas, 2008) Showed that 69% of all construction defect claims in U.S. are related to moisture penetration through the building envelope. It is injustice to beer this ratio to construction defects lonely, because these defects that relate to moisture penetration may result from using of bad insulation material or poor implementation of these materials.

Defective construction includes activities such as compaction not done to specifications, which leads to ground movement and eventual failure of foundations. This may lead to the complete failure of a structure (Zietsman, 2008). In London, The Building Research Establishment (BRE) study shows that only a small portion of defects are attributable to faulty materials in terms of storing or placing in position (BRE, 1991). Some manufactures of so-called high technology components have a little awareness of the rigors of a building site or the standard of accuracy achievable under such conditions.

Thus, whilst the materials may be perfect on leaving the factory they can quite easily be damaged during loading handling, unloading, storing or placing in position. Many such defects can be avoided by ensuring greater care at all stages in the process, proper training of operatives and closer supervision. To tackle this problem the construction industry is beginning to introduce the quality assurance techniques developed in other industries such as Quality Assurance (QA) groups and Quality Control (QC)". Poor construction’ is a broad term and it is associated with a number of faults, for example tile fixing, plastering, formwork, plumbing and flooring.

Therefore, it can be concluded that in order to avoid all such construction fault which can cause high future maintenance cost at a later stage, it is necessary to revise the traditional mode of procuring building construction by developing a correlation between designer and construction professionals (Ishak, Chohan, & Ramly, 2007).

METHODOLOGY

In this research, questionnaire survey (a quantitative approach) was used to collect the factual, perceptive, and attitudes of the respondents (Fellows & Liu, 1997; Israel, 1992). Two populations were targeted in this research. The first

population considered is UNRWA engineering department, which include around 80 of engineers; site/office, maintenance, and designers in different units in Infrastructure and Camp Improvement Program (ICIP), among of these units are maintenance unit, construction unit and design unit. The second population is Palestinian Contractors Union (PCU) in Gaza Strip based on the list of registered contractors at the PCU in December 2014. The fifty registered companies are classified under first, second, and third categories in terms of building maintenance. Most of them have undertaken a maintenance building project with UNRWA school buildings. The study was carried out in Gaza Strip and targeted the UNRWA engineering department and maintenance contractors distributed all over Gaza Strip as shown in Table 2 below:

Table 2: Geographical Distribution of the Sample

Group	North	Gaza	Middle Area	South	Total
UNRWA Eng. staff	11	20	6	8	45
Maintenance contractors	9	14	4	7	34

To determine the sample size for each population of UNRWA Engineering staff and maintenance of contractors, Kish's equation was used (Kish, 1965).

$$n = \frac{n'}{1+\frac{n'}{N}}$$

n' is the sample size from infinite population, which can be calculated from this formula

[$n' = S^2/V^2$]. The definitions of all variable can be defined as the following:

n: sample size from finite population.

N: Total population (80 UNRWA engineers and 50 maintenance contractors)

V: Standard error of sample population is 0.05 for the confidence level 95%, t = 1.96.

S^2: Error variance of population, $S^2 = P(1-P)$; maximum at P= 0.5

The sample size can be calculated as follows:

$n' = S^2/V^2 = (0.5)^2/(0.05)^2 = 100$

$$\text{n UNRWA engineering staff} = \frac{100}{1+100/80} = 45$$

$$\text{n maintenance contractors} = \frac{100}{1+100/50} = 34$$

For the first population of UNRWA engineering staff, the selected sample represented all engineering units, which include maintenance, design and construction units. For the second population of maintenance contractors, the selected sample represented all classification categories of the maintenance contractors in GS. Although the calculated sample size for UNRWA engineering staff is 45, the questionnaire was distributed to 60 of UNRWA engineering staff to mitigate the risk of not getting the feedback from some of the respondents. For the same reason, 44 questionnaires were distributed for the maintenance contractors. It turns out that 75% and 77% of the questionnaires were obtained from UNRWA engineering staff and maintenance contractors, respectively as shown in Table 2. According to (Moser & Kalton, 1971), the obtained

response rates of 75% and 77% are reasonable enough and will reflect good results and outputs.

Table 3: Sample Size and Response Rate of the Study Populations

Population Category	Total Population	Calculated Sample Size	Distributed questionnaire	No of respondents	Response Rate
UNRWA Eng. staff	80	45	60	45	75%
Maintenance contractors	50	34	44	34	77%

Based on literature review Hoe (2009), Buys & Le Roux (2014), Razak & Jaafar (2012), Al-Shiha (1993), Al-Khatam (2003), Assaf et al. (1996), and Al-Hammad et al. (1997). 41 main types of defects/errors in design phase that affecting maintenance of UNRWA school buildings were considered in this study. The factors were categorized under 5 groups, according to the pilot study.

Cornbach's coefficient of internal consistency reliability tests for level of frequency responses was also used. The RII technique has been widely used in construction research for measuring attitudes with respect to surveyed variables. Several researches (El-Hallaq & Tayeh, 2016; Enshassi, Arain, & Tayeh, 2012; Enshassi, Arain, & Tayeh, 2010; Tayeh, Al Hallaq, & Sabha, 2016) used the RII in their analysis. The respondents were asked to rate the identified interface problems on a five-point Likert scale (1, for the strongly disagree to and 5, for the strongly agree). Based on the survey response, a RII was tabulated using the following equation:

$$\text{Relative Importance Index} = \frac{\sum w}{AN} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{5N}$$

Where W is the weighting given to each factor by the respondent, ranging from 1 to 5, (n1 = number of respondents for strongly disagree, n2 = number of respondents for disagree, n3 = number of respondents for neutral, n4 = number of respondents for agree, n5 = number of respondents for strongly agree). "A" is the highest weight (i.e 5 in the study) and N is the total number of samples. The relative importance index ranges from 0 to 1.

RESULTS AND DISCUSSIONS

This part will show the results of the responding UNRWA Engineers and maintenance contractors regarding 5 groups of factors (total 39 factors) used as follows:

Group 1) Factors related to defects due to lack of inspection.

Group 2) Factors related to defects due contractor administration and his staff

Group 3) Factors related to defects due to due architectural /structural construction

Group 4) Factors related to defects construction equipment

Group 5) Factors related to defects due to construction material

Factors Related to Defects/Errors Due to Lack of Inspection (Group1)

Table 4 shows the opinion of respondents about the factors related to defects/errors due to lack of inspection in construction stage according to relative importance index ranked from high to low. Insufficient testing procedures during

preliminary of water feeding and sewerage networks were ranked first by all the respondents with RII of (0.848). This implies that both UNRWA engineers and the contractor admit that there is a flaw in the prevalent quality and inspection plan or program. It is understood that insufficient inspection program during construction stage could emanate from insufficient staff or lack of roadmap to capture the noticed gaps. Poor supervision could result from insufficient hand in conducting the required tests for plumbing, and sanitary works to test for leakages and clogging. Table 4 also shows the rank of weakness of inspection rule to 0.551. This implies that there is relatively strong inspection rule in existence but it appears the early damage of the building could also be traced to poor material quality or lack of inspection program.

Table 4 : Rank and RII of Factors Related to Defects Due to Lack of Inspection

Factors	UNRWA Engineers		Maintenance Contractors		All Respondents	
	RII	Rank	RII	Rank	RII	Rank
Insufficient testing procedures during preliminary of water feeding and sewerage	0.861	1	0.831	2	0.848	1
Lack of periodic inspection and monitoring	0.833	2	0.846	1	0.839	2
Ignore of owner monitoring and checking importance	0.772	3	0.669	3	0.728	3
Lack of experience and qualification of inspector	0.533	4	0.662	4	0.589	4
Weakness of inspection rule in implementing corrective actions.	0.528	5	0.581	5	0.551	5
All factors	0.706		0.717		0.711	

Adequate inspection and quality control in testing - such as the pressure tests and hydrostatic pressures - and validation of the feedback could minimize the emergence of such defects in the school buildings. This finding agreed with Al-Farra (2011), who emphasized that this factor is an important factor in the prevention of untimely defect in building. Assaf et al. (1996) and Buys and Roux (2014) also emphasized that this factor is an important factor that culminate against early deterioration in building and it could reduce the cost of building maintenance.

Factors Related to Defects/Errors Due to Contract Administration

Table 5 shows the opinion of respondents about the factors related to defects/errors due to contractor administration and his staff in construction stage according to relative importance index ranked from high to low.

Table 5: Rank and RII of Factors Related to Defects Due to Contractor Administration and his Staff

Factors	UNRWA Engineers		Maintenance Contractors		All Respondents	
	RII	Rank	RII	Rank	RII	Rank
Contract awarding on lowest bidders price	0.906	1	0.882	1	0.896	1
Accelerate in execution to avoid delay and lack of quality	0.850	2	0.846	2	0.848	2
Overlapping of finishing works quickly without giving every activity is suitable duration depending on engineering standards.	0.700	3	0.831	3	0.756	3
Lake of workers experience and bad workmanship	0.678	4	0.588	7	0.639	4
Lack of efficiency and expertise of contractor engineers	0.656	5	0.574	8	0.620	5
Non-compliance with specifications	0.617	6	0.618	6	0.617	6
The contractor engineer not resident fully in the site	0.572	7	0.662	4	0.611	7
Lack of communication between the designer and owner	0.528	8	0.632	5	0.573	8
All factors	0.688		0.704		0.695	

From Table 5, it could be seen that awarding the contract to the lowest bidder has been identified as the cause of the poor workmanship that led to early structural depreciation with the RII of 0.896 which directly followed by speedy execution at expense of quality. This suggests communication among the team was relatively effective while the

accommodation of construction engineers does not significant affect the untimely building deterioration. This also emphasizes that, contractor selection by lowest price is the most important factor responsible for defects/errors due to poor contractor administration and low quality of staff during the construction stage. On the other hand, it is shown that, accelerating project execution to avoid delay and lack of quality" was ranked second by all respondents with RII of (0.848). This means the selected contractors tend to do the job with rented tools or equipment quickly to reduce the rental time. In addition, they always tend to select inferior materials to save money.

Finally, it is shown that, “Lack of communication between the designer and owner" was ranked last by all respondents with RII of (0.573) while the responded UNRWA Engineers and the responding maintenance contractors ranked this factor as 0.528, and 0.632, respectively. This means there is a good communication between maintenance contractors and UNRWA Engineers (design and maintenance engineers) for understanding of specification and consultation, where the dependency on experience alone cause a lot of maintenance defects. The obtained results disagreed with Hoe (2009) who found that, this factor was in the first position in this group.

Factors Related to Defects/Errors Due to Architectural and Structural Construction (Group3)

Table 5 shows the opinion of respondents about the factors related to defects/errors due to architectural and structural issues in construction stage according to relative importance index ranked from high to low.

Table 5: Rank and RII of Factors Related to Defects Due Architectural /Structural Construction

Factors	UNRWA Engineers		Maintenance Contractors		All Respondents	
	RII	Rank	RII	Rank	RII	Rank
The damage due to the multi-use of formwork in the construction industry	0.839	1	0.889	1	0.861	1
Implementation of internal and external paint improperly	0.833	2	0.846	2	0.839	2
Inadequate insulation against water and sanitary works	0.689	3	0.735	3	0.709	3
Inadequate curing the casted parts well	0.550	5	0.647	4	0.592	4
Weakness and lack of homogeneity of concrete mix component or lack of compliance with the specifications components	0.539	6	0.639	5	0.582	5
Remove framework of concrete early before the allowed time	0.567	4	0.581	8	0.573	6
Lack of sufficient vibration	0.522	7	0.581	7	0.548	7
Weakness contiguity and coherence between materials (syrups)	0.489	9	0.581	9	0.529	8
Excavations with mechanical excavations tools near the existing building	0.467	12	0.603	6	0.525	9
Inadequate concrete cover for reinforced concrete	0.500	8	0.552	12	0.522	10
Lake of soil compaction	0.483	11	0.566	10	0.519	11
Cold spacers between the new and old concrete	0.483	10	0.559	11	0.516	12
Inaccuracy of dimensions and measurement	0.450	13	0.463	13	0.456	13
All factors	0.570		0.634		0.598	

As notice in Table 5, it is shown that, "The damage due to the multi-use of formwork in the construction industry” was ranked in the first position by all respondents with RII of (0.861). Each of them (UNRWA Engineers and Maintenance contractor) separately ranked first position with RII 0.839 and 0.889, respectively. This means that despite the good quality of concrete, the bad formwork is agreed to be responsible for the poor concreting, cracks or honeycomb formation, early corrosion initiation, and geometry distortion. Poor concreting could result from loss of water required for concrete

hydration and strength development. Hoe (2009) emphasized that this factor is an important factor related to defects due to structural and architectural construction.

On the other hand, “implementation of internal and external paint improperly" was ranked in the second position by all respondents with RII of (0.839). The failed painting could be adduced the quality of its substrate. Improper concreting resulted from poor formwork could be the reason while the failure in painting gained the second importance in defect ranking. Paints are chemical products, so moisture could easily affect its chemistry. Sometimes, painting may become a major maintenance item if it is of inferior quality or applied on a not well-prepared substrate. There are many causes of peeling of external paint in UNRWA school, among them were: bad quality of materials due to closure of Palestinian borders, fraud in painting, painting in humid weather, and dampness or water leakage which necessitate complete peel off of the original paint. Obtained results agreed with Hoe (2009) and who found that, this factor was in the third position in the group related to defects due to structural and architectural construction. Al- Farra (2011) emphasized that this factor is an important factor related to structural and architectural defects.

Besides, "Inadequate insulation against water and sanitary works" was ranked in the third position by all respondents with RII of (0.709). Each of the groups, UNRWA Engineers and Maintenance contractor, separately ranked it third position with RII of 0.689 and 0.735, respectively. This means that there are many water seepage problems, especially in the bathroom area in UNRWA schools, where water leaks from the above level to the level below. This resulted from poor workmanship from insufficient treatment and insulation of water supply system. This leads to initiation of corrosion in steel pipes and joint, that resulted in water leakages and dampness problems. Due to shoddy water proofing works by contractors and insufficient supervision in conducting the necessary tests and inspections for plumbing works, the problem became aggravated. Waterproofing and drainage are two of the items where contractors displayed their lack of adequate experience. The results obtained agreed with Hoe (2009) who ranked this problem as first in the causes of structural and architectural building failure. Al- Farra (2011) and Assaf et al. (1996) also emphasized that this factor is an important as regards building - structural and architectural - construction. Since leakage of water in piping further worsening the concrete performance, hence the failure of paint that lies over the concrete substrate is expected to be worse.

Finally, it is shown that, "Inaccuracy of dimensions and measurement" was ranked in the last position by all respondents with RII of (0.456). This implies that inaccurate measurement is not an important factor that could significantly affect building health. However, inappropriate sizes of building element could hamper its functionality and occupant convenience.

Factors Related to Defects/Errors Due to Construction Equipment

Table 6 was tabulated from five (5) factors related to defects/errors due to construction equipment in construction stage ranked from high to low.

Table 6: Rank and RII of Factors Related to Defects Due Construction Equipment

Factors	UNRWA Engineers		Maintenance Contractors		All Respondents	
	RII	Rank	RII	Rank	RII	Rank
The negligence of the periodic maintenance of the equipment	0.706	1	0.728	1	0.715	1
The lack of the required spare parts elements of the equipment	0.611	2	0.625	2	0.617	2

Factors	UNRWA Engineers		Maintenance Contractors		All Respondents	
	RII	Rank	RII	Rank	RII	Rank
Not taking into mind the availability of the equipment used in the maintenance in the local market during implementing	0.522	3	0.515	4	0.519	3
Inadequate quality performance and quantity of the equipment	0.450	4	0.522	3	0.481	4
Misuse of equipment	0.439	5	0.427	5	0.434	5
All factors	0.546		0.563		0.553	

"The negligence of the periodic maintenance of the equipment" was ranked by all respondents in the first position with RII of (0.715). This emphasizes that; this is the most important factor of defects/errors used by all respondents which affecting on maintenance of UNRWA schools in the construction stage. Periodical inspection, servicing and replacement of wearing parts lead to prevent sudden failure and increase the period of service for maintenance equipment.

On the other hand, it is shown that, “The lack of the required spare parts elements of the equipment " was ranked in the second position by all respondents with RII of (0.617). This means the use of poor quality spare parts will necessitate re-work additional maintenance and incessant part replacement. Having a well-maintained and appropriate equipment will help in performing the job properly. Therefore, inspecting equipment as a condition for prequalification prior to the contractor selection will mitigate this problem.

Finally, it is shown that, "Misuse of equipment” was ranked in the last position by all respondents with RII of (0.434). Each of them separately ranked it in the last position with RII of (0.439) and (0.427) respectively. This means there is enough expertise in equipment handling on the project but the main problem is lack of using the right equipment for right jobs.

Factors Related to Defects/Errors Due to Construction Material (Group5)

Table 7 shows the opinion of respondents about the factors related to defects/errors due to materials of construction according to relative importance index ranked from high to low.

Table 7: Rank and RII of factors related to defects due construction materials

Factors	UNRWA Engineers		Maintenance Contractors		All Respondents	
	RII	Rank	RII	Rank	RII	Rank
Choice of substandard materials that have a poor quality of specifications	0.767	1	0.728	1	0.750	1
Selection of material that is unsuitable for existing climatic conditions	0.761	2	0.625	2	0.703	2
Selection of cheap finishing materials price due to lack of fund	0.594	3	0.566	4	0.582	3
Ignore determine the time and duration of storage and handling of materials and choosing the appropriate places	0.578	4	0.544	7	0.563	4
Ignore the basic physical and chemical properties of materials	0.556	5	0.566	5	0.560	5
use of non-durable materials (which does not stand up)	0.528	6	0.581	3	0.551	6
The use of new materials are not known and did not examine the details of their quality in construction before in the local market	0.472	8	0.544	6	0.503	7
Use expired material	0.506	7	0.441	8	0.478	8
All factors	0.595		0.574		0.586	

As notice in Table 7, it is shown that, “Choice of substandard materials that have a poor quality of specifications" was ranked in the first position by all respondents with RII of (0.750). The shortage of project materials is one of the clearest factors causes cost overrun and delay of project. The political and economic situations affected the availability of the materials required because major borders are under strict military control in Gaza. This shortage of materials and equipment's resulted in increase of its price and hence increasing project cost. According to Palestinian contractors union, the contractors were suggested to use local materials and products in their construction projects to avoid any delay and cost overrun. So, it's important to use suitable materials produced locally after passing all required tests where are cheap and easy to get at any time.

On the other hand, it is shown that, “Selection of material that is unsuitable for existing climatic conditions" was ranked in the second position by all respondents with RII of (0.703). This means the designer should always select the color and type of a building’s exterior finishing material to suit the weather and environmental conditions of the building, e.g. not painting buildings with dark colors in a dusty area where they require a lot of cleaning, or using paints which cannot resist heat and humidity. Obtained results agreed with Hoe (2009) and Assaf et al.(1996).

Finally, it is shown that, "Use expired material" was ranked in the last position by all respondents with RII of (0.478). Also, the responding maintenance contractors ranked this factor in the last position with RII of (0.441), while the UNRWA Engineers ranked it in the seventh position with RII of (0.506). This means ignoring of this factors because, use of expired material at the construction stage will require the owner to replace it in short time after the building is in operation.

Comparison between all Groups of Factors Leading to Errors / Defects in Constriction Stage

Table 7 shows the opinions of the respondents about the groups of factors leading to errors/defects in construction stage according to relative index from high to low.

Table 7: Rank and RII of Groups Related to Defects / Errors in Construction Stage

Factors	UNRWA Engineers		Maintenance contractors		All respondents	
	RII	Rank	RII	Rank	RII	Rank
Factors related to defects/errors due to lack of periodic checking and monitoring of construction	0.706	1	0.717	1	0.711	1
Factors related to defects/errors due to contractor administration and his staff	0.688	2	0.704	2	0.695	2
Factors related to defects/errors due to architectural and structural construction	0.570	4	0.634	3	0.598	3
Factors related to defects/errors due to construction material	0.595	3	0.574	4	0.586	4
Factors related to defects/errors due to construction equipment	0.546	5	0.563	5	0.553	5
All factors	0.614		0.639		0.624	

“Factors related to defects/errors due to lack of periodic checking and monitoring of construction "was ranked in the first position by all respondents with RII of (0.711). This emphasizes that, this is the most important group used by all respondents which affecting maintenance of UNRWA schools building in construction stage. Because, when the construction inspection increases, the quality increases. Therefore, the maintenance needed is reduced.

On the other hand, it is shown that, “factors related to defects/errors due to contractor administration and his staff

" was ranked in the second position by all respondents with RII of (0.695). This emphasizes that, this is the most important group used by all respondents which affecting maintenance of UNRWA schools building in construction stage.

Finally, it is shown that, "factors related to defects/errors due to construction equipment" was ranked in the last position by all respondents with RII of (0.553). This implies that this group is thought to have little effect on UNRWA schools buildings.

CONCLUSIONS

In this study, thirty nine (39) factors which leading to defects/errors in construction stage were identified. Contract awarding to the lowest bidders is one of the most important factor that caused the defects/errors in construction, the second important factor is the use of materials of low quality especially the formwork and acceleration of pace of construction at the expense of quality control for safety and structural requirements. Quality of employee and quality control programs should be made as prequalification for the potential contraction for school building construction and maintenance. The quality was found to be compromised in the testing procedures during preliminary of water feeding, materials utilization in the sewerage networks, concreting with old formwork, leakages in piping network and painting of the structures. Since leakage of water in piping further worsening the concrete performance, the failure of paint that lies over the concrete substrate is expected to be worse. The data management database should also be created for UNRWA building projects in Gaza for adequate references for the future similar project to gain lesson learned or benchmarking advantages.

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