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An Assessment of the Impacts of Construction Projects on the Environment in the Gaza Strip

Ehsan Y. Rizqa[1] Sari W. Abusharar[2*]
1. Design and Supervision Department, Ministry of Education and High Education, Gaza, Palestine
2. College of Applied Engineering and Urban Planning, University of Palestine, PO Box 1075, Gaza, Palestine
* E-mail of the corresponding author: s.abusharar@hotmail.com

Abstract
The aim of this study is to assess the most common impacts of construction projects on the environment in the Gaza Strip and propose the best solutions in curbing down the adverse impacts. To achieve this aim, a structured survey, in the form of a questionnaire was conducted to identify the most critical and important impacts of construction projects on the environment. Environmental impacts were categorized into three safeguard subjects: ecosystems, natural resources, and public impacts. The results showed that dust generation, noise pollution, operations with vegetation removal, and air pollution are the most significant environmental impacts of construction sites in the Gaza Strip. In addition, the public impacts are the most important category that affects the environment in the Gaza Strip. Furthermore, the results demonstrated that the necessity of taking measures to protect labors and residents who are living near to construction sites. It is recommended to enhance the knowledge and awareness of construction participants to the environmental impacts of construction projects and enact strict laws to curb down the adverse impacts of construction projects. In addition, the researchers should look for alternative methods for construction to mitigate the adverse impacts of construction projects on the environment. The results of this study can help decision makers to identify major construction impacts on the environment and make environmentally friendly construction plans in the early stages of construction.
Keywords: Environment, Construction projects, EIA, Gaza Strip

1. Introduction

The environment is threatened severely by so many problems, some of which are caused by the activities of construction projects (Ijigah et al., 2013). Construction is not an environmentally friendly process by nature (Li et al., 2010). A research undertaken by Levin (1997) indicated that building construction and operations have a massive direct and indirect effect on the environment. Ijiga et al. (2013) stated that identify the impacts of construction project on the environment is a task that needs to be accomplished to realize an effective environmental. Shen et al. (2005) claimed that construction is a main source of environmental pollution, compared with other industries.

Li et al. (2010) agreed with Shen (2005) and maintained that any typical construction process involves the use of various construction equipments and natural resources and generates many pollutants. Ijigah et al. (2013) revealed major environmental impacts of building construction projects to include environmental pollution, resource depletion and habitat destruction causing destruction of ecosystem, desertification, soil erosion, and increasing material wastage. Several researchers summarized these pollutants as noise, air pollution, solid and liquid waste, water pollution, harmful gases, and dust (Morledge and Jackson, 2001; Ball, 2002; Chen et al., 2004; Zolfagharian et al., 2012). Furthermore construction projects have become one of the driving forces for the national economy, whose energy consumption, environmental emissions, and social impacts are significant (Chang et al., 2011).

This issue has preoccupied many researchers and prompted many construction participants to attempt to control the impacts of their activities by adopting environmental management systems (Lam et al., 2011). In line with the promotion of sustainable construction in the past decade, construction professionals have been contributing efforts in protecting the environment in implementing construction activities (Shen et al, 2005). Unfortunately developing countries are suffering from limited scientific data regarding the impacts of building materials and technologies on the environment and it is difficult to make informed choices aiming at reducing such impacts (Pittet and Kotak, 2009). It has been reported that very few contractors and private developers spend efforts in considering the environment and developing the concept of recycling building materials, because most of them rank completion time as their top priority and pay little attention to the environment (Lam, 1997; Poon et al., 2001). Anyway, a number of researches have shown that the impacts on the environment caused by construction activities are serious and need to be controlled.

Zolfagharian et al. (2012) studied this issue and concluded that the level of knowledge and awareness of project participants, especially project managers, to environmental impacts of construction processes needs to be enhanced (Zolfagharian et al., 2012). Gangolells et al. (2011) agreed with Zolfagharian et al. (2012) that enhancing the identification of the major environmental impacts of construction processes will help to improve the effectiveness of environmental management systems; furthermore Gangolells et al. (2011) stated that determination of major environmental impacts will assist to consider a range of on-site measures in order to mitigate those impacts.

Ijigah et al. (2013) suggested that in order to reduce environmental degradation, building construction stakeholders must adopt fully environmental impact assessment document and other regulations relevant for environmental protection. Also, all

environmental regulatory agencies and sensitization organizations should continuously sensitize the building construction public on requisite environmental management practice and sanction erring agents. Enhancing the identification of the major environmental impacts of construction processes will help to improve the effectiveness of environmental management systems. Furthermore, prediction of the correlated environmental impacts of construction before the construction stage, will lead to improve in the environmental performance of construction projects and sites. The determination of major environmental impacts will assist to consider a range of on-site measures in order to mitigate those impacts (Gangolells et al., 2011). This study aims to identify most frequent impacts of construction on the environment in the Gaza Strip and to propose the best solutions in curbing down these adverse impacts.

2. The Gaza Strip situation

The Gaza Strip is a very narrow and highly populated area along the coast of the Mediterranean Sea (Al-Agha, 1995). It is approximately 41 kilometers long, and between 6 and 12 kilometers wide, with a total area of 378 square kilometers. The current population is estimated to be 1,760,037 (PCBS, 2014).

The Gaza Strip is suffering from a weak and deteriorating ecosystem because of the very limited natural resources, deteriorating economic situation, and escalating population growth. In addition the Gaza Strip has been a theatre of conflict for decades which resulted in massive destruction of homes, livelihoods and infrastructure. The United Nation Environment Programme concluded that the war increased the pressure on environmental facilities and institutions in the Gaza Strip and summarized two of the most important. The United Nation Environment Programme (2009, p6) stated that:

"Two of the most striking examples are the significant volume of demolition debris that was generated and the serious damage done to the sewage system. Other adverse environmental impacts include the widespread destruction of agricultural areas, damage to smaller industrial enterprises and an increase in pollution discharged into the Mediterranean and into the groundwater".

The Gaza Strip witnesses widespread construction projects which cause a lot of problems and generated several pollutants. A research undertaken by Al-Agha (1997) discussed some of the impacts which hardly affected the environment; the impacts included noise pollution, air pollution, groundwater pollution, soil salinization and possible radioactive hazards. Enshassi (2000) stated that there is a massive need to take into account these pollutants and develop a green ethic which may upgrade the donors and developers intellectual to plan a project in an environmentally friendly way. In addition, there is a necessity of monitoring the environmental situation in the Gaza Strip and making environmental assessment. The experience with environmental assessment in the Gaza Strip demonstrates that construction projects have least impact on the environment if the assessment occurred in the early stages.

3. Impacts of construction on the environment

A typical construction process involves the use of various construction equipment and natural resources and generates many pollutants (Li et al., 2010). Identification of possible impacts of building construction projects on the environment is a task that needs to be accomplished for the realization of more effective environmental management (Ijigah et al., 2013). Quantitative assessment of the environmental impact of construction activities can help decision makers identify major environmental impact factors and make environmentally friendly construction plans in the early stages of construction (Li et al., 2010).

Any development project plans to improve the quality of life has some built-in positive and negative impacts. The development project should, thus, be planned in such a manner that it has maximum positive impacts and minimum negative impacts on the environment (Kaur and Arora, 2012). Prediction of the environmental impacts of construction in the early stages of projects, may lead to improvements in the environmental performance of construction projects and sites (Gangolells et al., 2011). A study by Dietz et al. (2001) showed that environmental impact can be gauged in the risk to human and ecological health as well as in the subtle but horrifying altering course of nature. This risks includes the dangers and changes to the quality of life that are determined by physical, chemical, biological and psycho-social factors which in turn shows how far the damage has been carried out.

It is expected that construction damages the fragile environment because of adverse impacts of construction, those impacts include resource depletion, biological diversity losses due to raw material extraction, landfill problems due to waste generation, lower worker productivity, adverse human health due to poor indoor air quality, global warming, acid rain, and smog due to emissions generated by building product manufacture and transport that consumes energy (Lippiatt, 1999). Environmental impacts are categorized into three safeguard subjects: ecosystems impacts, natural resources impacts and public impacts (Li et al., 2010; Chang et al., 2011; Zolfagharian et al., 2012).

3.1 Ecosystems impacts

In light of a large number of ongoing construction projects, the ecosystems impact of construction has become an important issue (Zolfagharian et al., 2012). Those adverse environmental impacts include waste, noise, dust, solid wastes, toxic generation, air pollution, water pollution, bad odor, climate change, land use, operation with vegetation, and hazardous emissions.

3.1.1 Air emissions

Air emissions are generated from vehicular exhaust and dust during construction (Kaur and Arors, 2012). This emissions

include Co_2, No_2, and So_2 (Kaur and Arors, 2012; Li et al., 2010; Pittet and Kotak, 2012).

3.1.2 Noise emissions

Noise emissions are generated from various construction equipments, air compressors, D.G. sets, and vehicles. The construction equipments and other sources will generate noise within the range of 70 to 120 dB within the vicinity of construction site (Kaur and Arors, 2012).

3.1.3 Wastes

Wastes are generated from construction activities, labors camps, sewage treatment plant, and other sources. The solid wastes generated during operational phase are categorized as biodegradable, recyclable, inert/ recyclable and hazardous. Out of the total wastes generated, 50% of the wastes would be biodegradable, 20% of the wastes would be recyclable, 30% would be inert and it is assumed that a small quantity, 0.3% of the wastes would be hazardous wastes (Kaur and Arora, 2012).

3.1.4 Waste water

Waste water is generated from construction activities, sewage, commercial activities, and other sources (Kaur and Arora, 2012).

3.2 Natural resources

Various natural resources are used during any typical construction process; these resources include energy, land, materials, and water (Shen et al., 2005). In addition, construction equipment operations consume a lot of natural resources, such as electricity and/or diesel fuel. Construction sector is responsible for consuming a high volume of natural resources and generation a high amount of pollution as a result of energy consumption during extraction and transportation of raw materials (Li et al., 2010; Morel et al., 2001). Construction sector generates worldwide substantial environmental impacts. It contributes to about half of the total energy consumption of high-income countries and is responsible of a major share of greenhouse gas emissions (Stern et al., 2006; Asif et al., 2007; Cole, 1999; Emmanuel, 2004). International studies have found that the construction industry contributes significantly to resource and environmental abuse. Some of the available statistics indicate that the construction and operation of the built environment accounts for 12-16% of fresh water consumption, 25% of wood harvested, 30-40% of energy consumption, 40% of virgin materials extracted, and 20-30% of greenhouse emissions (Macozoma, 2012).

3.3 Public impact

Most construction projects are located in a densely populated area. Thus, people who live at or close to construction sites are prone to harmful effects on their health because of dust, vibration, and noise due to certain construction activities such as excavation and pile driving (Li et al., 2010). During the construction phase of a project, construction dust and noise are regarded to be two major factors that affect human health (Tam et al., 2004). Li et al. (2010) and Zolfaghrian et al. (2012) conducted a research about environmental impacts of construction in United States of America; they categorized the environmental impact into three safeguard categories: ecosystems, natural resources, and public impacts. Li et al. (2010) used case study, and his results demonstrated that health damage accounts for 27% of the total impact, which is less than the ecosystem damage (65%), but far beyond the resource depletion (8%), which justifies the necessity of performing health damage assessment.

Zolfaghrian et al. (2012) conducted an interview with an expert panel group to determine the frequency and severity of the environmental impacts on the Malaysian construction industry. Results demonstrated that “transportation resources”, “noise pollution”, and “dust generation with construction machinery” are the most risky environmental impacts on construction sites. Among the three environmental impacts, “ecosystem impacts” has the greatest impact on the environment (67.5%) of the total impacts. “natural resources impact” accounts for 21% of the total impacts, while “Public impact” accounts for only 11.5% of the total impacts. The results of Li et al. (2010) and Zolfaghrian et al. (2012) are very similar. It is concluded that environmental impacts of construction are a serious and worldwide issue all over the world. In addition, it is very necessary to create systems to curb down the construction impact on the environment, and take the required measures to protect the ecosystem, human health, and natural resources.

4. Research methodology

A questionnaire was designed based on previous studies (Zolfagharian et al., 2012; Ijigah et al., 2013; Muhwezi et al., 2012; Li et al., 2010; Tam et al., 2006; Pittet and Kotak, 2012; Chang et al., 2011; Horvath, 2004; Kaur and Arora, 2012; Chen et al., 2000; Eras et al., 2013; Gangolells et al., 2011; Gangolells et al., 2009; Tam et al., 2004; Shen et al., 2005; Svensson et al., 2006). A set of 25 factors that affected the environment were identified. These 25 factors were further grouped under three major categories: ecosystem factors, natural resources factors, and public factors. Five-point Likert scale was used in this questionnaire (1 = very low effect, 2 = low effect, 3 = neutral effect, 4 = strong effect, and 5 = very strong effect). Likert scale was chosen in order to expand the way the respondents would reply. The target population of the study comprised of: governmental institutions, private institutions and international institutions. A total of 50 questionnaires were distributed to selected respondents and 40 were retrieved which were used for the analysis giving a response rate of 80%. Respondents were selected based on their level of education and experience in the construction field. The following formula was used to

determine the sample size (Ayyub and Mccuen, 2003).

$$SS = \frac{Z^2 \times P \times (1-P)}{C^2} \quad (1)$$

where: SS = Sample size

Z = Z value (e.g. 1.96 for 95% confidence level)

P = Degree of variance between the elements of population percentage

C = Confidence interval (margin of error), expressed as decimal (e.g., .05 = ±5)

Correction for the finite population can be determined as

$$SS_{correct} = \frac{SS}{1+\frac{(SS-1)}{N}} \quad (2)$$

Content validity test was conducted by sending the questionnaire to three experts in construction to evaluate the questionnaire validity, clarity, comprehensive, readability and reliability and to add more information or delete unacceptable wording if needed. They presented their opinions and comments about content of questionnaire, the degree to which questionnaire paragraphs are relevant to their groups, and lingual clarity of words. In this regard, few paragraphs have been dropped while others have been altered. Two statistical methods were used to analyze the data which obtained from the questionnaires. The first was to obtain percentage values through frequencies of the answers received. The other was to calculate a Relative Importance Index (RII). According to Tam et al. (2000) the RII was evaluated using the following expression.

$$\mathrm{RII} = \frac{\sum \mathrm{w}}{\mathrm{A}*\mathrm{N}} \quad (3)$$

where w is the weighting given to each factor by the respondent, ranging from 1 to 5; '1' is the least strong effect and '5" is the extremely strong effect, A is the highest weight; in this study it is 5; and N is the total number of samples. The RII shall be a variable ranging from 0 to 1.

5. Results and discussion

Table 1 shows the response rates of the target population of the study. The response rates of governmental institutions, private institutions, and international institutions are 90%, 82.3%, and 61.5% respectively.

Table 1. Response rate of questionnaire survey

Institution description	Distributed	Received	Response rate (%)
Governmental	20	18	90
Private	17	14	82.3
International	13	8	61.5
Total	50	40	80

Table 2 shows institution profile of the study sample. As shown in Table 2, the majority of works types (55%) are buildings. The majority of institutions (75%) have experience more than 5 years. Only 42.5% of the institutions haven't any permanent engineers working in the environmental impact assessment (EIA). The majority of institutions (75%) execute more than 10 projects in the last 5 years.

Table 2. Institution profile

Item	Category	Frequency	Percentage
Types of works	Buildings	22	55
	Roads	10	25
	water and sewer	8	20
	Another	0	0
Experience of the institution	Less than 5 years	10	25
	From 5 years – 15 years	16	40
	From 16 years – 25 years	9	22.5
	Over 25 years	5	12.5
Number of permanent engineers in the EIA team	Less than 5	15	37.5
	More than 5	8	20
	No one	17	42.5
Number of executed projects in the last 5 years	Less than10 projects	10	25
	From 11 – 20 project	10	25
	From 21 – 30 projects	8	20
	More than30 years	12	30

Table 3 shows the respondents profile of the study sample. As shown in Table 3, the majority of respondents (62.5%) work as site/office engineer. The results showed that 60%, 24.5%, and 12.5% of the respondents have P.A, Master, and Ph.D. degree respectively. The majority of the respondents (75%) have experience more than 5 years.

Table 4 shows the results of the awareness level of institutions to the environmental impacts of construction issue. As shown in Table 4, more than half (52.5%) don't take into account the adverse impacts of construction on the environment. The majority of institutions (72.5%) don't have an environmental impact assessment system. This means that the awareness of institution to the environmental impacts of construction needs to be enhanced. However 42.5% of them attempt to find a proposal or a practice solution to mitigate the environmental impacts of construction. The majority of labors (62.5%) don't wear protective respirator masks; this means that they are exposing every day to construction pollutants, and breathe a lot of dust, gases emissions, and chemical pollutants. These pollutants may be a strong reason to deteriorate their health, and lead them to suffer from many diseases especially respiratory diseases. Also, results show that only 10% of labors and residents have been complained because of the impacts of construction on the environment. It can be interpret that peoples in the Gaza Strip deal with construction impacts as a fait accompli, and believe that there is no strict laws to prevent or mitigate them.

Table 3. Respondents profile

Item	Category	Frequency	Percentage
Position of the respondent	Director	4	10
	Project manger	10	25
	Site/office engineer	25	62.50
	Engineer in the evaluation team	1	2.50
Educational qualifications	P.A	24	60
	Master	11	27.50
	Dr	5	12.50
Experience years	Less than 5 years	10	25
	From 5 years – 10 years	16	40
	From 11 years – 15 years	9	22.50
	More than 15 years	5	12.50

Table 4. Awareness level of institution to the environmental impacts of construction

Question	Response	Frequency	Percentage
Does your institution take into account the adverse impacts of construction on the environment?	Yes	15	37.5
	No	21	52.5
	Not Sure	4	10
Does your institution have an environmental impact assessment system?	Yes	8	20
	No	29	72.5
	Not Sure	3	7.5
Does your institution attempt to find a proposal or a practice solution to mitigate the environmental impacts of construction?	Yes	20	42.5
	No	17	50
	Not Sure	3	7.5
Have any labors or residents who are living beside the project ever harmed because of the impacts of construction on the environment?	Yes	16	40
	No	21	52.5
	Not Sure	3	7.5
Do labors wear a protective respirator masks?	Yes	11	27.5
	No	25	62.5
	Not Sure	4	10
Have any labors or residents ever complained because of the impacts of construction on the environment (noise-solid waste-dust)?	Yes	4	10
	No	29	72.5
	Not Sure	7	17.5

Table 5 shows the results of the environmental situation in the Gaza Strip. The results show that the majority of respondents (60%) have been suffered personally from the adverse impacts of construction on the environment. This means that the situation in the Gaza Strip is very serious and need to be controlled. The majority of respondents (72.5%) also mentioned that the war contributes to the environmental pollution. It can be interpret by the Israel attack to Gaza by land, air, and water through the latest war on Gaza. The potential consequence of this war irrespective of casualties is the substantial pollution of water, air, and soil. Moreover the war left a lot of demolished houses and institution which cause a lot of wastes and generate several hazard emissions.

The results also show that 27.5% of respondents live close to some demolished houses which have been damaged through the latest war on Gaza. An open ended questions show that the wastes of this demolished houses remained 1-4 months before it removed. This period considered as a very long period, and this means that the residents of these houses exposed to a large amount of hazard emissions, which may causes to them many health problems and diseases like cancer.

Table 5. Environmental situation of the Gaza Strip

Question	Response	Frequency	Percentage
Have you ever suffered personally from the adverse impacts of construction on the environment (noise-dust-pollution)?	Yes	24	60
	No	12	30
	Not Sure	4	10
Are you living closed to any demolished houses which have been damaged through the war on Gaza?	Yes	11	27.5
	No	27	67.5
	Not Sure	2	5
Did the war contribute the environmental pollution (water-air-soil)?	Yes	29	72.5
	No	9	22.5
	Not Sure	2	5
Have you ever suffered from any health problem because of your exposure to pollutants which generated from construction on the environment?	Yes	11	27.5
	No	29	72.5
	Not Sure	0	0

5.1 Ecosystem impacts

As shown in Table 6, the respondents ranked "dust generation" in the first position (RII= 0.865). This means that dust is the

most important impact that affects the environment in the Gaza Strip. It can be explained by divide the major causes of dust into three categories:

- Dust because of vehicles: vehicles entrance and exist to the site is very important task, which generate a large amount of pollutants. Transport materials to site of work cause a large amount of dust. Also vehicles wheels contain large amount of suspended materials such as dust, sand, clay, and cement. These dusts are suspended with air, soil and water. Furthermore vehicles transport this dusts out the site, this means that not only the labors will harm, but also the public.
- Dust because of construction activities: majority of construction activities causes an adverse effect on the environment, and generates a large amount of dust. These activities such as excavation, backfill, earthworks, bleaching, painting, tiling, mix of concrete, and finishing works.
- Dust because of construction materials: materials include cement, aggregate, sand, clay, lime, wood and calcium carbonate. Manufacture these materials caused a capture exposure to its emissions. This means that workers, managers in factories, and neighbors of these factories are the most injured people. Also labors who are working in the site and using these materials in their work are suffering from high exposure to the dust of these materials.

Table 6. Environmental impacts of construction

No	Environmental impact	Degree of effect					Total respond.	weight	RII	Rank	Rank in total
		5	4	3	2	1					
Ecosystems impacts											
1	Dust generation.	15	23	2	0	0	40	173	0.865	1	1
2	Noise pollution.	13	19	6	2	0	40	163	0.815	2	2
3	Operations with vegetation removal.	13	13	14	0	0	40	159	0.795	3	3
4	Air pollution.	7	24	9	0	0	40	158	0.790	4	4
5	Land pollution	2	24	13	1	0	40	147	0.735	5	9
6	Gas emissions due to construction machinery and vehicle movements.	11	11	11	7	0	40	146	0.730	6	10
7	Breakage of underground pipes (electric power cables, telephone lines, water pipes,…etc.)	10	11	13	6	0	40	145	0.725	7	11
8	Water pollution.	6	19	8	7	0	40	144	0.720	8	12
9	Landscape alteration.	8	11	16	5	0	40	142	0.710	9	15
10	Airborne suspended particles.	6	13	16	5	0	40	140	0.700	10	17
Natural resources impacts											
11	Raw materials consumption.	10	16	14	0	0	40	156	0.780	1	7
12	Increase in external road traffic due to construction site transport.	8	17	13	2	0	40	151	0.755	2	8
13	Energy consumption.	3	19	16	2	0	40	143	0.715	3	13
14	Resource deterioration	5	17	13	5	0	40	142	0.710	4	16
15	Substantial consumption of both renewable and non renewable resources.	5	14	16	5	0	40	139	0.695	5	19
16	Use of water resources.	2	19	13	6	0	40	137	0.685	6	20
17	Ground water pollution.	14	3	11	10	2	40	137	0.685	7	21
18	Electricity consumption.	3	11	24	2	0	40	135	0.675	8	23
19	Transportation resources.	3	13	19	5	0	40	134	0.670	9	24
20	Extraction of raw materials.	2	15	11	12	0	40	127	0.635	10	25
Public impacts											
21	Social disruption.	8	22	10	0	0	40	158	0.790	1	5
22	Site hygiene condition.	14	11	13	2	0	40	157	0.785	2	6
23	Public health effects.	8	10	19	3	0	40	143	0.715	3	14
24	Casualities.	6	17	10	5	2	40	140	0.700	4	18
25	Public Safety.	0	24	11	3	2	40	137	0.685	5	22

The above categories means that dust generation is considered as part and parcel during construction process. There is a lot of people exposing and breathing dust every day regardless they are labors, residents, or those who are using roads near to construction sites. Also there is a dust generated from Israeli demolition to homes and infrastructure in the Gaza Strip. Respondents in Gaza believe that this pollutant is very dangerous, serious, and have an adverse effect on public health and environment. The risk of exposure to dust regardless to its cause (from vehicles, construction activities, construction materials manufacture or delivery) is because dust create health problems, particularly for those with respiratory problems, cause environmental degradation, including air, soil and water pollution, obscures vision, damage or dirty property and belongings, and create unsafe working conditions.

Baby et al. (2008) as cited by Singh (2011) demonstrates that cement dust contains heavy metals like nickel, cobalt, lead, and chromium, pollutants hazardous to the biotic environment, with adverse impact for vegetation, human and animal health and ecosystems. Several studies have demonstrated linkages between cement dust exposure, chronic impairment of lung function and respiratory symptoms in human population. Cement dust irritates the skin, the mucous membrane of the eyes and the respiratory system. Its deposition in the respiratory tract causes a basic reaction leading to increased pH values that irritates the exposed mucous membranes (Zeleke et al., 2010).Occupational cement dust exposure has been associated with an increased risk of liver abnormalities, pulmonary disorders, and carcinogenesis. Decreased antioxidant capacity and increased plasma lipid peroxidation have been posed as possible causal mechanisms of disease (Aydin et al., 2010).

Ijigah et al. (2013) conducted their research in Nigeria, and found that "Dust Generation" is ranked in 11th position with RII equals 0.752, and "destruction of vegetation" is ranked in the 1st position with RII equals 0.841, these results reflect that construction participants in Nigeria take the necessary measures to mitigate dust effects on environment. Li et al. (2010) found that "dust generation" is ranked in the second position, and "steel use" is ranked in the first position. This result indicates that peoples in USA believed that dust is a very important impact that affects the environment. Also this result reflects the massive need to take measures to mitigate dust in USA. Zolfagharian et al. (2012) conducted their research in Malaysia, and found that "dust generation" is ranked in the 3rd position, and "transportation resources" is ranked in the 1st position. This result reflects the massive need to take measures to mitigate dust in Malaysia.

Also, the respondents stated that construction "noise" is in the second position with RII equals 0.815. The result can be due to the absence of strict laws to mitigate noise in the Gaza Strip. In addition Gaza is threat of conflict from decades, this means that people in this area are suffering from several causes of noise.

Regardless to Israeli aircraft, defenders, and gunboats noise, construction is a major reason of noise. It can be interpret by divide the major causes of noise into three categories:

1. Noise from vehicles movement (e.g., material transportation)
2. Noise from construction activities (e.g., excavation, backfill)
3. Noise from construction tools (e.g., concrete mixer, grinders)

Labors in the site are using tools such as: concrete mixer, concrete breakers, compactors, sanders, grinders and disc cutters, hammer drills, and chainsaws are the most people who are suffering from exposure to construction noise. Also residents who are living beside the sites of construction works and those who are using the roads near to sites are suffering from the noise of construction. That means that a lot of people are suffering every day from construction noise, in light of the widespread of construction process in the Gaza Strip.

People also believe that noise can cause hearing loss, which can be temporary or permanent, stress, annoyance, accidents if it makes it difficult for workers to communicate effectively or stops them hearing warning signals. Respondents say that construction noise can cause social disruption to them at their homes, works, and when they are trying to sleep. Construction noise has the potential to disturb people 24 hours a day, 7 days a week.

Noise health effects are the health consequences of elevated sound levels. Elevated workplace or other noise can cause hearing impairment, hypertension, ischemic heart disease, annoyance, and sleep disturbance. Changes in the immune system and birth defects have been attributed to noise exposure (Passchier-Vermeer and Passchier, 2000). Noise exposure also has been known to induce tinnitus, hypertension, vasoconstriction, and other cardiovascular adverse effects (WRUC, 2007).

Ijigah et al. (2013) conducted their research in Nigeria, and found that "noise pollution" is ranked in the 6th position with RII equals 0.794. This result reflects that construction participants in Nigeria take the necessary measures to mitigate dust effects on environment. Zolfagharian et al. (2012) conducted their research in Malaysia, and found that "noise pollution" is ranked in the 2rd position. This result reflects the massive need to take measures to mitigate construction noise in Malaysia.

5.2 Material resources impacts

As shown in Table 6, the respondents ranked "raw material consumption" in the first position in materials resource category with RII equals 0.78. This means that raw material consumption is one of the most important impacts that affect the

environment in the Gaza Strip. This finding can be interpret that construction process needs a lot of raw materials such as sand, gravel, clay, calcium carbonate, water, aggregate, wood, iron, bitumen, aluminum and fuel for vehicles. In light of the widespread of construction growing in the Gaza Strip, these raw materials are endangered by depletion. This means that the use of raw materials need to be controlled.

Zolfagharian et al. (2012) conducted a research about impacts of construction projects on environment in Malaysia, and found that "Raw Material Consumption" is ranked in the 7th position. This result indicates that construction participants in Malaysia controlled the use of raw materials in construction.

Also, the respondents stated that "increase in external road traffic due to construction site transport" is in the second position in material resource category with RII equals 0.755. The results can be due the high movement of construction vehicles which carrying construction materials, and transportation of construction tools and labors every day. This movements may affect the residents of this roads, and cause detriment to those people who are using this roads, by disrupt their interest, noise emissions, dust emissions, vehicles exhausts, traffic disruption and vibration.

5.3 Public impacts

As shown in Table 6, the respondents stated that “social disruption” is ranked in the first position in public effects category with RII equals 0.79. This result can be interpreted that construction works cause closure of roads and disrupt people’s interests. Construction transportation cause traffic disruption, because of the closure of roads which leading to the construction work sites, as well as due to the passage trucks which carrying construction materials. Also, respondents stated that construction noise and vibration which produced by construction activities and construction vehicles movement can cause social disruption to them at their homes, works, and when they are trying to sleep. Some of them said that Construction activities have the potential to disturb those 24 hours a day, 7 days a week.

Ijigah et al. (2013) and Zolfagharian et al. (2012) conducted their researches about impacts of construction projects on environment. Ijigah et al. (2013) conduct their research in Nigeria, and found that "social disruption" is ranked in 14th position with RII equals 0.711. This result reflects that construction participants in Nigeria take the necessary measures to mitigate construction social disruption. Zolfagharian et al. (2012) conducted their research in Malaysia, and found that "Social Disruption" is ranked in the 22nd position. This result reflects that construction participants in Malaysia take the necessary measures to mitigate construction social disruption.

Also, the respondents stated that a site hygiene conditions is ranked in the second position in public effects category with RII equals 0.785. This finding can be due to four points:

First construction activities produce a large amount of wastes which cause a filth site condition, second labors are exposing every day to these wastes, which contain a large amount of hazard emissions and cause a lot of diseases. This means that the construction sites suffering uncontrolled unhealthy conditions, third workers tools are always dirty, fourth workers breathe every day a large amount of dust, chemical pollutions, gas emissions, and vehicles exhausts. Furthermore they use pollutant water. This means that the construction sites suffering from dangerous and serious hygiene conditions which need to be controlled.

Zolfagharian et al. (2012) conducted a research about impacts of construction projects on environment, and found that "site hygiene conditions" is ranked in the 5th position. This result reflects the massive need to take measures to improve site hygiene conditions in Malaysia.

Li et al. (2010) and Zolfaghrian et al. (2012) categorized the environmental impact into three safeguard subjects: Ecosystems, natural resources, and public impacts. Li et al. (2010) conducted their research in United States of America; their results demonstrated that public impacts account for 27% of the total impacts. Ecosystem damage form 65% of the total impacts. Resource depletion form 8% of the total impacts .This means that developed countries like USA take the necessary measures to protect public health, and enacted strict laws to curb these effects down.

Zolfaghrian et al. (2012) conducted an interview with an expert panel group in Malaysia, to determine the frequency and severity of the environmental impacts in the Malaysian construction industry. Their results demonstrate that among the three environmental categories, Ecosystem impacts are ranked in the first position (67.5%) of total impacts. Natural resources impact forms 21% of the total impacts. Public Impact consists of only 11.5%. This means that Malaysia country has a high awareness regard to impacts of construction on public health, So it take the necessary measures to protect human health, and enacted strict laws to curb these effects down.

As shown in Table 6, "dust generation" is ranked in the first position (RII = 0.865). This finding can be due to severity and frequency of the effects of dust on environment, and because dust can be generated from several sources, such as construction activities, construction vehicles, and construction materials. In addition ,this results can be interpret that respondents believed that exposure to dust pollution may cause health problems, particularly for those with respiratory problems, cause

environmental degradation, including air, soil and water pollution, obscures vision, damage or owed dirty property and belongings, and create unsafe working conditions.

Results also showed that "noise pollution" is ranked in the second position (RII = 0.815). This results can be due noise pollution can be generated from several sources, such as construction vehicles, construction activities, and construction tools. Also, this results can be interpret that respondents believed that exposure to noise pollution may cause a lot of problems such as hearing loss, stress, hypertension, ischemic heart disease, annoyance, sleep disturbance annoyance, and accidents if it makes it difficult for workers to communicate effectively or stops them hearing warning signals. Respondents stated that construction noise can cause social disruption to them at their homes, works, and when they are trying to sleep. Construction noise has the potential to disturb people 24 hours a day, 7 days a week.

Ijigah et al. (2013), Li et al. (2010), and Zolfagharian et al. (2012) conducted researches about impacts of construction projects on environment. Ijigah et al. (2013) conducted their research in Nigeria, and found that "dust generation" is ranked in the 11st positions with RII equals 0.752, "destruction of vegetation" is ranked in the 1st position with RII equals 0.841, and "noise pollution" is ranked in the 6th position with RII equals 0.974. The results reflect that construction participants in Nigeria take the necessary measures to mitigate dust effects on environment. Li et al. (2010) conducted their research in USA, and found that "dust generation" is ranked in the second position, and "steel use" is ranked in the first position. The results indicated that peoples in USA believed that dust is a very important impact that affects the environment. Also this result reflects the massive need to take measures to mitigate dust in USA. Zolfagharian et al. (2012) conducted their research in Malaysia, and found that "Dust Generation" is ranked in the 3rd position, "noise pollution" is ranked in the 2nd position, and "Transportation Resources" is ranked in the 1st position.

Table 7 shows the results of proposed solutions to face the adverse impacts of construction projects on the environment. As shown in Table 8, "take the necessary measures to protect labors and residents who are living near to construction sites" is ranked in the first position with RII equals 0.93. This measures such as enact strict laws to enforce institutions to make environmental impact assessment (EIA) in the early stage of projects, and enhance the awareness of construction participants to the impacts of construction in the environment. Results also show that "search about alternative methods for construction to mitigate the adverse impacts of construction on the environment" is ranked in the second position with RII equals 0.825. The results interpret the massive need of enact laws and take a serious measure to protect the environment, and attempt to mitigate the adverse impacts of construction on labors and residents who are living close to construction sites.

Table 7. Proposed solutions to face the adverse impacts of construction on the environment

Question	Degree of approval					Tot. resp.	W	RII	Rank
	5	4	3	2	1				
Take the necessary measures to protect labors and residents who are living near to construction projects.	27	12	1	0	0	40	186	0.930	1
Search about alternative methods for construction to mitigate the adverse impacts of construction on the environment.	12	21	7	0	0	40	165	0.825	2
Search about alternative raw materials instead of concrete construction.	11	16	5	5	3	40	147	0.735	3
Accept these impacts as a fait accompli.	1	10	5	16	8	40	100	0.500	4
Ignore these affects.	1	3	0	19	17	40	72	0.360	5

6. Conclusions and recommendations

6.1 Conclusions

The results showed that construction sector has massive direct and indirect impacts on environment. The cumulative environmental impacts of construction processes have been increasing in the Gaza Strip due to a large number of ongoing construction projects. Based on the questionnaire results, the following conclusions can be drawn:

1. Results showed that "dust generation", "noise pollution", "operation with vegetation removal", "air pollution" have been ranked in the 1st, 2nd, 3rd, and 4th positions respectively. These results reflect the severity and frequency of these impacts on environment.
2. Results showed that "public impacts" is the most important category that affects the environment in the Gaza Strip.
3. Results showed that construction process has a massive effect on ecosystem, resources, and public health. Results also showed that labors and those who are working in construction sector are the most ones exposing every day to

health problems such as respiratory problems, liver, cancer, hearing impairment, hypertension, annoyance, sleep disturbance, and other cardiovascular adverse effects. Moreover construction impacts cause environmental degradation, including air, soil and water pollution, obscures vision, damage or dirty property and belonging and create unsafe working conditions. So there is a massive need to control these adverse impacts of construction, to protect human, environment, and resources.

4. Results showed that "take the necessary measures to protect labors and residents who are living near to construction sites" is ranked in the first position as a proposed solution to mitigate the environmental impacts of construction. This measure includes enacting strict laws to enforce institutions to make environmental impact assessment (EIA) in the early stage of projects, and enhancing the awareness of construction participants with regard to impacts of construction in the environment. Results also showed that "Search about alternative methods for construction to mitigate the adverse impacts of construction on the environment" is ranked in the second position with regard to proposed solutions to mitigate the environmental impacts of construction.

5. The results of this study can be very useful to enhance the awareness regarding the environmental impacts of construction. They can also help the decision makers to identify the major construction impacts on environment and make environmentally friendly construction plans in the early stages of construction. Moreover the results will be useful to architects, designers and builders in order to carefully design buildings and other infrastructure that are environmentally friendly and sustainable.

6.2 Recommendations

In order to contribute to reduce the adverse impacts of construction projects on the environment, the following recommendations should be considered:

1. The knowledge and awareness of construction participants with regard to environmental impacts of construction needs to be enhanced.
2. The decision makers, especially managers should take adequate measures to protect labors and residents who are living close to construction projects.
3. The government should enhance legislations to attempt curbing the adverse impacts of construction such as enforce institutions to make environmental impact assessment (EIA) in the early stage of the projects.
4. The researchers should look for alternative methods for construction to mitigate the adverse impacts of construction on the environment.
5. The government should enact strict laws to prevent establishing concrete materials factories in the urban cities, and oblige the involved people to establish it out of the cities.
6. The researchers should look for alternative friendly materials instead of concrete construction.
7. Because dust appears as the greatest critical impact that affects the environment, managers should issue their instructions for the contractors to use appropriate method to control dust by using one of the following techniques or a combination of them, such as using wet systems that use water sprays to prevent dust or capture airborne dust, enclosures to contain dust, and ventilation systems/exhaust systems to remove dust.
8. To reduce the amount of sediments transported onto paved roads by motor vehicles leaving a construction site, wheels of vehicles should be washed if they are carrying mud or debris.
9. The managers of the projects should oblige labors to wear protective respirator masks to protect themselves from breathing dust, gas emissions, and hazard materials.
10. The managers should make sure that the stockpiles of sand, aggregate, and other construction materials are exist for the shortest possible time.
11. People should re-vegetate green zones as possible as they can.

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