جامعة فلسطين
University of Palestine

# 1st International Conference on Engineering & Future Technology ICEFT 2018

University of Palestine

February 24-25, 2018
Faculty of Applied
Engineering & Urban Planning
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# Proceedings of the First International Conference on Engineering and Future Technology (ICEFT), 2018

**A Peer-Reviewed Scientific Conference**

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**The Seventh UP – Journal Volume**
**First Special Issue of ICEFT 2018**

**Conference Dates: February 24-25, 2018**
**Gaza- Palestine**

# Welcome Message from the Conference Chair

In the name of Allah, the most merciful, the most gracious All praise is due to Allah, and Allah's peace and blessings be upon his messenger.

The vision and strategic plans of the University of Palestine supports scientific research and the issues of concern to our society, region and the whole world. Based on this, the first international scientific conference is taking place now at the Faculty of Applied Engineering and Urban Planning at the University of Palestine, this conference is entitled "International Conference on Engineering and Future Technology – ICEFT 2018". This conference supports the University's continuous endeavor to achieve its pioneering vision, regionally and globally, and to emphasize the establishment of various scientific activities as outlined in its strategic plan and operational plans of the different faculties. the Faculty of Applied Engineering and Urban Planning, which organizes this scientific event, recognizes its responsibility towards achieving the University's vision, mission and goals and reflects its keenness to take care of the issues of interest to the community and its endeavor to be a pioneering faculty and an important platform for researchers.

Since the first moments of being appointed as the Dean of the Faculty of Engineering, me and my team have targeted to conduct this conferencebased on our belief in the importance of scientific research, because it is the most important channel that contributes to the development of our people and society. The need for scientific research is urgent because all countries of the world are racing to reach the precise and useful knowledge. The great nations are fully aware that they are great through the ability of individuals, their desire for knowledge, and excellence in thinking and achieving the best.

The target of the conference is to gather scientists, researchers and academicians to exchange experiences and benefit from the results of their scientific research in various engineering fields, in addition to meeting the scientific challenges facing them in different fields. The conference tackled several main topics, including: construction and materials engineering, architecture and urban planning, software engineering & information technology, infrastructure and environmental engineering.

The task of preparing for the conference was not easy. Furthermore, this achievement would not have been achieved without extensive efforts made by the members of the organizing committees. I therefore express my sincere appreciation to them. I am grateful to the speakers, the chairs of the sessions, the participating researchers and attendees who contributed to the success of this conference.

At the end of this brief speech, I would like to thank everyone who attended this conference or has done any small effort to make our dreams come true. The conference would not have been possible without them.

Peace and blessing and Allah’s mercy be upon you.

**Dr. Sari W. Abusharar**
**ICEFT 2018 Chair**
**Dean, Faculty of Applied Engineering and Urban Planning**
**University of Palestine**

# Message from the Scientific Committee Chair

In the name of God (Allah), the Most Gracious, the Most Merciful

All praise is due to Allah, the Lord of the universe, and peace and blessings of Allah be upon the best of all messengers, Prophet Muhammad (PBUH), his household and companions.

It gives me great pleasure to welcome you to the proceeding of the First International Conference on Engineering & Future Technology (ICEFT).

Firstly, I would like to thank everyone who attended and supported this conference. I especially want to express my gratitude to the members of the Scientific Committee and the Peer Reviewers for their guidance through this process, ideas and feedback. Sincere thanks are also extended to the Researchers who shared their expertise and knowledge. Warm thanks are due to the Scientific Research Deanship and the Organizing Committee, whose active participation and support make this conference possible.

'Thank you for all of your hard work making this conference a success'

The First International Conference on Engineering & Future Technology (ICEFT) was organized by the Faculty of the Applied Engineering and Urban Planning under the umbrella of the University of Palestine; which was supported by the Board of Directors, Board of Trustees and the Head of the University Board.

The First International Conference on Engineering & Future Technology (ICEFT) primary objective was to present, review, and discuss the current research issues and proposed solutions in engineering and technology. Yet, It had an ambitious vision of creating a network and possibly to strengthen cooperation with other professionals in the area. University of Palestine organized this interdisciplinary conference as a platform for exchange of views, ideas and help participants to keep up-to-date. The theme of the conference has given emphasis on Civil Engineering & Construction, Architecture and Urban Planning and Software Engineering to encourage researchers from the region to share their knowledge and building upon it.

The scientific committee for the ICEFT consisted of 18 members from different disciplines. The scientific committee adopted a two-stage review. Firstly, submitted papers were assigned for peer-review process. The results of this review process were then passed to the researchers as a feedback to improve the quality of their papers. A large number of papers were submitted by various researchers; meanwhile, 25 were approved through the review process. The researchers addressed a diversity of topics which was organized into five sessions and presented along the two days. The sessions were titles as: Geo-environmental, Structural Design, Management, Software Engineering and Architectural Engineering.

'Proud to bring a great synergy of expertise and being an eye opening experience'

**Prof. Hasan M. Hamouda**
**ICEFT 2018 Scientific Committee Chair**

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# Energy Management -Demand Optimization and Biogas Production

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**Abstract** Energy is the silver cord that delivers the needed nutrients to enrich the nerve of economy, social equity and environment. Worldwide, the growth of energy use is mainly driven by the expansion of population. Especially in the developing countries, a challenge is not simply to secure enough energy to meet demand, but also to minimize environmental impacts. In essence, renewable energy sources have become a topic of interest within the research community.
Every energy source has an impact on the environment; either positive or negative. While, debates over the advantages and disadvantages of various energy sources continues, it is agreed that renewable energy offers significant environmental benefits when compared to conventional ones. A case study of an egg carton manufacturing factory located in the Gaza Strip is presented in this paper. To establish a sustainable energy plan, this study documents a reduction in electric energy demand of such factory through optimization, as well as energy production by addressing a result of a pilot study; where an Anaerobic Digester was utilized to evaluate the energy potential associated with a composition of wastewater and solid waste. Finally, results reliability was confirmed by conducting a comparison between experimental and calculated outcomes.

**Keywords**
Anaerobic digestion, Biogas, Co-substrate, Renewable Energy

## 1.0 INTRODUCTION

Energy is the lifeblood that flows deeply through the veins of many sectors. It is a precondition to fulfilling the development goals, predominately those related to improving public health, exterminating poverty, driving food production and promoting economic growth. Consequently, access to affordable and reliable energy services is fundamental to achieving such goals.
Over time, the expansion of human population has been accompanied by a growth of energy demand. Thus, energy consumption patterns have significantly changed and new energy sources have been developed. Broadly, energy sources can be classified into two types: conventional and renewable. The major source of energy comes from fossils fuels dominated by oil, gas and coal and regarded as being conventional energy sources. Meanwhile, the renewable energy is a natural source of energy that is not depleted by use. It includes: solar photovoltaic, wind, tidal power, geothermal and biomass.
Until today, fossils fuels remain the primary energy source worldwide. Yet, there is no escaping from the fact that this source is expected to be depleted one day. Simultaneously, the environmental impacts of fossil fuels use have become hard to ignore; as concerns arose over carbon dioxide emissions contributing to global warming. This situation is expected to be further aggravated as the global energy demand is forecasted to increase by 53% in 2030; consequently, the cost of fossil fuels is predicted to increase. Addressing fossil fuel depletion, climate change, scourge on public health and population growth mean that renewable energy sources will need to play a prominent role in securing the environment as well as meeting the fast-rising energy demand.
In this context, the twin challenge of securing energy and tackling climate change has dominated/occupied the universal agenda. Developing the capability to effectively and economically capture, store and use renewable energy marched up the priority list. In effect, many countries have started utilizing renewable energy sources extensively, while; others are still

struggling to enact policies to promote such trend, (Terrapon-Pfaff, et al., 2014) and (UNEP, 2016).
Projections on developing countries, much of the increase in energy demand will result from rapid population growth. Deepening the dialogue between 'environmental degradation' and 'energy poverty' in such areas, more attention on harnessing renewable sources of energy should be given. In particular, this study looks at the case of prevailing energy poverty in the Gaza Strip (GS), where; restrictions on material entry, fuel shortage, power cuts, lack of resources and dramatic environmental degradation disfigure the picture of the area (Ouda, 2013). Increasingly, the rapid growth of GS's population continues to add pressure on finding an alternative source of energy.
In recognition of varying potential of renewable energy across world, a close investigation is essential to make a decisive action relevant to each region/on regional level. Related to the case study under consideration, biomass has caught the eyes; as it seemed to answer the question of energy poverty as well as meeting environmental preservation goals.
In essence, this paper presents a case study of an egg carton manufacturing factory located in Beit-lahia in the Gaza Strip (GS), where, GS is a developing area suffering from a chronic crisis of energy shortage accompanied by a dramatic environmental degradation. Specifically, it aims at optimizing the electric energy demand of the factory and evaluating the bio-energy production through bio-mass conversion; by utilizing a pilot-scale Anaerobic Digester.
Results and recommendation from this work will pave the road towards the adaptation of a larger scale environmentally friendly solution to the problem at hand.

## I. 2.0 THE GAZA STRIP

The Gaza Strip (GS) is a narrow strip stretches along the east-south corner of the Mediterranean consisting of five governorates including: Gaza, Middle, Northern, Khanyounis and Rafah. It has a temperate climate, with mild winters and dry, hot summers. Due to the absence of fossil fuel resources, GS has to import all its needs of petroleum products. With a demand of 350 Megawatts (MW), it relies on three main sources of supply: 120 MW from Israel, 22 MW from Egypt and 92 MW from the Gaza Power Generation Plant. Considering this situation, Gaza Strip is experiencing an electricity deficit of about 160 MW towards meeting the overall demand.
Being a theatre of conflict for decades, GS's electric power supply is witnessing a sharp decline since 2007. As a result, people are living on less than eight hours of electricity a day.
In addressing the needs of the energy sector in the GS, planned actions are needed to secure the electric power demand before all aspects of life being paralyzed. Thus, the absence of adequate infrastructure in the area of the GS strongly ties with the existing environmental degradation.
To this end, the Gaza Strip is in despite need to find an alternative source of energy and in particular renewable one in order to meet the urge demand and protect the environment.

## 3.0 LITERATURE REVIEW

There has been a great interest in the topic of renewable energy over the past few years. With the vast majority of the world's energy is generated from non-renewable sources, clearly, resource scarcity is not the only reason for considering renewable energy. As, Current energy production and consumption habits have been tightly linked to global climate change, resource depletion, land-use conflicts, air pollution, soil contamination and adverse health implications.
The global renewable energy resources base is enormous. When hammering on the availability of renewable energy sources, it is essential to define various types of potential. In literature, Resource, technical, economical and market potential were debated. Resource deals with the theoretical potential for renewable resources in certain area, addressing geographical location, quantity and trends in supply. While, technical potential focuses on engineering and technological criteria related to different renewable energy sources. In addition to theoretical and technical potential, economic potential considered costs attached to various options. Finally, market potential depends upon the real-world market conditions driven by different policies and sizes of various markets. Extensive research have been documented with regard to renewable energy potential across the

world ((Dincer, 2000), (Jacobson, and Delucchi, 2011). (Philibert, 2011), (Moriartya and Honnery, 2012), (Bhattacharyya, 2012), (Hinrichs-Rahlwes, 2013), (Alemán-Nava, et al., 2014)).

Collectively, studies declared that the total potential for renewable energy is higher than current and forecasted future demand.

Coincident with the world accelerating energy demand, the net growth is taking place in the developing countries. Consequently, developing countries are faced with a two-fold energy challenge. One is meeting the growing energy need due to exponential population growth. Simultaneously, keeping-up with the global trend towards clean energy source is another issue. As considerable renewable energy source potential still exists in developing countries, careful planning is required to effectively manage and maximize available opportunities.

Although, some studies have been attempted to assess the renewable energy potential in the GS, it is still lagging behind those of other regions (Ismail, et al., 2013). A study addressed solar photovoltaic as a highly appealing source of energy, as GS receives an approximate of 3,000 hours of sunshine per year and has an average daily solar radiation of 5.5 kWh/$m^2$ (Abu-Zarifa, 2014). Consequently, small-scale pilot solar power projects were implemented in the GS to generate and supply electricity to clinics, schools and residential areas. What limit the large scale use of solar panels are the space requirements. Meanwhile, wind applications are partially restricted due to topographical features of GS; as relatively low wind speed exists throughout the year; with an annual mean wind speed of 4.2 m/s (Alaydi, 2013). Furthermore, tidal power lacks the geographical circumstances to develop in GS; as no substantial water body to be utilized. Some insight into the geothermal source in GS shows low potential and inapplicability for large-scale production.

Notably, bio-energy remains the single most significant source of energy in the developing world today providing 35% of total primary energy supply in developing countries (World Economic Forum, 2013). The interest in such energy source has been driven by its potential to mitigate global warming as well as filling the gap between demand and supply. Although, bio-energy has a potential to account for in the area of the GS, lack of pilot projects and expertise are considered the main barriers to such application in the area.

## 4.0 ANAEROBIC DIGESTION

Anaerobic digestion is a process where micro-organisms, in the absence of oxygen molecular and produces biogas. Biogas primarily consists of a mixture of about 60-70% methane ($CH_4$), carbon dioxide ($CO_2$) and traces of other gases. Anaerobic digestion is a multi-stage process involving four fundamental steps as follow:

- Hydrolysis: large polymers are broken down into enzymes.
- Acidogenesis: this stage produces acetate as a main end product. Volatile fatty acids are also produced along with carbon dioxide and hydrogen.
- Acetogenesis: Breakdown of volatile acids to acetate and hydrogen.
- Methanogenesis: Acetate and hydrogen are converted to methane and carbon dioxide.
- Mesophilic and thermophilic are the two temperature ranges that allow different species of bacteria to survive providing optimum digestion conditions. The optimum temperature range for the mesophilic and thermophilic is 35°C-45°C and 55°C-60°C respectively (Ji-shi et al. 2006). The methane can be captured from the anaerobic digesters and be used directly as Bio-fuel or converted to electricity.

Interest has recently been growing in using the anaerobic digestion as a result of current environmental problems. Specifically those related to both growing volumes of 'waste and wastewater' and to 'global warming'. In essence, Anaerobic Digesters (AD) sparked as an attractive option for generating renewable energy and protects the environment of the GS.

## 5.0 METHODOLOGY

The factory started functioning in GS by 2008 using recycled paper and cardboard; with an electricity demand of 110kW covering two automatic pistons, two mixers, two compressors, two sieves, a pump, an oven and lightening. Currently, the factory manufactures up to 14000 egg cartons with a daily average production time

of only eight hours as a result of electricity cut-age. The first step of the research was optimizing the electric energy demand of the egg carton manufacturing factory. Then, a calculation was carried out to approximately estimate the methane production using the Anaerobic Digester with a mixture of five components; co-substrate. With ambitious step towards a more secure and sustainable energy source, the pilot study was initiated at the end of January, 2016, and operated until the end of March, 2016. The first injection to the AD marked the start of the process on the second of February, 2016. However, the AD was operated in a manner similar to a full scale digester under controlled conditions; as the microorganism culture in the AD maintained a pH in the range of 6.8 to 7.8, while the temperature was 37ºC with a tolerance of ± 2ºC and a Hydraulic Retention Time (HRT) of 20 days. Furthermore, both experimental and calculated results were compared for a reliability check. Process parameters, feed composition, description of the process units are followed.

### 5.1 Process Parameters

Efficiency of the Anaerobic Digester depends on various operational parameters. Table (1) presents these parameters, especially, temperature, pH, Hydraulic Retention Time and the Organic Load Rate

II. Table 1: AD operating parameters.

| Process Parameter | Range | Dimension |
|---|---|---|
| Temperature | 35-40 | $^0$C |
| pH-Value | 6.8-7.8 | - |
| Reactor Volume (AD) | 6000 | L |
| Hydraulic Retention Time (HRT) | 15-20 | d |
| Mixer | 200 | rpm |
| TS | 100 | kg/m$^3$ |
| $Q_{Excess}$ | 300 | L/d |
| Organic Load Rate (OLR) | 24 | Kg VS/d |

### 5.2 Feed Composition

The rate of methane production depends greatly on the characteristics of the co-substrate introduced to the AD. In essence, the reactor fed was made-up of a combination of primary sludge, fat, excessive sludge, cow and chicken dung. The typical composition and characteristics of the feed is detailed in Table (2), at a ratio of 1:1 for cow and chicken dung ((Sebola et al. 2015) and confirmed by Oechsner, 2016) as the cow dung can intercept the high concentration of ammonia associated with chicken dung.

III. Table 2: Composition & Characteristics of the Feed

| Component | Material | Rate of flow [l/d] | SS [g/l] | VS [%] | VS - Degradation [%] | Spec. Methane Yield [Nm$^3$/kg VS] |
|---|---|---|---|---|---|---|
| C1 | Primary Sludge | 1000 | 35 | 80 | 60 | 0.2 |
| C2 | Fat (used frying oil) | 100 | 270 | 95 | 90 | 0.8 |
| C3 | Excessive Sludge | 1000 | 7 | 70 | 30 | 0.2 |
| C4 | Cow Dung | 3200 | 80 | 80 | 50 | 0.2 |
| C5 | Chicken Dung | 700 | 450 | 75 | 50 | 0.25 |

### 5.3 Process Units

The reactor was provided with suitable arrangements for feeding and gas collection. A schematic diagram of experiment set up used in this study is depicted in Figure (1). A feed preparation system, consisting of a mixing tank, sieve and homogenizer, was provided. Initial mixing of the influent/feedstock was necessary to create homogeneous feed. The feed was then filtered through a 2 cm sieve to remove large particles. Finally, the feed is homogenized and introduced to the AD with a help of a pump. The digester was constructed using (material), with a volume of 6 m$^3$. The effective volume of the reactors was maintained at 5.7 m$^3$ and homogenized with mixer propeller. The digester was sealed with a top lid, provided with one port for gas outlet. Additionally, the AD (was equipped with an outlet)/ (had one outlet) at the bottom of
the AD for excessive sludge removal and sampling purposes. The resulted biogas is passed further to an absorber for the $CO_2$ removal and after that to a drying system. In the next step, the methane was compressed and ready to be used.

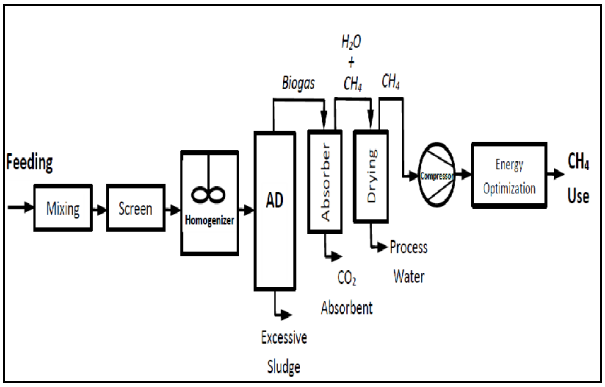


Figure 1: Schematic view of the experimental set up

## 6.0 RESULTS

In an effort to reduce the electric energy demand, information describing the current status of the factory demand has been collected. Then, optimizing the electric demand of the factory has been achieved by monitoring and assessing the factory operation. In particular, analysis of how much energy is needed to perform each activity has been deduced. Matching the electric demand for each activity, especially motors for mixers and compressors, to appropriate power supply resulted in a reduction of an electric demand from 110kW to 70kW.

This is followed by a theoretical calculation to approximately estimate the methane production with the five different components as shown in Table (3).

IV. Table 3: Typical Methane Yield for AD Volume 6m$^3$

| Parameter | C1 | C2 | C3 | C4 | C5 | Total | |
|---|---|---|---|---|---|---|---|
| Rate of flow (m$^3$/d) | 0.055 | 0.01 | 0.055 | 0.15 | 0.03 | 0.3 | |
| SS (g/L) | 35 | 270 | 7 | 80 | 450 | | |
| VS (%) | 8 5 | 9 | 7 | 8 | 7 | | |
| Mass Flow | | | | | | | |
| in kg VS/d | 1.64 | 2.57 | 0.27 | 9.60 | 10.13 | 24 | |
| in kg COD/d | 3.99 | 6.26 | 0.35 | 23.4 | 24.7 | 59 | |
| in kg SS/d | 1.93 | 2.70 | 0.39 | 12.0 | 13.5 | 31 | |
| Digester | | | | | | | |
| Degredation (% VS) | 60 | 90 | 30 | 60 | 50 | | |
| Specific Methane (Nm$^3$/kgVS-input) | 0.2 | 0.8 | 0.2 | 0.2 | 0.25 | 0.33 | |
| Mass Flow after Digester | | | | | | | |
| in kg VS/d | 0.65 | 0.26 | 0.19 | 3.84 | 5.06 | | |
| in kg COD/d | 1.60 | 0.63 | 0.46 | 9.37 | 12.3 | 24 | |
| in kg SS/d | 0.94 | 0.39 | 0.30 | 6.24 | 8.44 | 16 | |
| SS- reduction (%) | | | | | | 46.5 | |
| COD reduction (%) | | | | | | 58.4 | |
| Total mass (kg SS tonne/a) | | | | | | 6 | |
| Spec. Methane ( Nm$^3$/kg VS-Input) | | | | | | 0.28 | |
| Gas production (Nm$^3$/d) | 0.3 | 2 | 0.054 | 2 | 3 | **7** | m$^3$ meth. /d |
| Produced Energy (kWh electicity) | | | | | | **26** | |
| Produced Energy (kW electricity) | | | | | | **3** | |
| Produced Energy (Kg Methane/d) | | | | | | **4** | |

With reference to Table (3), it can be seen that the average calculated methane production is 7 $Nm^3/d$. For an AD volume of $6m^3$, values for the Volatile Solids (VS) mass and specific methane for the used components, methane yield per day was manipulated. In this case, calculations were based on an AD daily fed/Rate of Flow of 300L and an equivalent amount to be removed to maintain a HRT of 20 days. In addition, the SS reduction and the AD degradation efficiency were found to be approximately 50% and 60 respectively. Comparing the results of the suspended solid mass reduction of 50% to what is documented in literature, 60%, highlighted that the obtained results are relatively consistent. Thus, an apparent AD degredation efficiency of 60% is in the range of 40-60%; were reported in literature (Yung et al., 2000). In addition, specific methane production of 0.28 $Nm^3/kg$ VS-Input. This is consistent with literture, as a value of 0.3 CH4 /kg VS has been reported by Alvarez and G. Liden, 2008.

**6.1 Results for the Anaerobic Digester Pilot-Study:**

Temperature and pH level are considered important parameters for the biogas yield and rate of production. Daily measurements for both parameters were taken and time record histories were presented graphically. Collected data were incorporated as follows for:

**6.1.1 Temperature:**

The AD temperature target for the pilot study was 'mesophilic temperature' range (37 ± 2°C). During the start up of the process, low temperature, 15°C, was observed (see Figure (2)). Then, tendency of increasing from values of 35 up to 40 after ten days were confirmed. In turn, this implicates that the process maintained a steady mesophilic temperature for the remaining study period.

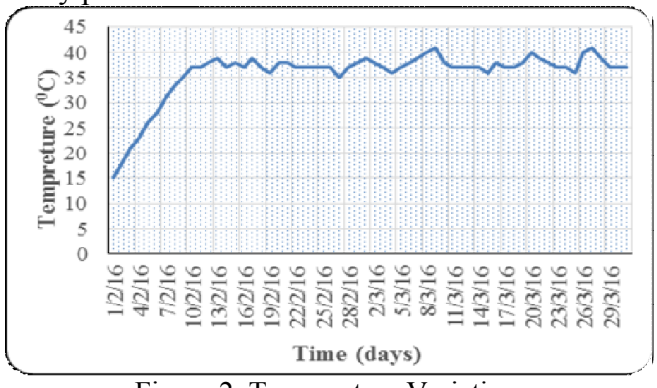


Figure 2: Temperature Variation

**6.1.2 pH:**

Referring to Figure (3), the pH level in the AD was initially 6.5. The pH was then decreased progressively over a period of seven days reaching a value of 4.7. Based on literature (Rittmann, 2001), the pH was adjusted to 7.3 using NaOH solution of (500 to 900) mg/L; as been recommended among four economically feasible chemical additives, Lime, Sodium hydroxide, Ammonia and Bicarbonate. Throughout the rest of the study period, the pH was monitored daily with a pH meter and maintained at vicinity of 7.3.

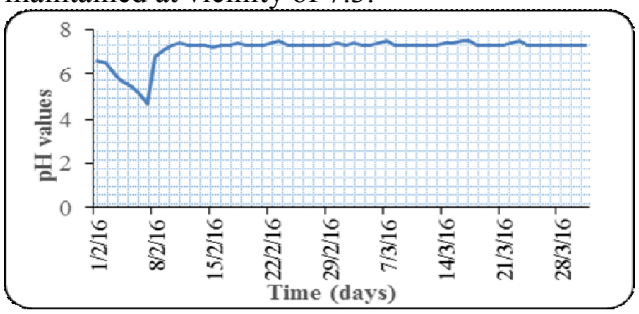


Figure 3: pH Variation

Daily biogas yield of the AD was monitored over the period of the study. The methane content in the biogas is shown in Figure (4). For the first 19 days, no methane was produced from the AD. Methane was first observed on day 20 and increases gradually until it reached a peak value of $18Nm^3$ on day twenty seven. Between day twenty seven and day thirty, the methane production remained almost constant. This is followed by a decline in the methane yield for three concessive days; reaching a value of 6 $Nm^3$ where it remained with this average value for the rest of the study time. Initial phase represents the AD batch stage; where the daily methane production builds-up to a maximum, then declines. Meanwhile, the methane yield pattern for the remaining period reflects the AD being operated with a continuous rate flow of 300L/d.

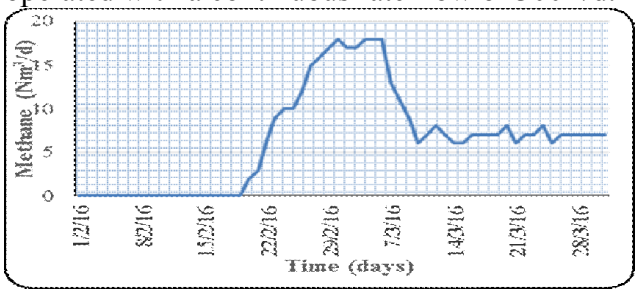


Figure 4: Methane Yield over Time

With reference to Figure (4) and Table (3), it can be concluded that the average methane production reported for the AD in this study, 6 $Nm^3/d$, is comparable to those obtained from calculations; 7 $Nm^3/d$. Following are photos taken for different methane uses.

Figure 5: Photos for Methane Uses

From a strategic point view, a planning initiative was undertaken by performing similar calculations for methane yields for a 200 m3 AD, see Table (4).

For an AD volume of 200m3, values for the Volatile Solids (VS) mass and specific methane for the used components, methane yield per day was manipulated. In this case, calculations were based on an AD daily Rate of Flow of $10m^3$ and an equivalent amount to be removed to maintain a HRT of 20 days .As shown in Table (4), the average calculated methane production is 223 $Nm^3/d$. Apparently, generated electricity of 85 kW will fully cover the daily electric energy demand of 70 kW for the egg carton factory.

## 7.0 CONCLUSION

Clearly, energy strategies are striving towards securing a stable and reliable energy source to meet the worldwide energy demand. As electricity demand escalated and supply is largely dependent on fossil fuels, concerns arose over carbon dioxide emissions contributing to global warming.

V. Table 3: Typical Methane Yield for AD Volume $200m^3$

| Parameter | C1 | C2 | C3 | C4 | C5 | Total | |
|---|---|---|---|---|---|---|---|
| Rate of flow ($m^3/d$) | 1.85 | 0.3 | 1.8 | 5 | 1 | 10 | |
| SS (g/L) | 35 | 270 | 7 | 80 | 450 | | |
| VS (%) | 85 | 95 | 70 | 80 | 75 | | |
| Mass Flow | | | | | | | |
| in kg VS/d | 55.04 | 76.95 | 9.07 | 320.0 | 337.5 | 799 | |
| in kg COD/d | 134.24 | 187.68 | 11.62 | 780.49 | 823.17 | 1,937 | |
| in kg SS/d | 64.75 | 81.00 | 12.95 | 400.0 | 450.0 | 1,009 | |
| Digester | | | | | | | |
| Degredation (% VS) | 60 | 9 | 3 | 6 | 5 | | |
| Specific Methane ($Nm^3$/kgVS-input) | 0.20 | 0.80 | 0.20 | 0.20 | 0.25 | | |
| Mass Flow after Digester | | | | | | | |
| in kg VS/d | 22.02 | 7.70 | 6.35 | 128.0 | 168.7 | | |
| in kg COD/d | 53.70 | 18.77 | 15.48 | 312.2 | 411.5 | 812 | |
| in kg SS/d | 31.73 | 11.75 | 10.23 | 208.0 | 281.2 | 543 | |
| SS- reduction (%) | | | | | | 46.2 | |
| COD reduction (%) | | | | | | 58.1 | |
| Total mass (kg SS tonne/a) | | | | | | 198 | |
| Spec. Methane ( $Nm^3$/kg VS-Input) | | | | | | 0.28 | |
| Gas production ($Nm^3/d$) | 11.0 | 62 | 1.81 | 64 | 84 | **223** | $m^3$ meth./d |
| Produced Energy (kWh electicity) | | | | | | **846** | |
| Produced Energy (kW electricity) | | | | | | **85** | |
| Produced Energy (Kg Methane/d) | | | | | | **145** | |

In essence, this research turns attention to biomass source of energy surging around in nature. It handled electrical energy management strategy from both the demand, by optimization, and supply sides by presenting an AD pilot-study. From one side, demand management yield an optimization of 40% reduction in the electric energy demand.

Meanwhile, results of typical methane yield reported from the analytical calculations proven to be comparable to those originating from the AD. Finally, the paper crafted a future strategic plan by scaling-up the AD.

## VI. ACKNOWLEDGMENT

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# Improvement of Bearing Capacity of Shallow Foundation on Geotextile Reinforced Layered Soil

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**Abstract**—In the present study, the improvement in the bearing capacity of sandy lean clay soil with sand layer on top and placing geotextiles at different depths was investigated with Laboratory modeling tests. Tests were carried out on a square footing resting on top of the soil to establish the load versus settlement curves of unreinforced and reinforced soil system. The test results focus on the improvement in bearing capacity of sandy lean clay and sand on unreinforced and reinforced soil system. The results show that bearing capacity increases significantly with the increased number of geotextile layers. The improvement in bearing capacity for sand underlain sandy lean clay maintaining $u/B$ and $h/B$ equal to 0.33; for one, two, three and four number geotextile layer were 31.62, 47.06%, 97.06%, and 125% respectively.

**Keywords—Bearing capacity, Geotextile, Load-settlement curve, Shallow foundation**

## VIII. INTRODUCTION

Geosynthetic soil reinforcement materials have been widely used in the field of geotechnical engineering applications including ground stabilization, road pavements, shallow foundations, and slope stabilizations. Numerous studies have been conducted on the improvement of load bearing capacity of shallow foundations supported by soil reinforced with various reinforcing materials such as geogrids (Shin et al. 1993; Das et al. 1998; Shin et al.,2002; Patra et al., 2005; Latha and Somwanshi, 2009; Vijaya and Gangadhara, 2010; Abu-Farsakh, et al., 2013; Asakereh et al., 2013; Badakhshan and Noorzad, 2015; Baldaniya and Somaiya, 2015; Cicek et al., 2015; Elsaied et al., 2015; Ronad, 2014; Sharma et al., 2015; Mehta and Jethwa, 2016; Surya and Niranjana, 2016; Budania, 2017), geotextile (Guido et al., 1986; Yetimuglu et al., 1994; Basudhar et al., 2007, Abu-Farsakh, et al., 2013; Cicek et al., 2015; Kumar et al., 2015; kumar et al., 2016; Sona and Soumya, 2016; Badakhshan and Noorzad, 2017), fibers (Akinmusuru and Akinbolade, 1981; Yetimoglu et al., 2005), metal strips (Fragaszy and Lawton, 1984; Huang and Tatsuoka, 1990), geocell (Dash et al., 2003, Hegde and Sitharam, 2015; Tafreshi et al., 2015), and geonet (Tafreshi and Dawson, 2010; Bazne et al., 2015).

The findings from several laboratory model tests have been reported in the literature which relates the ultimate bearing capacity of shallow foundations supported by soil reinforced with multiple layers of geotextile. Basudhar et al. (2007) carried out experimental and numerical analyses on behavior of circular footings with different size resting on reinforced sand with geotextile and reported that with increase in number of reinforcement layers, the settlement value gradually decreased. Yetimuglu et al., 1994 conducted laboratory model tests to investigate the bearing capacity of rectangular footings on geotextile reinforced sand. For a single layer of reinforcement, the optimal placement depth was found to be 0.3 times the footing width. The results indicated that the optimum vertical spacing of reinforcement layers is 0.5 times the outer diameter of the ring. Lovisa et al. (2010) studied behavior of pre-stressed geotextile reinforced sand bed supporting a loaded circular footing and found out that effects of the pre-stressed reinforcement configuration were evident for greater footing depths, in comparison with unreinforced and reinforced without pre-stressing. Abu-Farsakh et al. (2013) performed tests to determine the behavior of geosynthetic-reinforced sandy soil foundations and studied the effect of different parameters contributing to their performance using laboratory model tests and

reported that the reinforcement layout has a very significant effect on the behavior of reinforced sand foundation. Cicek et al. (2015) conducted laboratory model tests of a surface strip footing on unreinforced and reinforced sand beds to investigate the effects of reinforcement length. Based on their results, the length of footing required to achieve optimum improvement was determined for different numbers of reinforcement layers and different reinforcement types. It was also observed that the improvement obtained by reinforcing the subgrade was different for low settlement ratio values and large settlement values. Sona and Soumya (2016) investigated the behavior of model ring footings on geotextile reinforced dense river sand was studied by laboratory model test. The test was conducted on the rings on unreinforced as well as reinforced bed to determine the optimum vertical spacing of reinforcement layers. Badakhshan and Noorzad (2017) presented the results from a laboratory modeling tests and numerical studies carried out on circular and square footings to investigate the effect of foundation shape with the same plan area in central and eccentral loadings on the bearing capacity, settlement and tilt of footings in unreinforced and reinforced sand bed. The results indicated that in unreinforced condition, the ultimate bearing capacity is almost equal for both ofthe footings; but with reinforcing and increasing the number of reinforcement layers the ultimate bearing capacity of circular footing increased in a higher rate compared to square footing in both central and eccentrial loadings.

From the finding of numerous researchers, it can be concluded that the bearing capacity of soil also changed with various factors like type of reinforcing materials, number of reinforcement layers, ratios of different parameters of reinforcing materials, and foundations such as $B$ (footing width), $u/B$ (location of the first layer of reinforcement to width of footing), $h/B$ (vertical spacing between consecutive reinforcement layer to width of footing), $b/B$ (width of the reinforcement layer to width of footing), $D_f/B$ (depth of footing to width of footing), type of soil, texture, and unit weight or density of soil, (Shin et al. 1993; Patra et al., 2005).

Out of several studies, very few studies are available on the two-layer soils system. Generally, all the studies are ultimately related to improvement in the bearing capacity of soil using reinforcing materials and related to the effect of various parameters on bearing capacity. Several studies (Shin et al. 1993; Das et al. 1998; Yin 1997, Kolay et al., 2012; Ornek et al., 2012; Bai et al., 2013; Biswas et al., 2013; Kolay et al., 2013; Yadu and Tripathi, 2013; Manisana et al., 2014) show the effect of various parameters (e.g., $u/B$, $h/B$, $b/B$, and $D_f/B$), types of geosynthetic materials, effects of footing width ($B$), types of soils, layer of soils, and so forth. But no studies are available on sandy lean clay soil related to the improvement in bearing capacity of square footing by placing sand layer on top of sandy lean clay soil (i.e., two-layered soil) and geotextile system. Most of the studies either used sand or clay only and used geogrid or geotextile or geocell as the reinforcing material.

The present study investigates the bearing capacity of two layers of soil with varying the number of geotextile at different depths and by keeping other properties constant.

## IX. Materials and Experimental Program

### A. Materials

To investigate the bearing capacity of double layered soil reinforced with different layers of geotextile, the properties of materials used in the tests are described in this section as follows:

- Sandy lean clay soil and sand

Two types of soils were used to conduct the experimental study, that is, sandy lean clay soil and sand. The sandy lean clay soil sample was collected from location adjacent to University of Palestine. The collected soil was sun-dried, pulverized, and passed through US sieve # 10 (i.e., 2mm) for different physical, engineering properties and bearing capacity test. The properties of the sandy lean clay soil were determined in the laboratory by performing several tests using respective ASTM standard. A layer of sand was placed on top of sandy lean clay soil (two-layer soil system). The particle size distribution curve for the sandy lean clay soil and sand is presented in Figure 1. The physical and engineering properties of sandy lean clay soil and sand used in the present study are summarized in Tables 1 and 2 respectively.

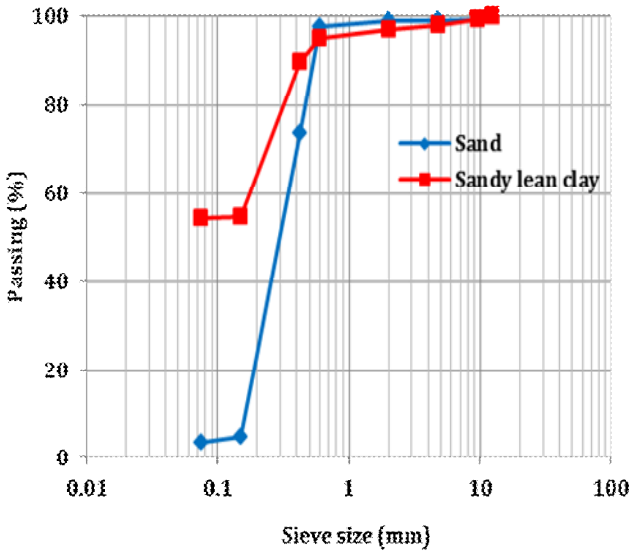



Fig. 1. Particle size distribution curve for the sandy lean clay soil and sand used in the study.

TABLE 1. PROPERTIES OF SANDY LEAN CLAY SOIL.

| Property | Value |
|---|---|
| Specific gravity ($Gs$) | 2.72 |
| Medium grain size ($D_{50}$), mm | 0.069 |
| Coefficient of uniformity ($C_u$) | 56.26 |
| Coefficient of curvature ($C_c$) | 4.11 |
| Liquid limit (LL), % | 25 |
| Plastic limit (PL), % | 15 |
| Plasticity index (PI), % | 10 |
| Maximum dry unit weight ($\gamma_{dmax}$), kN/m$^3$ | 19.36 |
| Optimum moisture content (OMC), % | 13.4 |
| Undrained cohesion ($c$) from UCS test, kN/m$^2$ | 10 |
| Angle of internal friction ($\phi$), (°) | 6 |
| USCS classification | CL |

TABLE 2. PROPERTIES OF SAND.

| Property | Value |
|---|---|
| Specific gravity (Gs) | 2.61 |
| Medium grain size ($D_{50}$), mm | 0.297 |
| Coefficient of uniformity ($C_u$) | 2.12 |
| Coefficient of curvature ($C_c$) | 0.86 |
| Maximum dry unit weight ($\gamma_{max}$), kN/m$^3$ | 17.26 |
| Minimum dry unit weight ($\gamma_{min}$), kN/m$^3$ | 15.40 |
| Relative density ($D_r$) of sand, % | 90 |
| Angle of internal friction ($\phi$), (°) | 36 |
| USCS classification | SP |

- Geotextiles

In order to provide horizontal reinforcement material for the model test, woven geotextile (PD381) layers were used. This type of reinforcement is an extruded polymer sheet made by using high density polyethylene (HDPE). The reason for selecting this type of reinforcement is almost the same peak tensile strength in every direction. The properties of this reinforcement are obtained from manufacture's manual of the product are given in Table 3.

TABLE 3. PROPERTIES OF GEOTEXTILE.

| Property | Value |
|---|---|
| Mass per unit area, (g/m2) | 147 |
| Thickness, (mm) | 1.35 |
| Tensile strength, MD (kN/m) | 30 |
| Tensile strength, CD (kN/m) | 29 |
| Tearing strength, MD (N) | 612 |
| Tearing strength, CD (N) | 475 |
| Puncture strength, (N) | 637 |
| Style (Quality no.) | PD 381 |
| Color | Yellowish-white |
| Polymer | Polyethylene |

- Model Test Tank

A model test tank with the dimensions having length 1000mm, width 1000mm, and depth 1000mm was designed and fabricated to perform the test. The dimensions were chosen 6 times longer than the width of footing to ensure that the footing rupture occurs inside the tank based on literature studies conducted prior to the model tests (Kolay et al., 2013; Badakhshan and Noorzad 2015; Badakhshan and Noorzad 2017; Elsaied et al., 2015). The horizontal and vertical sides of the model tank are stiffened by using steel angle sections at the top and bottom of the tank to avoid any lateral yielding during soil compaction in the tank and also while applying load at model footing during the experiment. All side walls of the tank were made of 10mm thick Plexiglas plates to permit observation and measurement below the surface in plane-strain tests. The inside walls of the tank were cleaned and smoothed to reduce the side friction.

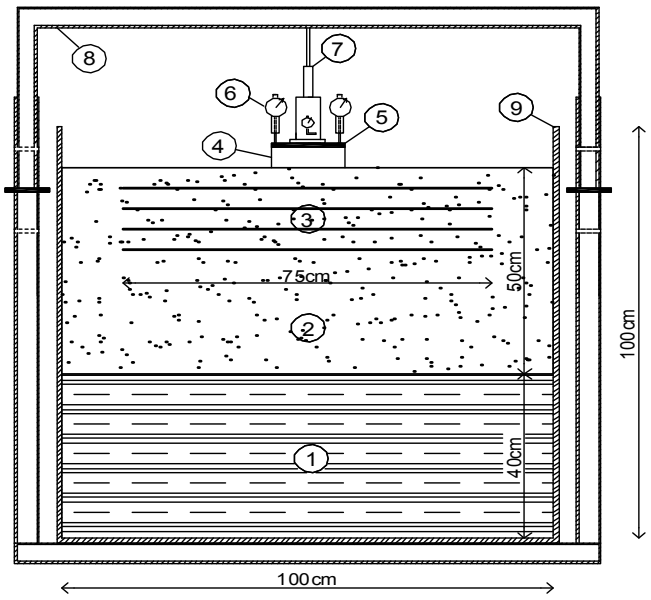
- Model Footing

A model footing made of steel plates, with the dimensions of length (L) equal to 150 mm, width (B) equal to 150 mm, and thickness (D) equal to 10 mm, was used in the experimental study. The footing dimensions were selected based on the model tank's dimension. The model footing was

designed in such a way that its width is not larger than 1/6 times the dimensions of the model tank so that the effect of the load could not reach the bottom and sides of tank (Shin et al, 2002; Sitaram and Sireesh, 2004). The footing was placed at the center of the soil surface. The bottom surface of the model footing was made rough by cementing a layer of sand with epoxy glue to increase the friction between the footing base and the top soil layer. Also a 50 mm thick concrete plate was used at the bottom of the model footing to reduce bending while applying the load.

- Laboratory Model Tests

Figure 2 shows the cross sectional view of the model tank and the model footing with two-layer soil system having different reinforcement layers. The model square footing is supported by sand at the top layer and sandy lean clay soil at the bottom layer reinforced with N number of geotextile layers having a width "b". The vertical spacing between consecutive geotextile layers is "h". The top layer of geotextile is located at a depth "u" measured from the base of the model footing.




1 Sandy silty clay
2 sand
3 Geotextile layers
4 Concrete square footing
5 Steel square footing
6 Displacement guage
7 Hydraulic jack
8 Reaction beam
9 Model box

Fig. 2. Schematic view of the experimental apparatus.

The magnitude of the bearing capacity for a given square footing resting on top of reinforced soil will depend on different parameters like $b/B$, $u/B$, and $h/B$ ratios. In order to conduct model tests with geotextile reinforcement in two-layer soil system, it is important to decide the magnitude of $u/B$, $h/B$ and $b/B$ to get the improvement of the bearing capacity for a particular footing. Several studies showed that $u/B$ can vary between 0.25 and 0.5 (Shin et al., 1993; Yetimoglu et al., 1994; Latha and Somwanshi, 2009). Previous researches concluded that $b/B$ can vary between 4 and 7 for a plane strain footing (Lee et al., 1999; Sitharam and Sireesh, 2004; Bera et al., 2005; Basudhar et al., 2007; Latha and Somwanshi, 2009; Tafreshi and Dawson, 2010). By considering the previous findings, it was decided to adopt u/B equals 0.33, h/B equals 0.33 and b/B equals 5.33 for the present study.

*B.* Experimental program

The sandy lean clay soil was compacted in 8 layers up to an approximately 400mm depth of the model test tank to obtain a uniform density. An approximately 15kg flat square hammer was used to compact the sandy lean clay soil in each layer. In the model test tank, the unit weight of the sandy lean clay soil was 90% of the maximum dry unit weight. After compaction of the sandy lean clay soil in the model tank up to 400mm, a 500mm thick sand layer was placed above the compacted sandy lean clay. The sand is placed by sand raining technique. The height of free pouring obtained through several trials. Based on the minimum and maximum void ratios of the sand, the relation between the height of fall and the corresponding relative density is developed. Afterwards, it is found that the sand should be filled in 50mm thickness intervals in order to achieve the desired density. Geotextile reinforcements were placed at predetermined depths below the base of the model footing. A square shaped reinforcement layer, 5.33 times the width of square footing is placed after leveling the surface of the bed and sand pouring is continued to the next level of reinforcement or footing. The model footing was placed at the top of sand layer. All tests were conducted at a constant relative density of sand, $D_r$ equal to 90% of sand and relative compaction of sandy lean clay soil, that is,

90% of the maximum dry unit weight of sandy lean clay. The load was applied to the model footing by using a manual hydraulic pump system with a capacity of an approximately 58.84kN. The loading rate was kept constant in every test. The load and corresponding foundation settlement were measured by using a load cell and a dial gauge, respectively. In the present study, different tests that were conducted for two-layer soil system with varying numbers of geotextile layers are presented in Table 4.

TABLE 4. SUMMARY OF THE TESTS SERIES.

| Test no. | Test types | N | u/B | h/B | d/B | b/B |
|---|---|---|---|---|---|---|
| 1 | Sandy lean clay soil with sand layer only | 0 | 0 | 0 | 0 | 0 |
| 2 | One geotextile layer | 1 | 0.33 | 0.33 | 0.33 | 5.33 |
| 3 | Two geotextile layers | 2 | 0.33 | 0.33 | 0.67 | 5.33 |
| 4 | Three geotextile layer | 3 | 0.33 | 0.33 | 1 | 5.33 |
| 5 | Four geotextile layer | 4 | 0.33 | 0.33 | 1.33 | 5.33 |

## X. RESULTS AND DISCUSSION

### A. Theoretical Ultimate Bearing Capacity.

The theoretical ultimate bearing capacity for double-layer soil system without reinforcement is calculated by using Meyerhof and Hanna's (Meyerhof and Hanna, 1998) equation. It is assumed that the top layer is strong sand ($c_1 = 0$) underlain by weaker saturated sandy lean clay ($c' - \emptyset'$ soil). Hence, the ultimate bearing capacity, $q_u$, for the double layer system can be calculated by using the following:

$$q_u = q_b + \gamma_1 H^2 \left(1 + \frac{B}{L}\right)\left(1 + \frac{2D_f}{H}\right) k_s \frac{(\tan \emptyset_1)}{B} - \gamma_1 H \leq q_t \quad (1)$$

$$q_t = c_1 N_{c1} F_{cs1} + \gamma_1 D_f N_{q1} F_{qs1} + 0.5\gamma_1 B N_{\gamma 1} F_{\gamma s1} \quad (2)$$

$$q_b = c_2 N_{c2} F_{cs2} + \gamma_1 (D_f + H) N_{q2} F_{qs2} + 0.5\gamma_2 B N_{\gamma 2} F_{\gamma s2} \quad (3)$$

where $q_t$ is the ultimate bearing capacity for top soil layer, $q_b$ is the ultimate bearing capacity for bottom soil layer where, $c_1$ is the undrained cohesion for top soil layer, $c_2$ is the undrained cohesion for bottom soil layer, $B$ is the foundation width, $L$ is the foundation length, $\gamma_1$is the unit weight for top soil layer, $\gamma_2$is the unit weight for bottom soil layer, $H$ is the depth for the top soil layer measured from the bottom of the foundation, $D_f$ is the depth of embedment, $\phi_1$ is the internal friction angle for top soil layer, $\phi_2$ is the internal friction angle for bottom soil layer, $N_{c1}$, $N_{q1}$, and $N_{\gamma 1}$ are the bearing capacity factors with respect to top soil layer, $N_{c2}$, $N_{q2}$, and $N_{\gamma 2}$ are the bearing capacity factors with respect to bottom soil layer, $F_{cs1}$, $F_{qs1}$, and $F_{\gamma s1}$ are the shape factors with respect to top soil layer, $F_{cs2}$, $F_{qs2}$, and $F_{\gamma s2}$ are the shape factors with respect to bottom soil layer, and $K_s$ is the punching shear coefficient which depends on ratio of $q_2/q_1$ where $q_2/q_1 = (c_2 N_{c2} + 0.5\gamma_2 B N_{\gamma 2})/(0.5\gamma_1 B N_{\gamma 1})$.

In the present study, the top layer is poorly graded sand (SP) with an angle of internal friction, $\phi_1 = 36°$, so the bearing capacity factor, $N_{c1}$, $N_{q1}$, and $N_{\gamma 1}$ can be obtained as 50.59, 37.75, and 56.31 respectively. The bottom layer is sandy lean clay (CL) and the angle of internal friction, $\phi_2 = 6°$, so the bearing capacity factor, $N_{c2}$, $N_{q2}$, and $N_{\gamma 2}$ can be obtained as 6.81, 1.72, and 0.57 respectively.

From (1), the ultimate bearing capacity ($q_u$) for double layer soil system can be obtained as 419.36 kN/m$^2$. Also from (2) and (3), the bearing capacity of the top layer and bottom layer can be calculated as 48.58 and 103.96 kN/m$^2$ respectively, which are quite low because the model width of the footing is only 150mm as compared to the real foundation size.

### B. Experimental Ultimate Bearing Capacity

One test was conducted on double layered soil system without reinforcement and other four tests were conducted on double layered soil system

with reinforcement by varying the number of geotextile layers. In all tests, the u/B and h/B ratios were kept constant and equal to 0.33.

Figure 3 shows the bearing pressure versus settlement curves obtained from all the tests conducted in this study. It is obviously that no distinctive failure point has been observed in bearing capacity tests. Several methods are available to estimate the ultimate bearing capacity from the bearing pressure versus the settlement curve (Lutenegger and Adams, 1998; Cerato, 2005). Currently, log-log, tangent intersection, 0.1B, and hyperbolic methods are available to estimate the failure of a shallow foundation, based on load settlement curves. Each method gives a different value of the ultimate bearing capacity and it is hard to decide which method is more accurate. Out of all available methods, 0.1B method was used to find the ultimate bearing capacity for each case in our experimental study. Accordingly, the settlement (s) is expressed into a nondimensional form by dividing the width of footing (B).

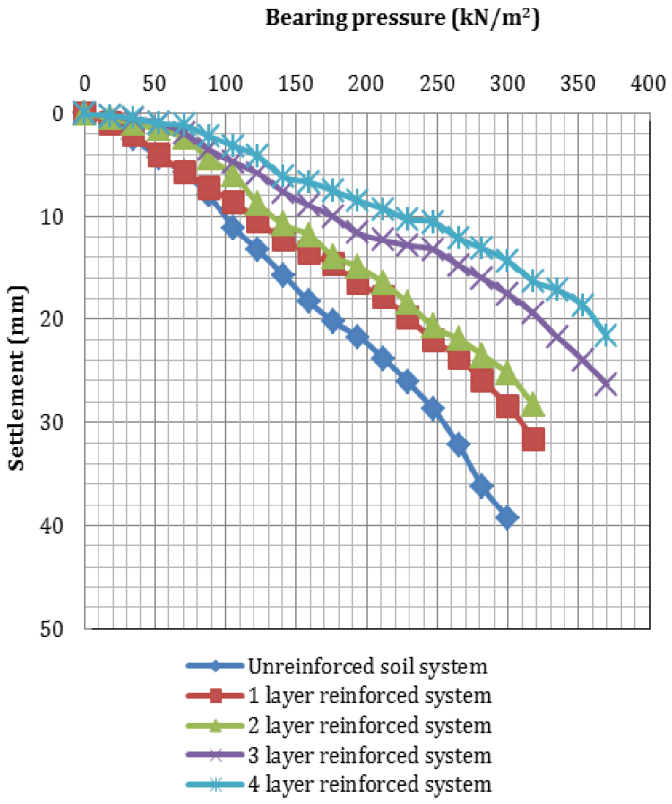



Fig. 3. Bearing pressure versus settlement curves for all the experimental tests.

The bearing pressure (q) versus settlement/width ratios (i.e., s/B) is shown in Figure 4. It is clear that the bearing capacity increases with the increase in the number of geotextile layers. The results of various tests conducted on two-layer soil system with and without geotextile are presented in Table 5. The results show that there is a significant increase in the bearing capacity after increasing the number of geotextile layers.

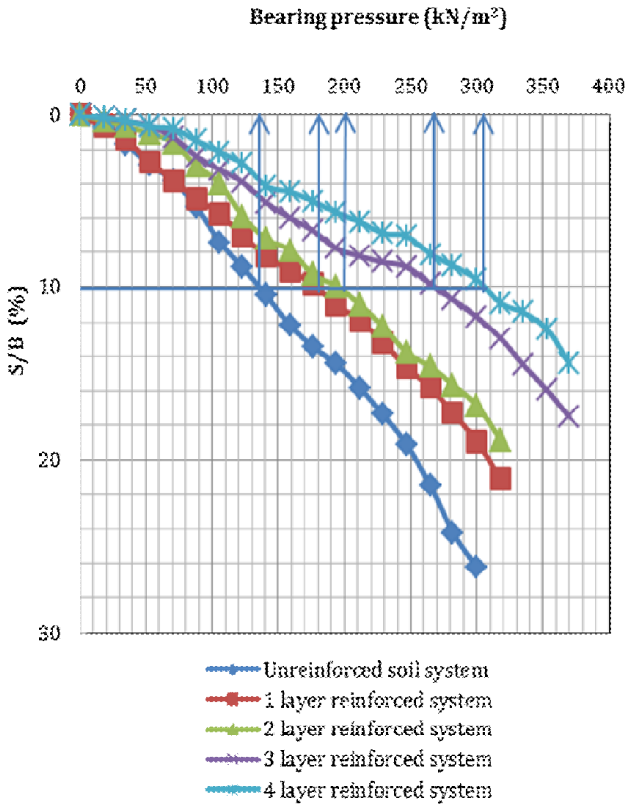



Fig. 4. Estimation for ultimate bearing capacity ($q_u$) from bearing pressure versus $s/B$ (%)

TABLE 5. ULTIMATE BEARING CAPACITIES FOR DIFFERENT TEST TYPES.

| Test no. | Test types | UBC (kN/m²) |
|---|---|---|
| 1 | Sandy lean clay soil with sand layer only | 136 |
| 2 | One geotextile layer | 179 |
| 3 | Two geotextile layers | 195 |
| 4 | Three geotextile layer | 268 |
| 5 | Four geotextile layer | 306 |

### C. Improvement in Ultimate Bearing Capacity Using Geotextile.

The bearing capacity of the double-layer soil system without reinforcement is considered as the reference value to be compared with the bearing capacities of all other geotextile reinforced soil system. The results of percentage improvement in bearing capacity, bearing capacity ratio (BCR), Settlement reduction ratio (SRR) obtained from all test series are summarized in Table 6. Bearing capacity ratio (BCR) is defined as the ratio of ultimate bearing capacity of reinforced soil to the ultimate bearing capacity of unreinforced soil. Settlement reduction ratio (SRR) is defined as the percentage reduction in settlement due to reinforced case relative to the unreinforced case at a constant pressure.

The results show that there is a significant increase in the bearing capacity after increasing the number of geotextile layers and a significant decrease in the settlement after increasing the number of geotextile layers. Therefore, geotextile can be considered as a good reinforcing material. Figures 5 and 6 show the effect of number of the geotextile layers on the improvement in UBC. The ultimate bearing capacity increases with the increase in the number of geotextile layers. Furthermore, It is obvious that the contribution of each geotextile layer to the improvement of bearing capacity is not constant. Figure 7 shows the effect of number of the geotextile layers on the settlement reduction ratio evaluated at ultimate bearing capacity equals 136 kN/m$^2$. The SRR increases with the increase in the number of geotextile layers. In the beginning the improvement is more significant as compared to last stage so that it can be concluded that the first layer of geotextile has a more contribution to the improvement of the bearing capacity.

## XI. Conclusions

A series of laboratory model tests were carried out to evaluate the load-carrying capacity of a square model footing supported on the sandy lean clay soil overlaid with sand and with inclusion of geotextiles at different depths from the base of the footing. Based on the results obtained, the following conclusions can be derived:

- Significant improvements are observed in bearing capacity and settlement behavior of geotextile reinforced double layered soil.
- The improvement in bearing capacity for double layer soil maintaining $u/B$ and $h/B$ equal to 0.33; for one, two, three and four number geotextile layer were 31.62, 47.06%, 97.06%, and 125% respectively.
- The SRR increases with the increase in the number of geotextile layers.
- The BCR increases with the increase in the number of geotextile layers.

TABLE 6. Improvement in Ultimate Bearing Capacities for Different Test Types.

| Test no. | Test types | UBC (kN/m$^2$) | Improvement in UBC (%) | BCR | SRR |
|---|---|---|---|---|---|
| 1 | Sandy lean clay soil with sand layer only | 136 | 0 | 1.00 | 0 |
| 2 | One geotextile layer | 179 | 31.62 | 1.32 | 21.49 |
| 3 | Two geotextile layers | 195 | 43.38 | 1.43 | 31.87 |
| 4 | Three geotextile layer | 268 | 97.06 | 1.97 | 52.43 |
| 5 | Four geotextile layer | 306 | 125.00 | 2.25 | 62.48 |

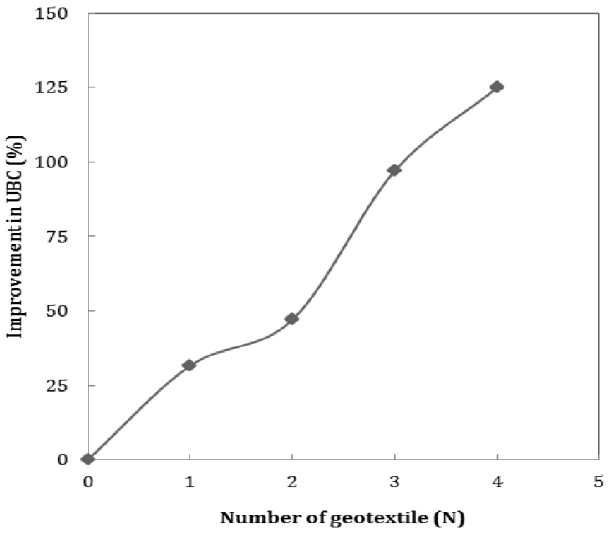



Fig. 5. Improvement in bearing capacity ratio (UBC) with the number of geotextiles.

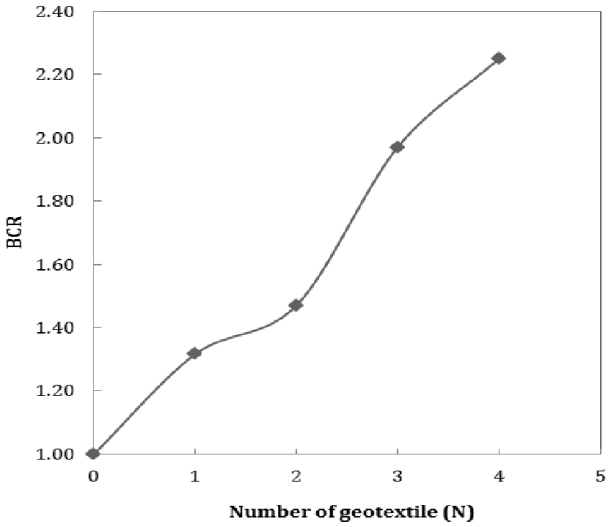



Fig. 6. Bearing capacity ratio (BCR) with the number of geotextiles.

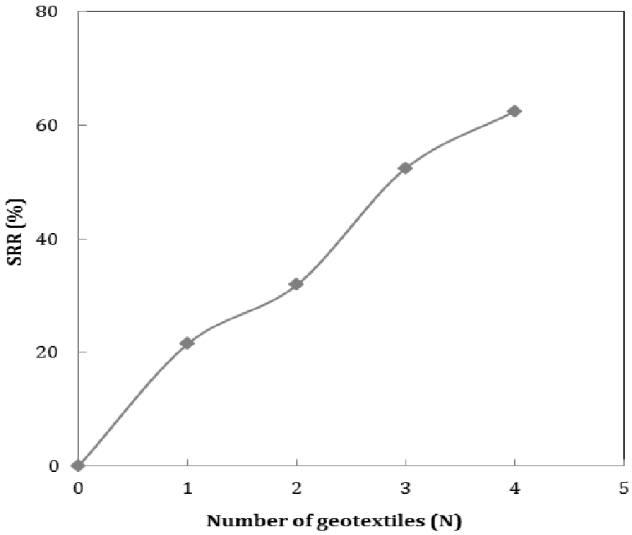



Fig. 7. Settlement reduction ratio (SRR) with the number of geotextiles at UBC = 136 kN/m2.

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# Studying the Possibility of Producing Porous Asphalt in Palestine

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**Abstract**— Porous Asphalt (PA) is designed to allow the water to infiltrate on-site through its pores and reduce storm water's runoff while recharging the groundwater, or collect it by special channels, PA is depending on certain blending of aggregates that increases the percentage of voids inside the asphalt layer (16-25)%, while preserving the enough strength of the asphalt layer to ensure that it could be used for a regular design period; The research has based on several international scientific studies to determine the proposed aggregate gradation that comprise the international PA gradation and ensure a large percentage of air voids; Several experiments have been conducted on aggregates such as sieve analysis, specific gravity and absorption. In addition, other tests are done to evaluate the binder material (bitumen). These tests are penetration point, softening point, ductility, flash point and density. Also, asphalt mixture have been prepared in accordance with the suggested gradation followed by testing asphalt samples to obtain values of the stability, flow and specific gravity for marshal samples; Marshall Method has been used for the design of the asphalt mix to determine the optimum bitumen content as well as to obtain the characteristics of the asphalt mixture at different percentage of bitumen. 24 samples prepared for aggregate blending; the results showed that any blending lies between the limites of proposed gradation can be used to produce PA. Therefore, the results of Marshall Test showed that the optimal bitumen content is more than 4% by the weight of total mixtures, and the voides ratio obtened is equal 20%.

**Index Terms**— Porous Asphalt, PA, Marshall, Void ratio.

## I. INTRODUCTION

The Porous asphalt is an emerging pavement technology out of experimentation with seal coats. It has been re- searched, improved, and installed in numerous locations worldwide. Porous friction courses are a form of porous as-phalt pavement surfacing that has become well established in the United States. Even in Europe the full-depth Porous As- phalt (PA) roadways are common, and interest is increasing worldwide due to the significant potential benefits like re-duce runoff, and the water quality degradation that can be associated with it. [1, 2].

Also, the potential safety and noise benefits are equally compelling although porous asphalt mix design, construc- tion methods, and maintenance have improved with experi- ence, there is a need for additional research. Contemporary full-depth porous asphalt consists of bituminous asphalt pavement with greatly reduced fine aggregate particles (gap graded) and a relatively high interconnected air void content (typically between 16% and 22% voids) [3, 4].

The surface permeability and high porosity allow water to pass vertically through the pavement to the subgrade be- low to naturally recharging groundwater levels, a filter layer of aggregate is often installed on the top of the base to pro- vide a uniform, stable construction platform. The water in the base is stored temporarily in stone reservoir consisting of uniformly graded layer thick enough to allow sufficient water storage during anticipated rain events, clean crushed stone with 40% voids, often allowed to infiltrate into perme- able subgrade soils, and can recharge the groundwater di- rectly [4].

Unlike conventional pavements, porous asphalt pave- ments are typically built over an uncompact subgrade to maximize infiltration through the soil. Above the uncompact subgrade is a geotextile

fabric, which prevents the migration of fines from the subgrade into the stone recharge bed while still allowing for water to pass through (Figure 1). All layers are usually installed without crown or slope to maximize in- filtration potential. [4]

The objectives of this study are to:

a) determine an aggregate gradation suitable for local aggre- gates.

b) determine the void ratio percentage that can be reached by using the previously mentioned gravel mixture in acordance with the international researches.

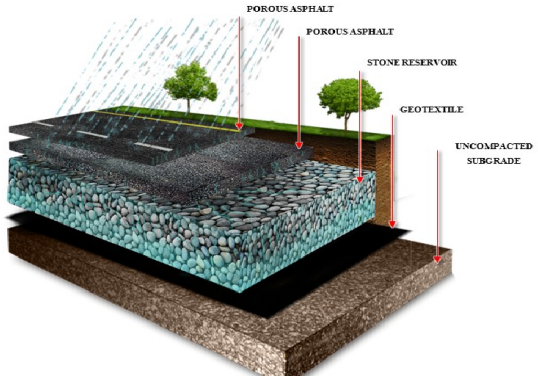


Figure (1): Typical section of Porous Asphalt pavement

## II.ADVANTAGES

There are several advantages for the porous asphalt pave- ment some of them shown in the summary below from sev- eral references:

1. Remove the pollutants and improve water quality. [5, 3]
2. Melting snow and ice fast and reducing the need for de- icing salts [2].
3. Reducing contamination in water runoff and sediment loading [2].
4. Recharging groundwater to underlying aquifers and providing flood control [3, 6].
5. Increasing permeability, potentially improving the water quality through filtering capabilities [5, 7].
6. Improving water and oxygen transfer to nearby plant roots [3, 4].
7. Improving skid resistance, splash and spray, and driving speed [2, 8].
8. Reducing hydroplaning on pavement surfaces by reduc- ing glare on the road surfaces specifically during wet night conditions [5].
9. Absorption of noise from tires and engines (sound is not reflected but absorbed by the porous layer) [2, 8]
10. Reducing fuel consumption due to enhanced smooth- ness [8].
11. Reducing tire wear on the asphalt [8].
12. Extending pavement life due to well drained base [6].

## III.MATERIALS AND TEST RESULTS

### A. Materials properties

In this study, Laboratory tests were performed to evalu- ate the properties of this bitumen: penetration, softening point, ductility, flash and fire point and density of bitu- men. Table (1) illustrates the test results.

Table (1): Bitumen properties and specifications.

| Bitumen Tests | | | |
|---|---|---|---|
| Test | Standard Specifica-tion | Test Re-sult | Specifica-tion Values |
| Density of (g/cm³) | AASHTO T 228-94<br>ASTM D 70 – 03 | 1.03 | 1.01-1.06 |
| Penetration 1/10 mm | AASHTO T 49-96<br>ASTM D 5 – 97 | 68.33 | 60-70 |
| Ductility (cm) | AASHTO T 51-94<br>ASTM D 113 – 99 | 150 | Min 100 |
| Softening Point (°C ) | AASHTO T 53-96<br>ASTM D 36 – 95 | 49.6 | Min 48<br>Max 56 |
| Flash and Fire points | AASHTO T 48-96<br>ASTM D 92 – 02 b | 286<br>+336 | Min 230<br>Max 330 |

Several laboratory tests are conducted on the aggregate to determine their properties, as shown in Table (2).

Table (2): Aggregates Tests According to ASTM Specific tions.

| Aggregates Tests | |
|---|---|
| **Specification** | **Test result** |
| Specific Gravity (g/cm³) | 2.58-2.61 |
| Water Absorption (%) | 1.87-3.0 |
| Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion in the Los Angeles Machine (%) | 19.2 |
| Sieve Analysis of Fine and Coarse Aggregates | See blending table in appendex |
| Materials Finer than (No. 200) Sieve in Mineral Aggregates by Washing | See blending table in appendex |

### B. Blending of aggregates

Several specifications and researches [1, 9] were studied to determine gradation limit curves as shown in the appen- dex. The suggested limits and the result of the aggregates blending used in this study are illustrated in Figure (2). These aggregates were brought from stockpile and the final proportion of each aggregates type in PA and the blending gradation according to the limits curves shows in Table (3).

The method of Blending explained in referance [9] also you could see the appendex B.

Table (3): Blending of Stockpile Aggregates.

| Aggregate Size(mm) | Blending % |
|---|---|
| Simsimia (0/12.5) | 50 |
| Adasia (0/19) | 45 |
| Folia (0/37.5) | 5 |

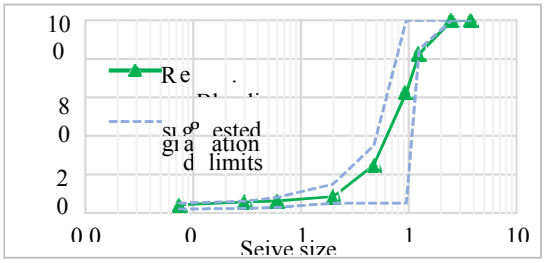


Figure (2): Gradation Curves of Aggregate in Comparison with Limits Curves.

### C. Mechanical Tests results

Marshal Method of asphalt mixture design performs this part to analyze the effect of different percentage of bitu- men content on gradation that we have from previous part to find optimum bitumen content.

The results are shown in Table (4).

Table (4): Marshal samples tests results.

| $m_b$ % | Sta-bility (KN) | Flow (mm) | $\rho_A$ g/cm³ | $V_a$ % | $V_b$ % | VMA % | VFB % |
|---|---|---|---|---|---|---|---|
| 3.50 | 6.57 | 2.85 | 1.90 | 20.90 | 6.45 | 27.37 | 23.64 |
| 4.00 | 4.97 | 2.88 | 1.91 | 20.19 | 8.59 | 27.60 | 26.85 |
| 4.50 | 5.38 | 2.90 | 1.91 | 19.42 | 8.34 | 27.78 | 30.09 |

### D. Optimum bitumen content $m_b$%

Asphalt (bitumen) content ($m_b$%) has to be obtained from optimum bulk density, optimum stability, and Air voids was needed.

Table (5) shows the values of each prop- erty of bitumen content.

Table (5) Values of each property with best bitumen content

| Property | Value | $m_b$% |
|---|---|---|
| Max stability | 6.75 KN | 3.50 % |
| Max bulk density | 1.91 g/cm³ | 4.50 % |
| $V_a$ Required | 20.9 % | 3.50 % |

$$Optimum\ m_b\% = \frac{3.5 + 4.5 + 3.5}{3} = 3.83 \approx 4\%$$

Figure (3) shows the flow of water through the Porous asphalt spec- imen, which has the above properties in table (5)


Figure (3): Porous asphalt specimen while permeability test

## IV. CONCLUSION S AND RECOMMENDATIONS

1. To obtain Porous asphalt mixture, the aggregate grada- tion should be locating inside the limits of the suggested gradation mentioned in Table (6) and shown in appendex A

Table (6) Sieve Size Passing Percent for the limit Curves.

| Sieve Size (mm) | Percent Passing (%) | |
|---|---|---|
| | **Min** | **Max** |
| 22.4 | 100 | 100 |
| 16 | 93 | 100 |
| 12.5 | 85 | 100 |
| 11.2 | 70 | 100 |
| 9.5 | 5 | 100 |
| 4.75 | 5 | 35 |
| 2 | 5 | 15 |
| 0.063 | 2 | 5 |

2. The effective bitumen content that was obtained by mar- shal should be more than 4%, also using bitumen con- tent less than 4% increase the possibility of raveling for the surface of asphalt pavement.
3. The Air Voids ratio obtained is 20% of sample volume, so $V_a$ should not be more than 25% because it de- creases the density, and it increase the weakness of the pavement, and $V_a$% can be (19-22) % in the pavement to achieve enough permeability.
4. The stability of PA samples was lower than the asphalt concrete because of the high percentage of air voids.
5. The values of flow were suitable and in range of (2-4) mm.

# V. REFERENCES

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## APPENDIX A

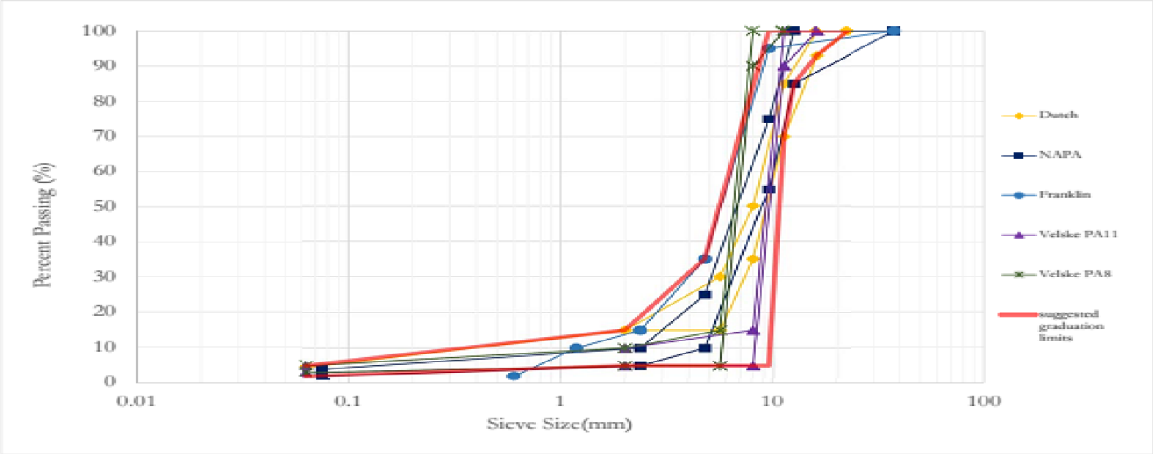


Figure 4: The proposed gradient in comparesion with the international gradients

## APPENDIX B

Table (7). The blending of stockpile samples.

| Agg. Mix | Aggregate Size(mm) | | | | | | | | | Blend-ing % |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0-0.075 | 0.075-0.3 | 0.3-0.6 | 0.6-2 | 2-4.75 | 4.75-9.5 | 9.5-12.5 | 12.5-25 | 25-37.5 | |
| Simsimia (0/12.5) | 5.58 | 1.82 | 0.88 | 4.31 | 31.53 | 55.45 | 0.42 | | | 50 |
| | 2.79 | 0.91 | 0.44 | 2.15 | 15.76 | 27.73 | 0.21 | 0.00 | 0.00 | |
| Adasia (0/19) | 2.72 | 1.31 | 0.21 | 0.31 | 1.22 | 21.18 | 42.31 | 30.73 | | 45 |
| | 1.22 | 0.59 | 0.10 | 0.14 | 0.55 | 9.53 | 19.04 | 13.83 | 0.00 | |
| Folia (0/37.5) | 1.50 | 0.50 | 0.10 | 0.21 | 1.01 | 7.84 | 16.60 | 69.71 | 2.54 | 5 |
| | 0.07 | 0.02 | 0.01 | 0.01 | 0.05 | 0.39 | 0.83 | 3.49 | 0.13 | |
| Total | 4.09 | 1.52 | 0.54 | 2.31 | 16.36 | 37.65 | 20.08 | 17.32 | 0.13 | 100.0 |
| **Req. Blending** | **4.09** | **5.61** | **6.16** | **8.46** | **24.83** | **62.48** | **82.56** | **99.87** | **100.00** | 100.00 |
| **Min of suggested Gradation** | 2 | 2.3 | 2.8 | 5 | 5 | 5 | 85 | 100 | 100 | |
| **Max of suggested Gradation** | 5 | 6 | 8 | 15 | 35 | 100 | 100 | 100 | 100 | |

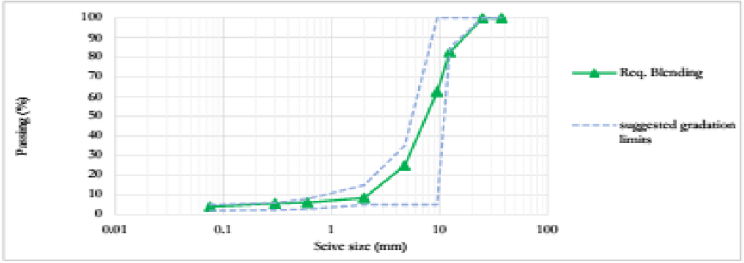


Figure (8): Gradation Curves of Aggregate in Comparison with Limits Curves.

# Potential of Extend Service Life of the Asphalt Pavement by Using Recycled Metallic Particles in the Bituminous Mixture

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**ABSTRACT:** Asphalt is a complex visco-elasto-plastic material with very slow self-healing properties that can be accelerated by means of induction heating. With this purpose, metal particles have to be added to the mixture and heated once the first microcraks appear in the road. By using this method, it is possible to extend the service life of roads by at least 30%. One of the main disadvantages of asphalt induction heating is the in- creased production costs and environmental impact caused by the metallic particles. However, this inconven- ient might be minimized through the use of waste metallic particles. The present investigation explores the use of 4 types of metal particles for asphalt induction heating, 2 of them waste materials. These are (1) steel grit, (2) steel wool, (3) metal fibers from old tires and (4) steel shavings. Results show that even contents be- low 0.45% can produce satisfactory heating and healing results.

## INTRODUCTION

Conventional asphalt roads are made of a mix of aggregates and bitumen. Since the bitumen is a liq- uid with very high viscosity (Read & Whiteoak 2003) it can flow, even at environmental tempera- ture, and self-heal the cracks that might occur due to traffic loads (Garcia et al. 2015). However, this natu- ral process is too slow (Qiu 2008) and requires the disruption of traffic for long periods of time (Garcia et al 2013a). In order to accelerate it, the viscosity of bitumen can be drastically reduced by increasing the temperature of the material. One of the most promis- ing methods that has been recently developed in this regard, is the addition of metal fibers to the asphalt mixture that can be heated by means of external electromagnetic induction (Garcia et al. 2013b). The differential heating between aggregates and bitumen and the consequent differential thermal expansion, produces a confining effect that forces the flow of bitumen through the cracks (Gomez-Meijide et al. 2016). When the temperature decreases to ambient temperature the cracks remain healed.

This not-invasive technology can be applied very easily on-site by means of a coil and a power gen- erator (Garcia et al. 2012) and, as the metal particles remains in the mixture forever, the induction heating can be applied as many times as necessary (Noram- buena-Contreras & Garcia 2016), prolonging the lifetime of the road around

30% for each application (Menozzi et al. 2015).

The alternating electromag- netic field focus the heating energy only on the con-

ductive fibers embedded by the bitumen (Garcia et al. 2012), differently from conventional heating methods based on heat radiation and conduction (Garcia 2012). As a consequence, the induction heat- ing resulted to be very energy efficient, being able to increase the temperature of the bitumen above its flash point in just 1-2 minutes (Ajam et al. 2016). Nevertheless, previous research showed that it is not necessary to reach so high temperatures, being enough increases above the so-called Newtonian Temperature (normally between 50-70 ºC) in order to obtain an effective healing of cracks (Sung et al. 2005, Heyes et al. 1994).

Previous research has proven the important role that the morphology and content of metal fibers plays regarding the healing potential and the me-

chanical properties of asphalt mixtures (Garcia et al. 2013c, 2014). That investigation reported that the fi- bers tend to produce clusters during the first mo- ments of mixing that can affect negatively the me- chanical properties. Although these clusters can be dissolved during prolonged mixing times, they are more likely to appear as long as the fibers content is increased and their diameter is reduced. Neverthe- less, other publications show that metal fibers can be used in asphalt mixtures in order to enhance their strength and fatigue resistance while increasing duc- tility (Brown et al. 1990, Fitzgerald 2000), what contributes to avoid the formation and propagation of cracks (Maurer & Gerald 1989) and improves the re- sistance to ageing, moisture damage and reflection cracking (Goel & Das 2004). Other considered benefits of conductive particles in asphalt mixtures in- clude improving electrical conductivity (Wu et al. 2002, 2005, 2006, Garcia et al. 2009), useful in monitoring (Wu et al. 2009) and defrosting applica- tions (Wu et al. 2006).

Despite previous considerations, the method also involves disadvantages, being the main ones, the in- creased production costs and environmental impact of these mixtures due to the use of metal particles. This inconvenient might be minimized through the use of conductive by-products that can be obtained in great quantities at very low price. At the same time, it would also contribute to reduce the amount of heavy waste disposed in landfills which consid- ered non-biodegradables waste and may remain thousands of years if it's not recycled.

The present investigation explores the use of dif- ferent metal products and by-products, such as (1) steel grit, (2) steel wool, (3) metal fibers from old tires and (4) steel shavings from the metal industry and their affection on the healing properties of as- phalt mixtures.

## 2 MATERIALS AND METHODS

### 2.1 Description of materials

The present investigation was carried out with the following 4 kinds of metal particles (Fig. 1):

(1) Steel grit, normally used for basting, is metal granular material with uniform gradation be- tween 1 and 2 mm.

(2) Steel wool. This product was supplied as very fine fibers with diameter ranging from 16 μm to 72 μm and length from 0.15 mm to 5 mm. It is used in industrial applications, such as the reinforcement of materials ex- posed to high levels of abrasion (for exam- ple, car breaks components).

(3) Steel fibers from old tyres. This recycled product was selected for its low cost and en- vironmental interest. It was obtained as fibers with maximum length 30 mm and average diameter 1.1 mm.

(4) Steel shavings from metal industry. This by- product of metal industry, such as cars manu- facturing, was supplied at zero-cost, being the most economical of the studied kinds of particles. In this case, the helical shape of the fibers did not allow an accurate measurement of lengths and diameters.

The natural aggregate was limestone (density 2.67 g/cm$^3$), whose gradation is graphically described in Figure 2, and the binder used for all the samples was 40/60 pen (density 1.03 g/cm$^3$).

Due to its rounded shape, the steel grit did not present any kind of mixing problem, as it behaved like a conventional aggregate. Additionally, because the fine particle size of the steel wool, it also tended to mix well providing it has been sprinkled to the mix gradually. However, the shavings and especially the fibers from old tyres tended to form clusters dur- ing mixing resulting in mixtures not homogenous and with high air voids contents (Fig. 3). It was checked that the most critical kind of metal particle was the fibers from old tyres (the clusters size for the tyre fibers in some sections reached 55-60 mm$^2$), not being possible the addition of more than 0.45% by volume of dry aggregate (1.2% by mass). Thus, in order to compare the performance of mixtures with the different kinds of fiber, all of them were added in the same proportions: 0.15%, 0.225%, 0.30%, 0.375% and 0.45%.

Another problem detected when old tyre fibres are used is that, due to their greater length and stiff- ness, a series of fibres emerge from the surface even after compaction (Fig. 3). This might cause safety issues for road users if this kind of mixture is used in superficial course layers. For this reason, the use of this type of fibres needs to be restricted to lower lay- ers (i.e.

base layers) providing that a course layer with a different type of fibres is placed on top.

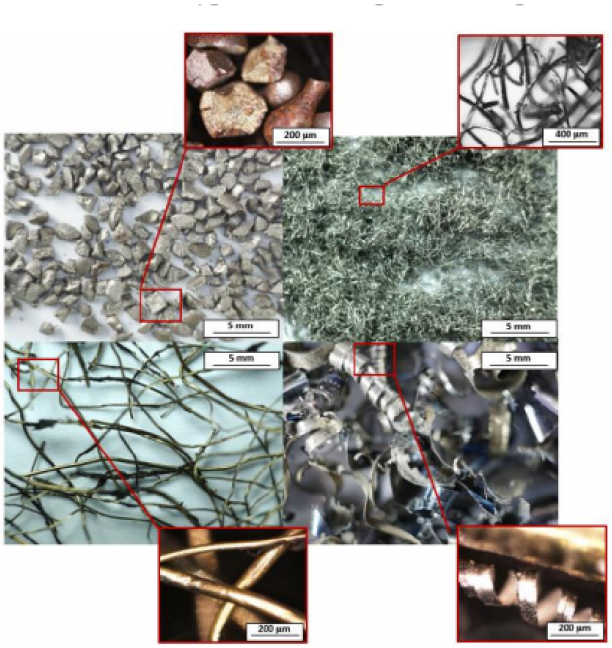


Figure 1. Appearance of the metal particles used in this study: steel grit (top left), steel wool (top right), metal fibres from old tires (bottom left) and steel shavings (bottom right)

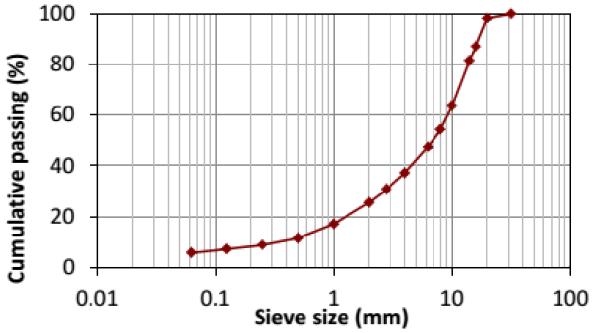


Figure 2. Gradation curve of asphalt samples

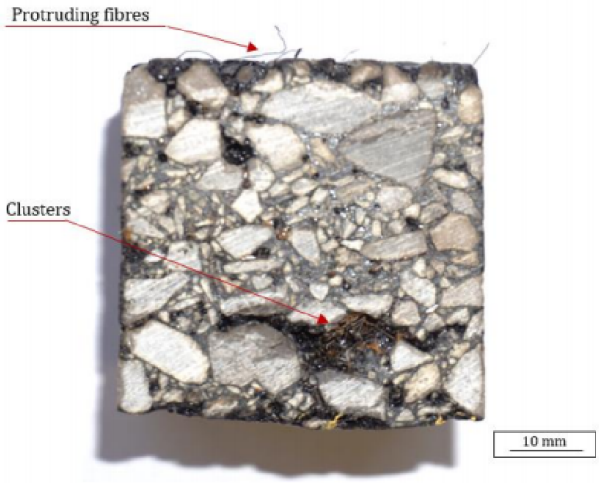


Figure 3. Clusters and protruding fibres observed in asphalt samples when old tyre fibres are used in a 0.45% volumetric content

## 2.2 Manufacture of test specimens

First, 101.6 mm diameter x 50 mm height cylindrical specimens were manufactured by blending 920 g of natural aggregate with the corresponding amount of metal particles and pre-heated at 160ºC. Then, 5.5% of bitumen (by mass of aggregate) was added and mixed for 3 min. This mixing time was enough in order to produce the homogenous distri- bution of metal particles, although the highest levels were achieved by the steel grit and wool thanks to their reduced size. This could be checked by CT- Scans, as shown in Figure 4. The compaction was carried out by applying 50 blows of Marshall Ham- mer to each end of the specimens.

The test samples were produced by cutting the cylindrical specimens through the diametrical plane by a radial saw blade suitable for concrete and stone materials and a notch was cut at the midpoint of the diametrical plane in the direction of the loading, with a thickness= 3 mm and a depth= 5 mm (Fig. 5).

## 2.3 Testing of asphalt self-healing properties

The samples were cooled down to -20±2ºC (to ensure a brittle crack) and split in two halves under 3-point bending conditions (Fig. 5) in strain control with an increasing load ramp at a constant defor- mation rate of 50mm/min. The ultimate force ap- plied at the moment of break is registered as $F_i$. Then both halves were stored at 20±2ºC for 4 hours, put together again into a mould and heated by apply- ing an alternating electromagnetic field. The elec- tromagnetic field was obtained by circulating an al- ternating current of 80A through a 15x15 cm squared coil composed by three windings and placed at a distance of 1 cm above the samples. For each kind of the studied conductive particles, 6 samples were manufactured, healing each of them for a dif-

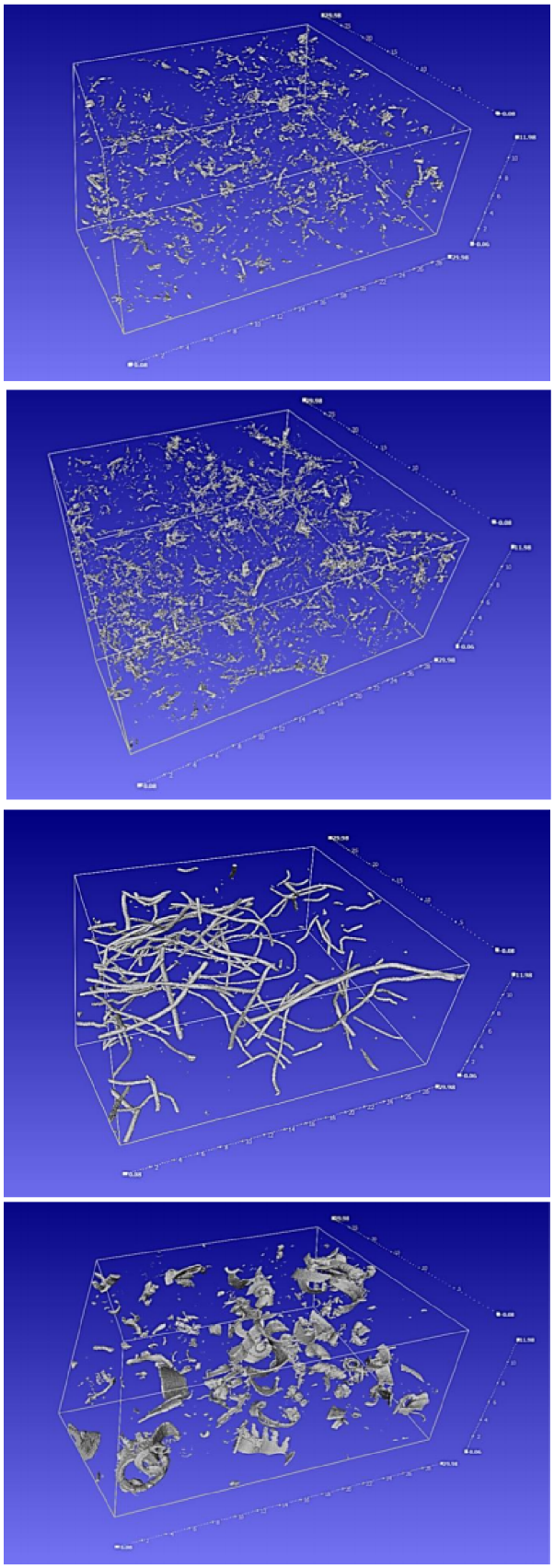

Figure 4. CT-Scans of metal particles after compaction of asphalt specimens. From top to bottom: steel grit, steel wool, fibres from old tyres and metal shavings different heating time (20, 40, 60, 80, 100, 120 s). Fi- nally, the healed samples were cooled plus the energy involved in 4 hours of cooling stage 20±2ºC and the 3-point bending test was repeated under the same conditions explained above. The new ultimate force obtained at the moment of the second brake was registered as $F_f$ and compared to the ini- tial strength through the concept of healing ratio
(HR), giving an idea about the percentage of initial strength that was recovered thanks to the healing process:

$$HR(\%) = \frac{F_f}{F_i} \quad (1)$$

## 3 THEORETICAL FRAMEWORK

### 3.1Healing energy

The healing of a crack in an asphalt material is a process that not only occurs during the heating, but also during the cooling of samples (Fig. 6), as long as the temperature remains above a critical tempera- ture normally so-called Newtonian temperature ($T_{newt}$) (Ajam et al. 2016). Furthermore, the healing will be more effective if higher temperature and/or Washburn equation (Hamraoui & Nylander 2002, Washburn 1921, Duarte et al. 1996). This research will follow this theory. According to the model, the healing happens until it is reached an equilibrium between surface tension, gravity and energy dissipa- tion due to friction. According to Garcia et al. (2013a), after solving the balance of forces and inte- grating, the healing level $S(\tau)$ can be predicted us- ing the following equation:
longer heating time is applied. Hence, in order to fairly compare the healing results of samples that were heated for different times and/or temperatures (as in the present investigation, since not all the fi- bers have the same heating potential), the concept of healing energy was defined in (Ajam et al. 2016) as the area below the temperature-time curve that a cer- tain samples experiments during both heating and cooling stages. The expressions that mathematically give such an area, in units of K·s are given by Eq. 2 and 3 for heating and cooling phases respectively:

$$\tau_h(t) = T_{ss} \cdot t + \frac{T_{ss} - T_{air}}{k_h}\left(e^{-k_h t} - 1\right) \quad (2)$$

$$\tau_c(t) = T_{air} \cdot \left(t - t_{heat}\right) + \frac{T_{max} - T_{air}}{k_c}\left(1 - e^{-k_c(t - t_{heat})}\right) \quad (3)$$

Where $\tau_h$ and $\tau_c$ are the healing energies obtained during the heating and cooling stages; $k_h$ and $k_c$ are heat transfer coefficients ($s^{-1}$) during the heating or the cooling phase respectively. $T_{air}$ is the ambient temperature (293±2 K); $T_{ss}$ is the steady state tem- perature that the samples reach after a certain heat- ing time and never exceed, since the heating energy is balanced with the energy dissipation to the envi- ronment (in K); and $t_{heat}$ is the heating time (s).

Since the samples were cooled at ambient tem- perature for 4 hours and then stored at -20±2ºC, time at which the healing process was considered fin- ished, the total energy will be calculated as the ener- gy applied during the whole heating stage ($t=t_{heat}$)

plus the energy involved in 4 hours of cooling stage ($t$=14,400s):

$$\tau = \tau_h(t_{heat}) + \tau_c(14{,}400s) \quad (4)$$

### 3.2 *Asphalt self-healing theory*

In (Garcia et al. 2013a) it is explained that heal- ing of cracks in asphalt mixture starts when both faces of a crack are in contact. Then, bitumen can drain from the mixture into the cracks, healing them. In (Garcia et al. 2013a) the capillary phenomena were studied through a modification of the Lucas–Washburn equation (Hamraoui & Nylander 2002, Washburn 1921, Duarte et al. 1996). This research will follow this theory. According to the model, the healing happens until it is reached an equilibrium between surface tension, gravity and energy dissipa- tion due to friction. According to Garcia et al. (2013a), after solving the balance of forces and inte- grating, the healing level $S(\tau)$ can be predicted us- ing the following equation:

$$S(\tau) = \frac{C_1}{F} \cdot e^{-D\tau}\left(-1 + e^{\frac{D\tau}{2}}\right)^2 \quad (5)$$

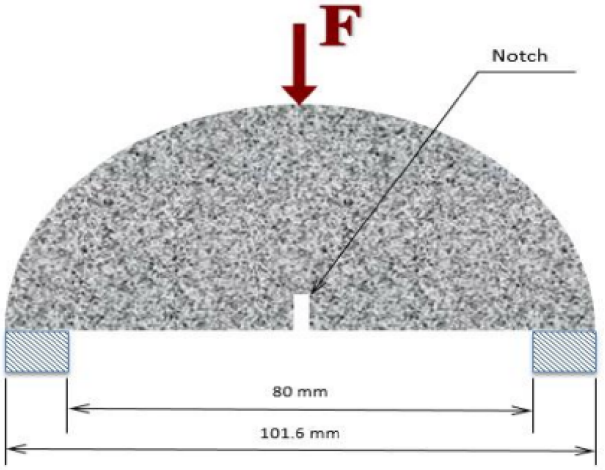


Figure 5. Setting for healing test

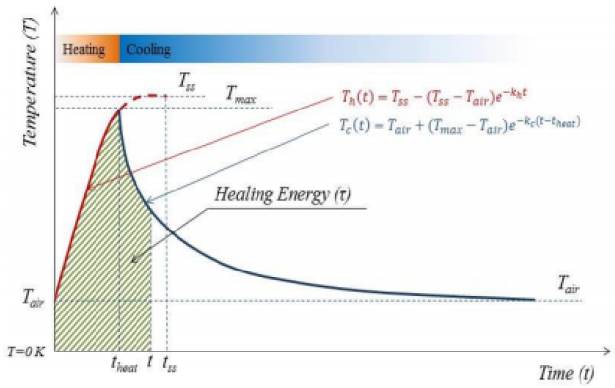


Figure 6. Temperature changes during the heating and cooling processes

Where S(τ) is the healing rate or percentage of re- covered strength after the healing treatment (%), $F_0$ is the initial 3-point bending strength of the test samples (kN), τ is the energy applied during the healing (K·s) and D and $C_1$ are parameters that can be calculated as:

$$D = \frac{\rho g r}{\beta} \quad (6)$$

$$C_1 = 8\frac{\sigma_u \cdot C}{L \cdot H} \quad (7)$$

Where $\rho$ is the density ($kg/m^3$), g is the gravity ($m^2/s$), r is the width of the crack (m), β is a dimen- sionless parameter that takes into account possible sources of energy losses, $\sigma_u$ is the maximum force resisted by the beam (N), L is the span of the beam
(m), H is its height and C is a material constant with units ($m^2$). Furthermore, the D value is an indication
of the healing rate, when its value increases, the

healing happens faster.

In the present research, this model will be fitted to the experimental data in order to better clarify the trends followed by the results and compare them de- pending on the type of metal particle that was added to the mix.

## 4 RESULTS AND DISCUSSION

As an example, the experimental healing ratios obtained by samples with steel wool at different healing energies can be seen in Figure 7 for asphalt samples containing 5 different metal contents. Moreover, the model described in Eq. 5-7 was fitted to these data, unravelling the correlation between all these factors. As expected, a direct correlation be- tween the healing ratio and both the healing energy and the metal content in the mix could be observed.

This double increasing trend was also found for the other sorts of metal particles, although not so sharp. In order to illustrate it, a reference healing energy was chosen (in this case 4.3·106 K·s, obtained approximately after 120 s of heating) and the healing ratios obtained by different contents of different types of particles were gathered in Figure 8. Besides the mentioned increasing correlation, it is also no- ticeable that steel grit tends to produce, in general,

Figure 8. Healing ratios obtained with different contents of dif- ferent types of conductive particles after heating for 120s

the highest healing values (average 38.4%), followed by the tyre fibres (33.4%) and the shavings (18.5%). With steel wool, it is possible to obtain healing ratios comparable to the grit but only for the highest studied contents, as for the lowest, the per- formance resulted even close to the shavings.

Once explained this, it must be also mentioned that, as explained above, due to their greater length the tyre fibres tended to make clusters during the mixing when the content exceeded 0.45%. In this case, none of the studied samples contained more.

than that but it was detected than after splitting the samples by the first time, it was very difficult to put both sides of the crack together due to the interfering fibres. This fact could have produced reductions on the experimental healing ratios, especially for the highest contents. Proof of this, are the satisfactory results obtained for low contents and the exceptional temperature that these fibres can gain under electromagnetic induction, compared to the rest (Figure 9). In a real case, the cracks to be healed would be product of small deformations at a micro-scale, re- maining both sides of the cracks very close to each other. Therefore, the performance of this kind of fi- bre is expected to be significantly better than as shown by this simplified test.

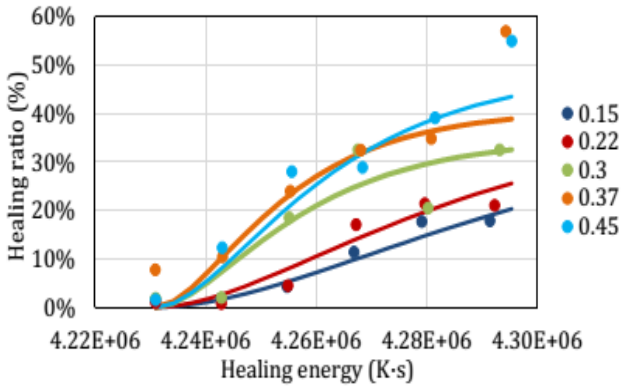


Figure 7. Relationship between the healing ratio and the healing energy and fitting of the model to the experimental data obtained by samples with different contents of steel wool (0.15%, 0.22%, 0.30%, 0.37% and 0.45%)

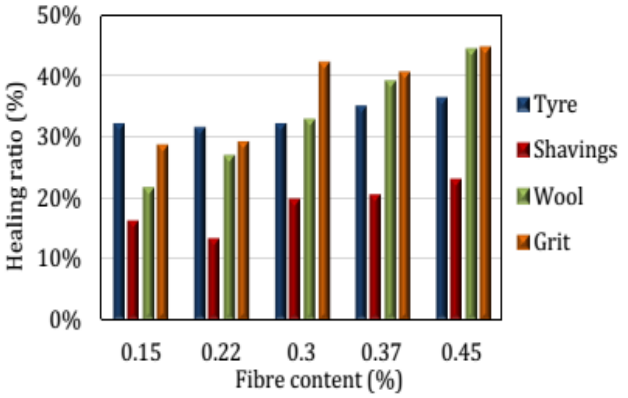


Figure 8. Healing ratios obtained with different contents of different types of conductive particles after heating for 120s

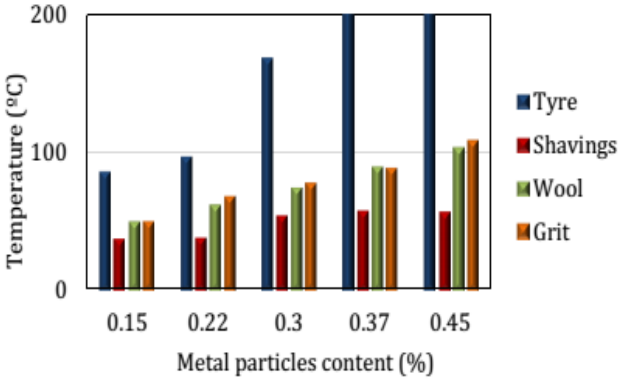


Figure 9. Temperature of samples with different contents of different sorts of metal particles after being heated for 100 s

As can be seen, the temperatures obtained by these fibres can even reach the bitumen flashpoint. This is obviously counterproductive, not only due to the damage that this can produce to the binder, but also from the point of view of health and safety of workers implementing the healing technology. Nev- ertheless, it must be taken into account that these re- sults were obtained with a distance between coil and sample of 1 cm. As these fibres were already reject- ed to be used in superficial course layers due to the emerging spikes and considering that the induction heating potential decreases exponentially with the distance between coil and metal, these fibres become again very recommendable for lower layers (i.e. base layers). On the other hand, steel grit and steel wool are more advisable for their use in superficial layers, close to the induction coil. Due to the poorer results obtained with metal shavings, further investigation would be advisable in order to improve its healing capacity.

Finally, the increasing trends show that in order to improve the healing ratios, it would not be neces- sary to increase the content of metal particles, and consequently the price of the asphalt mixture. For this purpose, it would be enough to increase the healing energy by increasing the current intensity through the induction coil (in this case only 80A were used) and/or the heating time (for the present research no times longer than 120 s were studied).

## 5 CONCLUSIONS

Since the fibres from old tyres tended to produce clusters during the mixing process, the maximum volumetric content was limited to 0.45%, although the rest of particle types, due to their smaller size, could have been added in greater proportions. Nev- ertheless, the healing results were satisfactory with such a low contents, at low induction intensity (80A) and with a maximum testing time of only 2 min, be- ing enough to increase any of these parameters to reach higher healing results. In any case, the objec- tive of the present paper was not the optimisation of any of them, but a comparison of properties obtained with the four types of metal particles. From such a study, the following conclusions could be obtained:

1- For a given heating time, the fibres from old tyres increase the temperature of the samples significantly more than the rest of the fibres. This difference was not observed in the heal- ing results but probably due the configuration of the healing test. It is expected that this type of fibre produces healing rates significantly higher than those observed when only mi- crocracks are produced in real conditions.
2- For all the fibres studied, the healing ratio is proportional to the metal particles content and to the applied healing energy. Steel grit and wool produced healing results very similar and satisfactory, while the results obtained by the shavings were considerably lower.
3- Further deeply studies should be done to ex- amine the side effects that may occurred like corrosion of these steel fibres. Where the metal fibres in asphalt pavement may be rust- ing by frequent touching of water (like : Rain- fall that leaching into pores and voids of as- phalt pavement ).
4- Designing a real section of asphalt pavement at a certain road ( for example 100m in length) according to the results of this study. This is in order to explore more facts about adding metal fibres into asphalt mixture. And once micro-cracks appear, electromagnetic induction should be applied. Hereafter , the healing time, healing ratio , healing energy and heating temperature should be analysed And a decision can be made on the efficacy degree of these fibres in the maintenance of cracks in the asphalt roads.

Taking into account the previous conclusions, in order to increase the healing ratios, the amount of metal particles (with exception of fibers from old tyres) could be increased, what would also increase the price of the mixture. As an alternative, it would be enough to increase the healing energy by increas- ing the current intensity through the induction coil (in this case only 80A were used) or the heating time (for the present research no times longer than 120 s were

studied).

From the studied types of fiber, it can be recom- mended the use of fibers from old tyres for lower layers (i.e base layers). These fibers have great heat- ing potential what can be translated to higher healing ratios, even when they are placed far from the sur- face and the induction coil. In addition, their waste nature make them a cheaper and more sustainable product whose use in base layers (the thickest one) can contribute to reduce the ecological impact of roads without increasing the costs and needs of raw materials in a significant way.

For superficial course layers, it is advisable the use of steel wool or grit. They behave very similar and satisfactory when placed close to the surface. In addition, they can be mixed very easily, not produc- ing clusters or emerging spikes.

## 6 ACKNOWLEDGEMENTS

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# Review: Indoor Air Quality and the Risk of Lower Respiratory Tract Infection

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**Abstract**—Indoor air pollution is a major environmental risk to public health. Specifically, acute lower respiratory infections associated with indoor air pollution is a major cause of morbidity and mortality in children under 5 years. This review analyses literature data on indoor air quality and health, ventilation effectiveness, environmental tobacco smoke, thermal comfort and heath, and crowdedness and health for the past 10 years. Consequently, a valid framework was drawn to address the relationship between indoor air quality and Lower respiratory tract infection from the Palestinian perspective.

Keywords—Indoor air quality; lower respiratory tract infection; Palestinian; Thermal comfort; Ventilation.

## 1 INTRODUCTION

Air pollution is considered to be one of the main challenges facing humans in the 21st century. It is seen asa severe threat to national health in many countries, hence the enforcement of strict regulations, among other solutions, in order to reduce its impacts as much as possible [1]. Pollutants range from chemicals, gases, or living organisms like mold and pests. They could be liquid, solid, gaseous, radioactive, or microbial chemicals suspended in the air. Therefore, sources of indoor pollutants are in homes, schools, and offices [2] .

Pollution is generally caused by different human activities related to industry, construction, transportation, or natural resources, which adversely affect humans, animals, and plants [3].

Exposure to Air pollutants may cause health problems such as sore eyes, burning in the nose and throat, headaches, or fatigue. Other effects include allergies, respiratory illnesses (such as asthma), heart disease, cancer, and other serious long-term conditions. Sometimes, individual pollutants at high concentrations such as carbon monoxide cause death [2].

Apart from outdoor pollutants, Pollutants released due to human activities indoors such as combustion of fuels for cooking or heating, lead to a broad range of health problems and may even be fatal [4]. The quality of air inside homes, offices, schools, day-care centers, public buildings and health care facilities where people spend a significant part of their time, is an essential determinant of healthy life and people's well-being. Good indoor air quality is essential for human wellbeing, while poor indoor environment may lead to several health problems, including infectious diseases; stress and depression [5].

Globally, more than 1.5 million deaths caused by respiratory infections annually are attributable to environment factors. About 42% of these causalities are due to lower respiratory tract infections (LRTI) and approximately 24% are caused by upper respiratory infections in developing countries [6]. Acute lower respiratory

infections remain the single most important cause of death globally in children under 5 years and it accounts for around 2 million deaths annually in this age group. There are several studies in Least Developed Countries (LDCs ) including Palestine which report the correlation between indoor air pollution exposure and acute lower respiratory infections [7].

Effective Pollutants control has the potential to reduce the global burden of life threatening diseases such as respiratory infections, heart disease, and lung cancer. According to WHO, nearly 50% of pneumonia deaths among children under five were due to particulate matter inhaled from indoor air pollution [8]. Many Studies show a direct relationship between certain concentrations of air pollutants and internal health problems, such as: allergies, asthma, bronchitis, pneumonia and lung cancer [9].

The aim of this study is to review previous literature on indoor air quality and its relationship with lower respiratory tract infection. The outcome will provide a valuable basis for proposing a framework to investigate this challenge in the Palestinian scenario.

## 2 INDOOR AIR QUALITY

This section reviews the literature on the quality of air at indoor environments. According to Ambu et al., [10], 24% of illnesses worldwide, caused by exposure to environmental pollutants , are preventable. . Furthermore, 33% of childhood diseases are credited to the same cause and these can be prevented too.

Fisk, studied the relation between indoor environment and airborne transmission of infectious diseases and his research found that improvements in the indoor environment may reduce the sick leave due to infectious diseases up to 9-20 % [11]; [12].

Globally, 20 % of the population suffer from asthma and other allergic diseases caused by substances present in indoor environments. Indoor pollutants such as tobacco smoke, radon, asbestos and benzene may substantially contribute to the increase of cancer incidents in the population [13] .

As stated by Kirk et al., acute respiratory infection (ARI) is the most common cause of disease in children and a major cause of death in the world. Among children under five years of age, three to five million deaths annually were attributed to ARI, of which 75% are from pneumonia [14].

Tabaku, et al., studied the effects of air pollution on children's pulmonary health and the results propose that air pollution is associated with respiratory health of children causing a slight decrease in values of children pulmonary function in urban areas compared with those of suburban areas [15].

House inhabitants may be exposed to a multiplicity of pollutants from cleaning products, carpets and furnishings, perfumes, cigarette smoke, microbial growth (fungal / mold and bacterial) and insects. Other factors such as indoor temperatures, relative humidity, and ventilation levels can also affect how individuals respond to the indoor environment quality [16].

The economic implications of environmental pollution are also massive. For instance, The United States can save between $6 billin to $14 billion from reduced respiratory illness, $1 billion to $4 billion from reduced allergies and asthma, $10 billion to $30 billion from reduced sick building syndrome (SBS) and $ 20 billionto $160 billion from worker performance and productivity gains [11].

The indoor environment in any structure is a result of the contact between the site, climate, building system, construction techniques, contaminant sources (building materials and furnishings, carpets, moisture, processes and activities within the building), and these environmental factors which may cause several problems in the lower respiratory tract problem [17].

A study conducted by Kovesi et al., investigated the relationship between indoor air quality and the risk of lower respiratory tract infections in young Canadian Inuit children. The results showed that the mean ventilation rate per person was 5.6 L/s , 80% (37/46) of the houses had ventilation rates below the recommended rate of 7.5 L/s per person. The mean indoor carbon dioxide ($CO_2$) concentration of 1358 ppm was higher than the recommended target level of 1000 ppm and smokers were present in 46 homes (94%) [18].

Furthermore, 55% of the children had a history of lower respiratory tract infection; and lower respiratory tract infection was significantly associated with mean indoor $CO_2$ levels, occupancy, relative humidity and age of houses. Many factors increase the risk of lower respiratory tract infections in children less than 5 years of age, such as reduced ventilation, crowdedness,

environmental tobacco smoke and other contaminants of indoor air [18].

According to the U.S. Green Building Council (USGBC), indoor environmental quality (IEQ) is one of the main categories in their program of Leadership in Energy and Environmental Design (LEED) certification. It consists of indoor air quality, thermal comfort, acoustics, daylight and views. However, IEQ is comprised of many more complex factors that may have an effect on the occupants as shown in table 1 [19].

Table 1.The IEQ category.

| Indoor Environmental Quality category | |
|---|---|
| Prerequisite 1 | Minimum IAQ Performance Required |
| Prerequisite 2 | Environmental Tobacco Smoke (ETS) Control Required |
| Credit 1 | Carbon Dioxide ($CO_2$) Monitoring |
| Credit 2 | Ventilation Efficiency |
| Credit 3 | Construction IAQ Management Plan |
| Credit 4 | Low-Emitting Materials |
| Credit 5 | Indoor Chemical and Pollutant Source Control |
| Credit 6 | Controllability of Systems |
| Credit 7 | Thermal Comfort |
| Credit 8 | Day lighting and Views |

adopted from [19].

## 3 INDOOR AIR QUALITY AND HEALTH

Al Khatib showed that IAQ is a challenge to environmental health, where the air pollutants are not only physical attributes and chemicals but also microbiological agents [20]. According to Environment Canada, diseases such asthma, lung cancer, cardiovascular disease, allergies and many other human health problems were linked to poor indoor air quality [21].

Common sources of indoor air pollution include tobacco smoke, biological organisms, building materials and furnishings, cleaning agents and pesticides, in addition to airborne lead and mercury vapors. Indoors, the chief source of lead is paint, and all these may cause serious health risks, mainly for the respiratory system [20]

Ambu, et al., states that the health influences due to poor IAQ can be classified as acute or chronic. Examples are asthma, respiratory infections, allergic rhinoconjunctivities, lung cancer and pulmonary tuberculosis. These health impacts are referred to as Sick Building Syndrome (SBS) and BRI (Building Related Illness) [10].

Marmot et al., classified IAQ into physical factors, chemical factors and psychosocial factors which have been found to be linked with building related illnesses (BRI), the symptoms of BRI that are attributed to the physical environment of specific buildings are part of the SBS. physical factors associated with building-related illnesses can range from temperature, humidity, and air movement to dust, lighting and noise, while chemical factors include pollutants arising from paint, carpets, new furniture, environmental tobacco smoke (ETS), drapes, cosmetics asbestos and insecticides [22].

In the study by Ambu, et al., indoor air quality may have significant effect on health which decrease production and economy of a country. It has been estimated that in the US, building related illnesses (BRI) symptoms have a relationship with decrease (3% to 5%) in work performance in an affected population resulting in an annual loss of US 60$ billion in revenue [10].

Seppanen and Fisk studied the relationship between ventilation system type and SBS symptoms in the office of workers and they found that there was an increase in SBS symptoms associated with mechanically ventilated buildings [23].

Syazwan Aizat et al., studied the association between SBS and indoor air pollutants in two different houses (old and new) from April to September 2008. The study results showed that indoor pollutants in old construction were high, while new construction found high values of temperature humidity index (THI) and ultra-fine particle (UFP), where the level of THI and $CO_2$ concentration were the major factors which contributed to SBS complain among office workers [24].

A study conducted by Fisk and Rosenfeld, showed that the yearly cost of indoor air quality associated impacts is $100 billion. These costs are incurred due to SBS, BRI, absenteeism, operation and maintenance cost of problematic buildings [25].

Dasgupta, et al., examined the improvement of indoor air quality in poor families' houses. It was concluded that if cooking with clean fuel is not possible, then kitchens should be built with porous materials providing good ventilation, which will lead to better indoor environment quality [26].

A study conducted by Misra et al., investigated the association between acute lower respiratory infection (ALRI) and low birth weight (LBW) attributable to Indoor air pollution (IAP) in children under the age of 5 [27]. The findings show that the risk of ALRI increased by 2.51 times, while the risk of LBW increased by 1.45 times due to IAP exposure. Similarly, Ballester, et al., investigated exposure to air pollution during pregnancy and anthropometric

measures at birth in a cohort in Valencia, Spain. The results suggest that maternal exposure to air pollution may retard foetal growth [28] .

Breysse, et al., studied indoor air pollution and asthma in children, the outcome suggests that modifying the indoor environment to reduce particulate matter, $NO_2$ and mouse allergen may be an important asthma management strategy [29]. EU Joint Research Center (JRC), showed that indoor air pollution leads to high health risks and indoor air can be at least two times as polluted as outdoor air [30].

Mustafic, et al., discovered that all the key air pollutants excluding ozone were significantly associated with a short-term increase in myocardial infarction (MI) risk [31]. While Ciencewicki and Jaspers, highlighted an association between air pollutants and the increased risk of respiratory virus contaminations [32].

Kumar et al., investigated the effects of indoor air pollution on respiratory function of children (aged 7-15 years), during the summer months (June - July 2004). Indoor air pollutant (suspended particulate matter, $SO_2$, $NO_2$) was measured, and the effect of these pollutants on the children's respiratory function was analyzed. the respiratory health profile suggests that children had cough, sputum production, and shortness of breath, wheezing, common cold, and throat congestion. Furthermore, the results showed that indoor $SO_2$, $NO_2$, and suspended particulate matter levels were high in houses with history of smokers [33].

St-Jean et al., investigated the associations between building characteristics and IAQ in day-care centers (DCCs) in a randomly selected sample of 21 DCCs having space for at least 40 children. Temperature, relative humidity, and concentrations of $CO_2$, formaldehyde and volatile organic compounds were measured in January and February 2008 in rooms which accommodate children aged between 18 and 60 months. The sampling was conducted in the winter when building ventilation was generally low. Results showed that most DCCs (81%) had a mechanical ventilation system [34]

85% of the DCCs had a mean $CO_2$ concentration higher than 1000 ppm, the value generally targeted for comfort in buildings. Mean $CO_2$ concentrations were significantly lower in DCCs having a floor space meeting the provincial standards [34].

Tramuto et al. investigated the short-term exposures to particulate matter and gaseous ambient pollutants including carbon monoxide, nitrogen dioxide, sulfur dioxide and emergency room admissions for respiratory symptoms. The results showed a positive association between the pollutants and the emergency room admissions for respiratory symptoms, particularly during the warm season [35].

a. Ventilation effectiveness and health

Ventilation helps in maintaining human health, where the objectives of ventilation are, to eliminate pollutants such as(bacteria, Water vapour, smoke, soot, mist, fumes, pollen, plant fibres, mould spores, viruses, carpet fibres, furniture fibres), to deliver a continuous supply of oxygen necessary for human living and to eliminate production of heat, moisture and carbon dioxide from people [36].

Air circulation is an essential factor for maintaining healthy indoor air quality. Prevalence of infectious diseases (respiratory illnesses) seem to be influenced by ventilation [13]. According to [16], ventilation is a vital factor which influences the relationship between airborne transmission of respiratory infections and productivity of workers.

Wargocki, et al., investigated the effects of outdoor air supply rate in an office on perceived air quality, SBS symptoms and productivity. The results showed that raised ventilation effectiveness can help to reduce the intensity of SBS symptoms, enhancing the perceived air quality and productivity of the residents [37].

Roy, et al., studied the relationship between indoor air pollution and lung functions growth among children. The results showed that residents with excellent home air circulation are linked with significantly higher lung function growth while poorly ventilated homes are linked with significant decrease in children's lung function growth [38].

b. Environmental tobacco smoke (ETS)

Sick Home Syndrome (SHS) in common is responsible for 600,000 premature deaths every year. SHS has been identified as a main cause of premature death and disease in non-smokers [39]. Saade found that exposure to SHS among children is a main pediatric problem and it is linked with high risk of many diseases such as

sudden infant death syndrome, acute respiratory infections, ear problems, and increased severity of asthma symptoms [40].

A study conducted by Héroux, et al., investigated indoor air concentrations in smoking and non-smoking residences. The results showed that smoking households had higher $PM_{2.5}$ levels than non-smoking households [41]. Also referred to as involuntary smoking, passive smoking, or ETS [42]. Several studies showed that passive smoking or SHS increases the risk of several adverse outcomes in children, including lower respiratory tract infections, middle ear infection, asthma, and sudden infant death syndrome.

Findings from Suzuki, et al., show that exposure to environmental tobacco smoking (ETS) is associated with an increased risk of hospitalized pneumonia among children under 5 years old. consequently, 44,000 additional children are hospitalized annually due to pneumonia [43].

Kurz and Ober, studied the role of environmental tobacco smoke in genetic susceptibility to asthma, exposure to environmental tobacco smoke exposure, linked to polymorphisms or chromosomal [44].

Smith, et al., studied indoor air pollution in developing countries and its relationship with acute lower respiratory infections in children. The outcome highlighted a strong significant rise in risk for exposed young children compared with those who are living in households that are using cleaner fuels [45].

According to Kurmi, et al., (2010), there is a positive link between the use of solid fuel and chronic bronchitis. Collective evaluations for different types of fuel show that exposure to firewood smoke presents a greater risk to chronic bronchitis [46]. A study conducted by Po et al., (2011) revealed that Biomass firewood is linked to diverse respiratory diseases in rural people [47].

Abusalah, et al., studied the relationship between low birth weight and prenatal exposure to indoor pollution from tobacco smoke and wood fuel smoke. The results showed that low birth weight is a significant health problem associated with passive maternal exposure to numerous tobacco and firewood smoke during pregnancy [48].

c. Thermal comfort and health

U.S. Environmental Protection Agency (EPA) reported that humidity is a source of thermal comfort. when relative humidity (RH) increases, the ability to lose heat through sweat and vaporization decreases, with an effect similar to raising the temperature [17].

Canada Mortgage and Housing Corporation (CMHC), showed that more than enough or insufficient humidity can produce a host of difficulties for persons who own houses as shown in Table 2 [49].

**Table 2. Humidity problems**

| | **Too much humidity** | **Too little humidity** |
|---|---|---|
| **Typical symptoms** | ❖ Condensation on windows<br>❖ Wet stains on walls and ceilings<br>❖ Moldy bathroom<br>❖ Musty smells<br>❖ Allergic reactions | ❖ Chapped skin and lips<br>❖ Scratchy nose and throat<br>❖ Breathing problems<br>❖ Static and sparks<br>❖ Problems with electronic equipment |
| **Long-term effects** | ❖Damage to the house and its contents<br>❖Ongoing allergies<br>❖Other health problems | ❖ Continuing discomfort<br>❖ Damage to furniture and other items |

Adopted from [49]

Temperature is the main environmental variable which effects thermal feeling. However the influence of temperature can be changed by the humidity and air movement [13].

The Eurowinter Group studied the relationship between cold exposure, winter mortality from ischemic heart disease, cerebrovascular disease and respiratory disease in warm and cold regions of Europe. The results showed that low indoor temperatures during winter were linked with raised death rates mainly among the elderly from respiratory and cardiovascular diseases [50].

According to study by Xu et al., children are more sensitive to hot and cold temperatures than adults because of hysiological, metabolic and behavioral characteristics. Children under one year of age are at high risk of heat- related mortality, where emperature extremes are prone to cause more morbidity mong children with regards to infectious diseases and allergic diseases [51].

A study conducted by Ma¨kinen, et al., revealed that the development of RTIs is increased by cold exposure and lowered humidity in a northern population. The results also showed that cold temperature and low humidity were associated with increased occurrence of RTI [52].

Munch showed that the occurrence of great relative humidity in structures, especially when attended by warm temperatures can encourage the presence of dust mites in buildings with carpets and other soft furnishings. These factors cause asthma and other allergic diseases, where great relative humidity can also be a strong cause for moulds growth [53].

Humphreys et al., advised the use of low dwell air temperature and low relative humidity in the winter for a better IAQ and energy economy [54]. Arundel, et al., examined indirect health effects of relative humidity in indoor environments The results showed that the contaminability of these organisms is reduced by exposure to relative humidifies between (40-70) % and mite inhabitants are reduced when the relative humidity is below 50% while it reaches an extreme size at 80% relative humidity. Most type of fungi cannot grow unless the relative humidity exceeds 60% and the majority of adverse health effects caused by relative humidity would be minimized by maintaining indoor levels between 40 and 60 % [55].

Frankel, et al., studied the relationship between seasonal variation of indoor microbial exposures, temperature, relative humidity and air exchange rates. Final results demonstrated that temperature, relative humidity and air exchange rates were significantly associated with numerous indoor microbial exposures. Season significantly affects indoor microbial exposures, which are impacted by temperature, relative humidity and air exchange rates [56]

Andriessen, et al., studied the relationship between home dampness and respiratory health status in European children during the winter of 1993 – 1994. The results show that the occurrence of cough and upper respiratory symptoms was significantly higher in children living in houses with informed moulds than in dry homes. Also there was a positive link between the peak flow variance of respiratory symptoms and the moulds living [57].

In Australia, Garrett, et al., studied the relationship between house dampness, levels of airborne fungal spores, housing factors and the health outcomes in children. This study was conducted on 80 households with 148 children aged 7 – 14 years in the period between March 1994 and February 1995. The results showed that indoor exposure to certain fungal types in winter was a risk factor for asthma, allergy, and respiratory symptoms [58].

According to a study by Valerie, there are strong links between dampness and headaches, sore throats, and respiratory problems including asthma, especially among children [59]. Segala, et al., studied the relationship between emergency hospital visits for bronchiolitis and air pollution in the Paris region during four winter seasons. The results showed that air pollution may cause acute bronchiolitis cases and the risk of bronchiolitis increased with cold temperature, high humidity and strong wind [60]

In Europe, a study conducted by Andriessen, et al., evaluated the association between home dampness and incidence of respiratory symptoms. The study showed that occurrence of cough and upper respiratory symptoms was significantly higher in children living in houses with reported molds, compared with ‘dry’ homes [57].

Spengler, et al., conducted a study on 9–11 years old children in 24 North American communities and the results showed that chronic respiratory symptoms (bronchitis, asthmatic and lower respiratory) were significantly associated with reported home dampness and presence of moulds [61].

In Finland, Jaakkola, et al., studied the association between home dampness and moulds as determinants of respiratory symptoms and asthma in pre-school children.

The study revealed that stubborn cough, wheezing, phlegm and nasal symptom were positively associated with the presence of moisture and visible moulds. In this study, asthma was not found to be associated with home dampness [62].

In the United States of America (USA), Brunekreef, et al., observed the association between measures of home dampness and respiratory illness and symptoms in a cohort of 4,625 children of age 8- to 12 years old who are living in six U.S. cities. The results showed that there was a reliable and strong link between reported dampness in the home and childhood respiratory symptoms. They discovered only a weak, insignificant association between home dampness and pulmonary function [63].

A study conducted by Douwes, showed that cold households have been linked with increased prevalence of respiratory symptoms and other chronic health problems [64]. In Thailand, based on a 2012 literature review conducted by Guo et al., exposure to both hot and cold temperatures were associated to increased death. Both cold and hot effects occurred directly, but cold effects lasted longer than hot effects temperatures on population health [65].

In England and Wales, a study conducted by Langford and Bentham, showed that high temperatures had significant effects on deaths from all causes, chronic bronchitis, pneumonia, ischemic heart disease, and cerebrovascular disease [66].

WHO conducted a case-control study of asthma in the West bank and Gaza Strip, including participants in villages, cities and refugee camps. The results showed that 62 of 110 dwellings (56%) had observable moulds on the walls and ceilings. Another study in Ramallah City showed that the occurrence of houses characterized as damp with visible moulds was the highest in the refugee camps, where 75% of the houses investigated were affected [67].

According to a study conducted in the West Bank by Al-Khatib et al., 188 randomly selected houses in the Al-Ama'ri refugee camp located south of Ramallah city revealed that 78.2% of the houses had damp problems, leaks or indoor moulds [20]. When the humidity decreased in the indoor dwelling, this residents experienced improved comfort and air quality [68].

Fisk et al, study showed that the occurrence of dampness or moulds in houses is approximately 50 % [69]. In Singapore, the occurrence of dampness in the child's bedroom was 5% and that of mould was 3%, of the studied 4759 children houses [70].

Yang,et al., investigated the relationship between dampness in houses and respiratory symptoms in 4,164 primary school children in the subtropical rural areas of the Kaohsiung region. This study showed that 12.2% of the parents or guardians considered their dwelling to be damp; 30.1% informed the occurrence of visible mould inside the house in the past year; 43.4% informed about the presence of standing water, water damage or leaks; and 60% informed about at least one of these incidences [71].

d. Crowdedness and health

Overpopulation in households cause ill-health due to easier spread of disease and lack of private space, which results in stress. Because overpopulation is related to socioeconomic level, the poor often have little choice but to live in restricted situations [72].

Ibsaiss studied the impact of housing conditions on the health of the people at Al-Ain refugees Camp in Nablus district/Palestine, with a focus on upper Respiratory Tract diseases, during the period of January to February 2003 using interviews. The results showed that 47% of children sleep alone, while 23.5% of children share bed with another child, 8.1% of children share with two other children, 3.4% of children share with three other children. Furthermore, 34.2% of houses have no resident smoker, while 49% have one resident smoker,10.4% have two resident smokers and 3.4% have three family members who smoke. overcrowding is linked with other factors such as income and exposure to other risk factors such as tobacco smoke [73].

Overpopulation as a public health challenge is depicted in two forms: ffirst, the crowdedness within the household, where more than two people stay in one habitable room, i.e. bedrooms and living rooms. While the second aspect, overpopulation between the households, is reproduced by the densely populated area. The housing patterns in the refugee camps in Palestine consist of wall to wall housing with narrow paths and streets in between [74].

Al-Khatib and Tabakhna, studied some of the housing conditions at Jalazone Refugee Camp and their impact on refugees' health inside the camp, especially those who suffer from respiratory symptoms and diseases. A

randomized sample of 200 housing units, representing one fifth of the camp's population, was selected. The results showed significant relationship between some respiratory conditions (common cold, cough, tonsillitis and ear infection) and poor housing conditions (including damp and mould) [75].

In terms of overcrowding and high population density, 60% of households had 3 or fewer rooms and 75.0% of the households had 1 or 2 bedrooms, smokers were present in 74.0% of the households and overpopulation aided the spread of infectious illnesses, e.g. common cold, tuberculosis, influenza [75].

Farah found that nearly 40% of the Gazans households have a density of three individuals or more per room. it's also stated that in most houses, the rooms are not evenly or equally developed, and in some houses accommodate four to six persons in the same room [76].

## 4 CONCEPTUAL FRAMEWORK

For the scenario in Gaza/Palestine, the following proposed conceptual framework was developed in order to guide the research process, organize the work and make the research findings meaningful. The conceptual framework in Figure 1 was built to address the main domains of the proposed study in accordance with previous studies and this conceptualization.

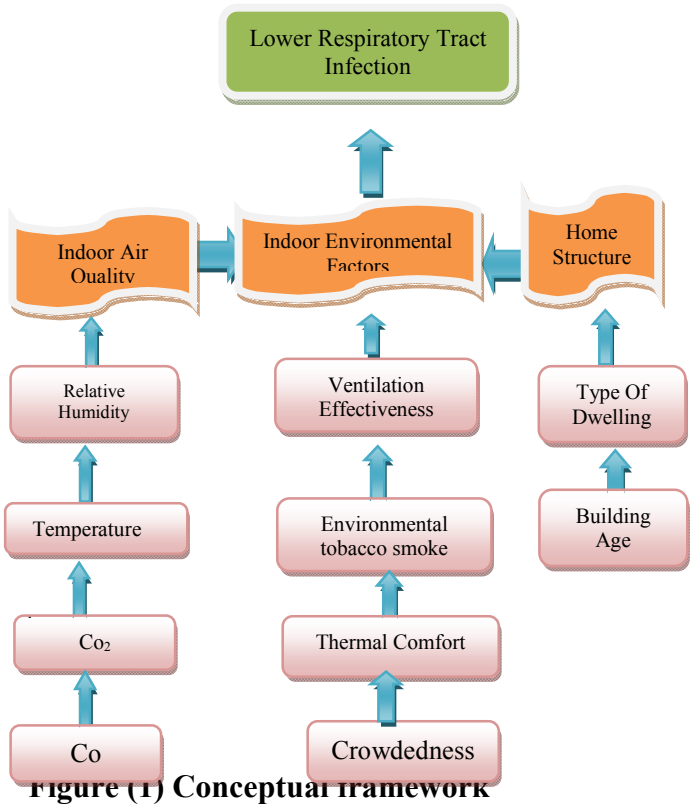


**Figure (1) Conceptual framework**

The first domain is indoor environmental factors, which consists of a number of variables as follows; ventilation effectiveness, environmental tobacco smoke, thermal comfort and crowdedness. While the second domain is home structure, which consists of type of dwelling and building age. Lastly, the third domain is indoor air quality, which include relative humidity, temperature, $CO_2$ and CO.

## 5 CONCLUSION

The current review showed that there are several factors influencing the indoor environment quality including ventilation effectiveness, environmental tobacco smoke, thermal comfort (humidity and temperature) and overcrowding.

The quality of indoor air can be influenced also by; change of house designs, smoking, poor ventilation and change of people attitude in term of energy utilization. Based on the studied literature, a conceptual framework was proposed to investigate this challenge in Gaza/ Palestine and advise possible solutions.

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# Modification of Hydraulic Conductivity of Sandy Soil using Seawater and Alkaline Solutions

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Abstract The precipitation of calcium carbonate between soil particles is sufficient to alter the engineering characteristics of the soil. The study described by the current paper investigated the reduction of soil hydraulic conductivity by chemical precipitation of the calcium carbonate. The designed experiment involved of readily mixed two solutions into a soil column. One of the solutions served as a source of calcium ions and the other contained carbonate ions. The paper investigated using seawater as a source of calcium in comparison to an artificial source. The results showed that crystals formed are small in size such that they transport with solution as colloids. Thus, reductions in hydraulic conductivity were governed by the filtration mechanisms; and the precipitated calcium carbonate was filtered close to the injection point. Employing seawater and artificial source of calcium ions induced reductions in hydraulic conductivity of 35%, and 28% of the original magnitude, respectively. Using seawater as a source of calcium is useful for geo-environmental applications that are conducted in the vicinity of the shore and require reduction of hydraulic conductivity.

*1)* Keywords

Calcium Carbonate, Precipitation, Hydraulic Conductivity

## 1. Introduction

A variety of constructive and destructive biochemical reactions have been shaping the earth's surface (the pedosphere) since the early stages of its formation. However, the significant role of these chemical and biochemical reactions in soil has not been regarded for geotechnical engineering until recently (Mitchell and Santamarina, 2005).

Precipitation of calcium carbonate between soil particles is one of the techniques that recently acquired the interest of the scientific community and geotechnical engineers as a potential soil improvement technique. However, the instantaneous occurrence of the chemical reaction hinders the in-situ precipitation. The research described by the current paper employed an experimental approach in order to investigate the potential modification of hydraulic conductivity of the sandy soil using chemical precipitation of the calcium carbonate.

## 2. Literature Review

The amendments that occur to the engineering characteristics of soil by precipitation of calcium carbonate are governed by a wide range of physico-chemical processes (Achal and Pan, 2014; Cheng et al., 2013; Gorospe et al., 2013; Kawano et al., 2002; Nemati and Voordouw, 2003). The following sections were restricted to the chemical factors that govern the precipitation process. Also, the previously reported studies on the soil behavior were briefly reviewed.

### 2.1 Chemical Precipitation of Calcium Carbonate

The chemical precipitation of calcium carbonate is an instantaneous irreversible reaction. It can be described by the equation:

$$Ca^{2+} + CO_3^{2-} \rightarrow CaCO_3\downarrow \qquad (1)$$

However, the precipitation process in governed by several factors that influence the characteristics of the resulting mineral.

Calcium carbonate occurs in several mineral forms that include the stable forms of calcite and aragonite, metastable vaterite, and other amorphous forms (Wei et al., 2004). The

precipitation reaction of calcium carbonates results initially in the mineral forms of calcium carbonates that are thermodynamically unstable. This comports with Ostwald's Law of Stages, which states that 'the least stable phases with the highest solubility, precipitates first and subsequently transforms to the more stable ones' (Kralj et al., 1997, 1990). The calcite precipitation is a phased complex process, which is controlled by temperature, nucleation sites, ionic strength, pH, solution stoichiometry and degree of supersaturation (Wei et al., 2004; Wolthers et al., 2012). These factors control the essential processes necessary for the crystallization of calcite, which are the nucleation, the crystal growth, and the transformation process.

These processes govern the precipitation of calcium carbonate in the form of calcite, which is essential for the amendment of the engineering characteristics of soils. Other metastable and transformable forms do not contribute effectively to particles cementation. Moreover, they are vulnerable to dissolution in the pore water and being flushed out of the soil.

**2.2Hydraulic Conductivity**

Previous studies reported differential behavior of the hydraulic conductivity of the soil that examines precipitation of calcium carbonate. Most of these studies describe the precipitation that is biologically induced.

The sites of calcite precipitation within the soil pores are located at the zones of low shear forces (DeJong et al., 2010). These zones would present at the contact points between the particles and at the narrow throats. These sites work as preferential sites for sedimentation of any colloids. This phenomenon (if valid) would alter the clogging of soil by calcium carbonate precipitation from clogging by other physical colloids. As the concentration of calcite content increases by treatment, the flow paths get narrowed down to full clogging. The occurrence of this clogging depends on the treatment conditions. The rate of calcite precipitation and the growth rate of calcite crystals increases as the concentration of the treatment solution increases. The concentration also specifies the maximum sizes of calcite crystals that can form, which finally controls the behavior of the hydraulic conductivity of the bulk soil.

Such variable factors that control the bulk hydraulic conductivity may explain the differences in reduction of hydraulic conductivity that were reported by different researchers.

For example, DeJong et al. (2010) reported a reduction of void ratio by 6% and 17% of the initial condition for 'heavily' and 'moderately' treated soils. The 'moderately' treated condition is similar to the one described by Whiffin et al. (2007) that caused reductions not less than 31%. It is expected that hydraulic conductivity would change according to the calcite content for each zone, and the bulk hydraulic conductivity of treated soil is dependent on the homogeneity of the property along the flow paths.

In fact, most of the measured values found in literature for hydraulic conductivity comes as part of the parameters measured for different experiments of different designs, purposes, and conditions. The experiments that were carried out by (Al Qabany and Soga, 2013) could be one of the few studies that focused on the changes in hydraulic conductivity in specific. It was the first study how the concentration of treatment solution affects the way the treatment amends permeability. The low-concentration treatment was found to maintain the hydraulic conductivity of the soil with no significant changes, while abrupt and severe clogging was noticed when high-concentration treatment was employed. This has been explained by Al Qabany (2011) on the basis of the size of calcite crystals and their relation to the concentration of the solution. Large crystals seem to clog the pores much faster than the small ones that instead get uniformly precipitated over the surface of soil grains. This study also reported reductions up to 75% in hydraulic conductivity at 2.5% of calcite content.

The mechanism described for clogging of the pores by calcite precipitation indicates that a full clogging of soil is possible if the treatment conditions are set properly. This has been validated by Stabnikov et al. (2011) as they treated a model of sand with MICP by permeation, and circulating the effluent back again to the model. A thin crust of calcite with

low permeability $1.6\times10^{-7}$ m/s at the surface of the model with thickness of 1.0 mm. However, the small depth of the crust gives an indication that clogging is more likely to happen close the injection point rather than to extend with a uniform distribution along the flow path.

Dawoud et al., (2014) showed that the reduction in the hydraulic conductivity occurs according to two phases. The first phase was characterized by insignificant reductions in hydraulic conductivity that is accompanied by remarkable increase in calcium carbonate content in the soil. In the following phase, the hydraulic conductivity sharply decreases by any increase in the soil content.

2.3Seawater as a source of calcium

Calcium is of the most abundant ions in seawater. Its concentration is governed by the overall speciation of other ions. For example, oceans acidification causes dissolution of calcareous rocks and coral bleaching. For the case of Gaza Strip, insufficient information is available on the concentration of different ions. Therefore, the reported average concentration of $Ca^{2+}$ in the seawater (which is 0.0103 M) was employed for stoichiometric calculations in the current research.

## 3.0 Design of Experiment

The experiment design involved a timed system for simultaneous injection of two chemical solutions in a column of a soil specimen, as shown in **خطأ! لم يتم العثور على مصدر المرجع.**.

Two separate tanks were used to store the chemical solutions. One tank contained the calcium-source solution, while the other was used to store the alkaline solution. Two tests were conducted using two different sources of calcium. For the first test, a solution of 0.1M $CaCl_2$ was used. For the second test, the seawater was used as the source of calcium. Seawater samples were collected directly from the sea in containers of 29L each. The Alkaline solution composed of 0.1M and 0.01M $NaHCO_3$ solution for Tests 1 and 2 respectively. The suction tubes from the two tanks are mixed at a tube junction that is fitted before the pump.

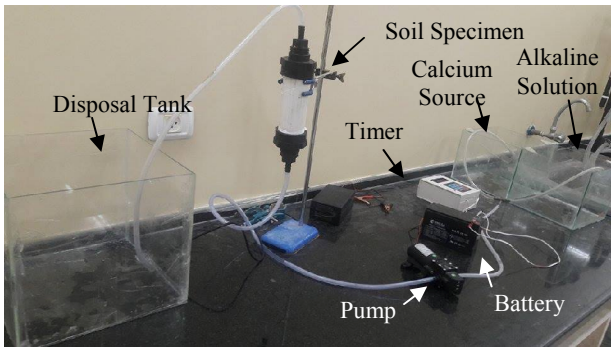



Figure 1: Setup of the experiment in the lab

A spray pump was used for injection of the solutions. The pump was sufficient to provide the flow and pressure required for the experiment. However, as a centrifugal pump, the flow rate and the exerted pressure varied during the experiment. Thus, the pump was characterized in order to identify the pump curve. The flow rate was measured, and the hydraulic head was identified using the pump curve.

A timer was used to run the pump intermittently. The timer was designed and programmed explicitly for the current experiment. A retention time of 1 hour was given after each injection. This retention time was suggested to allow for any short-term potential transformation of the crystal forms of calcium carbonate.

A soil specimen of silica sand – medium grade was used for the test. The initial hydraulic conductivity of the specimens was measured as 2.13 m/s and 2.49 m/s for Tests 1 and 2, respectively. The column was 15 cm in height, and 5 cm in diameter. A nylon filter of 0.2 mm-diameter of openings was used at the top and the bottom surfaces of the soil specimen.

The effluent of the soil specimen was collected in a dedicated disposal tank.

## 4.0 Results and Discussion

The measured flow rate during each injection was transformed into a hydraulic head using the equation fitted to the pump curve. This helps calculating the hydraulic conductivity of the specimen at each injection using Darcy's equation:

$$K = Q\,L / (A\,\Delta h) \qquad (2)$$

Where:

Q is flow rate ($cm^3/s$);
L is the length of the soil column;
A is the cross-sectional area of the soil column ($cm^2$);
Δh is the head exerted by the pump (cm).

The calculated hydraulic conductivity from both tests is plotted together in خطأ! لم يتم العثور على مصدر المرجع. For comparison reasons, the results of the two specimens were plotted against the cumulative number of moles of carbonate ion that were injected. This was applied since the available data is the number of injections. At the same time, the concentration of the chemicals used was different. The real indicator for the soil behavior is the amount of the precipitate. In the current case, it is presented by the amount of precipitate precursors that were injected since no approach is available for real-time measurement of the precipitate changes.

As shown in the figure, soil specimen in Test 1 (which employs $CaCl_2$ as calcium source) exhibited a gradual reduction in hydraulic conductivity by treatment. The general behavior matches the behavior described by Dawoud et al., (2014) for the reduction of the hydraulic conductivity by microbial calcite induced precipitation.

However, the visual inspection of the effluent shows that the effluent contained a precipitate of small particles that behave as colloids. It was suspected that these colloids exhibit sedimentation by gravity, and they are stable such that they do not transform into larger crystals. Mitchell and Ferris (2006) reported that the calcite crystals that form as a result of chemical reaction are considerably smaller than the ones that are triggered biologically. This probably due to the lack of preferential surfaces of precipitation. Furthermore, the calcium carbonate accumulated close to the injection surface causing clogging. After injection of 10.9 mole/g of soil of $Ca^{2+}$ and $CO_3^{2-}$, the hydraulic conductivity of specimen from Test 1 dropped down to 2.7% of the original hydraulic conductivity. Figure 3 shows an optical microscopic scanning of the specimen from Test 1. The scanning was made to the specimen surface at the injection point. The white color shows

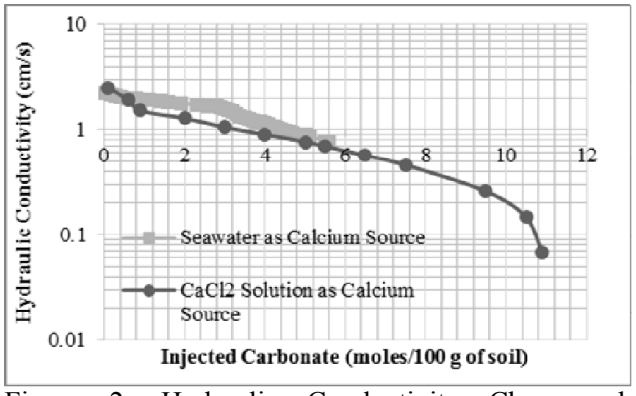
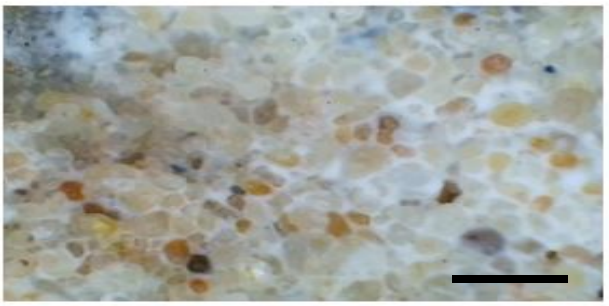



Figure 2: Hydraulic Conductivity Changes by Chemical Treatment



(a)

(b)

Figure 3: Optical microscopic scanning of samples from Test No. 1 at injection surface after termination of the experiment (a) bar scale 500 μm (b) bar scale 100 μm

The use of seawater emerged in similar results for the same amounts of the precipitate precursors that were injected. 35% reduction in the original hydraulic conductivity was attained after injection of 5.5 moles $CO_3^{2-}$/100 g of soil. This is comparable to the 28% reduction that was achieved using the artificial source of calcium ions.

However, the number of injections using the seawater was ten times the number of injections needed for Test 1 for the same amount of injected chemicals. This required huge amounts of water

and a long time of the experiment; therefore, experiment was terminated at this stage. In fact, the effort and time required for treatment using seawater is an obstacle that has to be studied from a practical point of view.

## 5.0 CONCLUSIONS

The study described by the current paper investigated the reduction of soil hydraulic conductivity by chemical precipitation of the calcium carbonate. The experiment involved of injection of readily mixed solutions two into a soil column. One of the solutions served as a source of calcium ions and the other contained carbonate ions. Two tests were conducted. The first test employed 0.1M solutions of $CaCO_3$ and $NaHCO_3$. The other test involved mixing a solution of 0.01M $NaHCO_3$ with seawater (as the source of calcium). During the test, it was noticed that crystals formed in small size and they were prone to transport by fluid flow. This suggest that the precipitate followed the mechanisms of colloids transport and sedimentation; and reductions in hydraulic conductivity were governed by the filtration mechanisms. The precipitate accumulated at the surface of injection.

Employing seawater and artificial source of calcium ions induced reductions in hydraulic conductivity of 35%, and 28% of the original magnitude, respectively. These reductions were achieved after injection of 5.5 mole/100 g of soil. both specimens exhibited the same general behavior of reduction of hydraulic conductivity by treatment.

Using seawater as a source of calcium is useful for geoenvironmental applications that are conducted in the vicinity of the shore and require reduction of hydraulic conductivity, such as impermeable barriers. This proposed technique offers several advantages against traditional methods. Using sweater would minimize the costs of treatment to a competitive level to other techniques and materials which are used for the same kind of treatment. The materials used by the current research are non-hazardous, and the applied treatment is easily reversible.

However, the amount of injected water is considerably high. Therefore, this technique has to be assessed in terms of energy consumption and required time of treatment.

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Review: Indoor Air Quality and the Risk of Lower Respiratory Tract Infection

# Effect of Polypropylene Fibers and Sea Water on the Performance of Recycled Aggregate Concrete

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**Abstract:**

Reusing of concrete rubbles extracted from construction and demolition(C&D) wastes in concrete can be described as a goodsolution for environmental protection and economical savings. Owing to the very limited space for land reclamation in Gaza Strip to dispose million tons of C&D waste and no any kind of aggregate resources, there is bad need to find another resources of aggregate.Using of recycled aggregate (RA) extracted from concrete rubbles in concrete can be useful for environmental protection and economical saving terms. This paper reports the results of an experimental study on the mechanical properties of recycled aggregate concrete (RAC) as compared to natural aggregate concrete (NAC). The effect of Polypropylene (PP) fiber on physical and mechanical properties were also discussed in this paper. The research involved experiments to analyze the mechanical behavior of RA concrete after immersing the samples in sea water and to analyse sea water effects on recycled aggregate mixed with polyprobelyne (PP) fibers . The (NA) was replaced in concrete mixes by (RA) extracted from concrete rubbles with percentages .0, 50.0 and 100.0%. The RA concrete mixes was mixed with (PP) fiber with various percentages 0.0,.25 0.1,0.5 ,1.0,1.5% of total volume , 0.1% PP fiber resulted in maximum compressive and tensile strength was used in the other concrete mixes. To investigate the intended mechanical properties 94 specimens were casted .The workability of concrete was reduced when the NA aggregate was replaced by RA and adding PP fibers to concrete mixes increased the reduction of the workability. The compressive, splitting tensile (ST) and flexural tensile (Fr) strength for 50.0% RCA mixes was reduced by 12.7, 7.5 and 20.34% respectively, but when 100.0%RCA was used the strength was reduced by21.8, 20.5 and 30.83% respectively .Adding PP fibers enhanced the strength of RA concrete specially tensile strengths, where 100 % RCA concrete gained 7.2,29.3 and 74.3% for compressive, ST and Fr respectively. It was concluded that replacing NA with RA reduced the
strength of concrete and modulus of elasticity but adding PP fibers enhances the strength of concrete and
modulus of elasticity. Immersing plain concrete mixes in sea water for 8 months increased the compressive strength for concrete without fibers by 16.5, 15.5 and 7.0% for 50.0 and 100 % RA concrete but immersing RA concrete mixed with PP fiber in seawater reduced the compressive strength by about 4.0% butST and Fr increased for RA concrete mixed with fibers 8 months in seawater .

**Keywords**
Fiber ,Sea water , Recycled Aggregate , polypropylene fiber , concrete

## 1.1.Introduction

The amount of construction and demolition waste in Gaza Strip has been increasing rabidly as a reason of continuous military campaigns that have destroyed huge number of concrete buildings. Till now the accumulated amount of C&D wastes about four million tons (MPWH, 2014).Gaza Strip is a narrow strip of a total area 365 Km2 Since the available spaces in Gaza Strip couldn't accommodate this huge quantity, thoughts have been started to reuse C&D waste. One of those aspects thoughts is

to use RA extracted from concrete rubbles in concrete structures.

The C&D wastes in Gaza Strip was generated due to explosives, the produced RA may differs than recycled aggregate concrete extracted using mechanical demolishing equipment or natural crisis. . In Gaza Strip, about 100% of C&D wastes exposed to heavy explosives with very high elevated temperatures, this explosives and elevated temperature has affected the RA(especially adhered mortar)and consequently the chemical, physical and mechanical properties of RA concrete also has been affected .Up to today, many national symposiums and international conferences about the optimum use of R A as an alternative of natural aggregate have been conducted in many countries.RA mainly differs from natural aggregate (NA) as it is composed by two different materials: NA and residue old cement mortar attached. Old cement mortar is the origin of the worse properties of RA: lower density, higher absorption, and higher Los Angeles abrasion ( Juan .et el. 2009;Debieb F et el. 2010) . RA is also highly heterogeneous and porous, as well as a high content of impurities. The heterogeneity influences the characteristics of RA and these aggregate properties have a negative influence on recycled aggregate concrete (RAC) quality such as reduction of the compressive strength, tensile strength due to the increased concrete porosity and a weak aggregate–matrix interfacial bond (Tam.et el. 2005;Zaharieva.et el. 2003) (33 fiber concrete-PHD2)MirjanaMalešev et al say, the way of preparing recycled aggregate for concrete mixtures influences the concrete workability: Workability of concrete with natural and recycled aggregate is almost the same if — water saturated — surface dry recycled aggregate is used. Also, if dried recycled aggregate is used and additional water quantity is added during mixing, the same workability can be achieved after a prescribed time. Additional water quantity depends on the time for which the same workability has to be achieved. (MirjanaMalešev et al., 2010).

Recycled concrete mixes require more water (increase of w/c ratio) than conventional concrete to maintain the same slump without the use of admixtures. This affects the quality and strength of the concrete, resulting in lower concrete strength (Sami and A, kmal, 2009). The conclusions showed that even in the case of high-performance concrete, the interfacial transition zone (ITZ) is a zone of low resistance, because of the big porosity of adhered mortar. And as more porous is the concrete its ITZ will be less resistant (Konin et al, 1998).

A significant influence was found on the stress–strain curve of different concrete mixes due to the use of different generations of repeated recycled coarse aggregate. Similar pattern of the stress –strain curves was found for all the repeated recycled concrete mixes (SumaiyaBinte Huda and M. ShahriaAlam, 2014). The RCA replacement percentage has a considerable influence on the stress–strain curves of RAC. For all considered cases from r = 0% to 100%, the stress– strain curves show a similar behavior. The stress– strain curves of RAC indicate an increase in the peak strain and a significant decrease in the ductility as characterized by their descending portion and also added. The peak strain of RAC is higher than that of normal concrete. he modulus of elasticity test indicates a decreasing trend of modulus of elasticity value when the percentage of recycled aggregate increased. (N. Siva Kumar . et al .2014) .

a correlation between elastic modulus and compressive strength of recycled-aggregate concrete was found showing that, in general, 16% lower elastic modulus is achieved by using 30% coarse recycled aggregates, whatever the recycled aggregate grain size distribution (Valeri a Cori n a ldes I,2011). Several researches have studied the influence of RA on concrete properties such a s compressive strength, tensile strength, etc. (Ajdukiewiez and Kliszczewicz, 2002; RA is heterogeneous in nature as they contain attached mortar to the aggregates. This property of RA limits its use in concrete, as it decreases the compressive strength of RAC.

The results also shows that the concrete specimens with more replacement of recycled aggregate will get the lower strength when compared to the concrete specimens with less recycled aggregate From the obtained result, it is possible to use 30 to 40% recycled aggregate with the less water cement ratio in the high strength concrete mixes. (N.Sivakumar.et al.2014).

Vázquez et al. observed that, when replacing 100% of NA with RA, the splitting tensile strength can vary between 6% and 20%, but if the incorporation is lower than 50% the difference is practically imperceptible (Vázquez E, et al.,2006). The results of experiments conducted by Zong-ping Chen et al show that the flexural strength and cubic compressive strength of the recycled aggregate concrete approximate to those of normal concrete . The flexural strength of recycled aggregate concrete (RAC) is obtained experimentally, and the influence of replacement percentage of recycled coarse aggregate on the flexural strength is analyzed.

After his experimental work in reinforced recycled aggregate concrete and natural reinforced concrete beams which includes the deflection and crack spacing, Ippei Maruyama et al concluded the following : (1)Crack widths of reinforced recycled concrete (RRC) beams with wet curing are wider than those of conventional reinforced concrete (RC) ,when the stress in reinforced concrete beam is 20 N/mm2, while crack spacing of RRC beams are smaller than those of RC beams.(2) Expansive additive contributed to decreasing the crack widths, the magnitude of the effectiveness in reduction is 20-30% in this present study. (3)The deflections of RRC beams, when the stress in reinforced beam is 30 N/mm2 , are larger than those of conventional RC beams. This tendency can be predicted by considering the difference of Young's modulus, even in the case of adding the expansive additive. (4) Measured ultimate moments are larger than the calculated results using measured yield stress of RB by 10-20%.

Many investigators investigated the effect of sea water on RA, Jianxiu Wang, et al established: (1)Marine environment did not affect the shape of the stress-strain curve of R A concrete; it was as natural aggregate concrete irrespective of R A percentage but, the RCA replacement percentage and corroding time have remarkable influences on the stress strain curve of RC. (2)The compressive strength of RC decreases with the replacement percentage, and the suitable replacement percentage should not exceed 30% in marine environment.(3). The compressive strength of RC is time dependent as exposed to marine environments where it decreases 2% within 8 months exposure and 4% to 8% when corroding time exceeds 8 months . (4)The elastic modulus of the RC in marine environment is lower than that of normal concrete, and it decreases with increasing replacement percentage and corroding time. The elastic modulus is reduced by about 7.5% when the replacement percentage is 60%, and it dropped by 2% and 9% when the corroding time is within or over 8 months, respectively. (5) The failure behavior of compressive test for R A concrete under marine environment is faster than behavior of natural aggregate concrete taking inclination angle 65–85∘ between the failure plane and the loading plumb .

Umadevi C.V and M. Rame,(2014) Gowda concluded after their investigations on PP fiber R A aggregate the following:(1)The presence of fibers in concrete changes the failure mode of plain concrete from spalling behavior to blugging mode behavior in transverse directions.(2)Use of fiber in recycled aggregate concrete increases strength characteristics mainly flexural &split tensile strengths of concrete. The structural and mechanical properties of fiber reinforced recycled aggregate concretes can go a long way in developing cost effective sustainable concrete structures with numerous applications in pavement and other concrete activities (M.L.V. Prasad and P. Rathish Kumar , 2007). VladimiraVytlacilova proved positive effect of synthetic fibers on tensile mechanical properties of R A concrete, splitting and flexural, and also proved ductility of beams

and their behavior after load removal .Also Vladimira stated that it is viable to produce concrete made with recycled concrete or masonry aggregates as full replacement of natural aggregate suitable for structural concrete. From previous literature, the results that was concluded as following:1)The main problem with RA is the old cement paste layer on original aggregate.2) W/C ratio should be increased or using plasticizers to achieve same workability for RA concrete as NA concrete. 3) As the percent of RA increases the compressive, tensile, flexural strength decreases. 4)The modulus of elasticity of RA concrete is reduced by 40% than NA concrete. 5) Marine effect is faster in RA concrete than NA concrete.5)Treating RA with polymers reduce water absorption. The effect of PP fibers on deflection and crack width of RA concrete weather plain or reinforced wasn't investigated in previous studies but in this research ,this effect was studied. The effect of immersing of RA concrete in sea water was also investigated which wasn't studied in previous researches Any previous study doesn't study all the mechanical properties ,deflection and crack width of treated RA with SP. The effect of PP fibers and SP for the same samples was also studied

## 1.2.Research aim and objectives

### 1.2.1.Research Aim

In general, this research aims to develop the performance of recycled aggregate (RA)extracted from concrete rubbles .This developed performance, concentrates on reusing RA in concrete mixes as reinforced structural elements and subsidiary building ,matching the performance of natural aggregates concrete .Many studies about RA concrete has been established in Gaza Strip ,but none of this studies has studied PP fibers effect on RA concrete. All the previous studies has proved that the compressive strength of concrete decreases as increasing the percent of RA (Zuhud,2008).

### 1.2.2.Research Objectives

The principal objectives of this research are as following To provide a detailed review of the state-of-the-art in recycled aggregate concrete.

- To investigate the chemical and physical properties of the recycled aggregate
- To determine the mechanical properties of recycled aggregate concrete with different percentages of recycled aggregate.
- To study the effect of polypropylene fibers mixed with R A on the mechanical properties of fiber recycled aggregate concrete(FRAC)with different percentages of recycled aggregate.
- To study the behavior of reinforced concrete (RC) beams including strength ,deflection and crack widths.
- To study the effect of sea water on the best mechanical properties mix during 12 months period.

## 1.3.Test program

- **The materials** used in this program were tested before beginning of any mix.
- The test program consisted of three main mixes 0.0,50.0 and 100.0% of RA.The mix was mainly designed using 0.0% RA then the NA was replaced by 50.0 and 100.0% RA. After trial mixes of PP fibers with100.0%RA,it was found that the optimum percent of PP fibers was1% by volume.The RA concrete was mixed with0.1% PP fibers without any treatment of RA.The coated RA was used for concrete mixes with 50.0 and 100.0%.The final mix type was mixed using 100.0% coated SP RA with 0.1% PP fibers.From every mix type ,18 standardcylinders,6 standardflexural prisms and 3 reinforced beams was casted. All mix types was immersed for 8 months in seawater except reinforced beams. All specimens was tested for workability,compressive strength,splitting strength and flexural strength.The modulus of elasticity was investigated for all concrete specimens, the deflection of beams and the crack width was investigated.

## 1.4.Experimental Studies

### 1.4.1.Materials

All the materials used in this experimental program has satisfied all the specifications required specially the aggregate comply with the ASTM specifications and the other materials was used according to the manufacturer directions.

| Physical Property | NCA | RCA | Crushed Stone | Sand |
|---|---|---|---|---|
| Unit Weight | 1.436 | 1.3532 | 1.82 | 1.656 |
| Water content | 0.025 | 0.01914 | 0.0267 | 0.0316 |
| Bulk Gs (SSD) | 2.61 | 2.44 | 2.7 | 2.66 |
| Bulk Gs (DRY) | 2.55 | 2.334 | 2.65 | 2.64 |
| Bulk Gs (Apparent) | 2.7175 | 2.613 | 2.81 | 2.68 |
| Water Absorption % | 2.45 | 4.62 | 2.17 | 0.48 |

#### 1.4.1.1.Cement

Type I Ordinary Portland Cement (OPC) was used in this experimental program which has a chemical composition, and also satisfies standard specification for Portland cement of ASTM designation C150-92 .

#### 1.4.1.2.Water

Ordinary tap potable water is to be used in the concrete mixes.

#### 1.4.1.3.Aggregates

The used aggregate in this program classified to two types; natural aggregate with both kinds coarse and fine (N A) and recycled coarse aggregate (RA).Only coarse RA was used in this experimental program where the fine RA were excluded.The NA used is a mix of crushed lime stone and dolomite, collected from stockpiles belongs to the Ministry of General Work and Housing and the RA (extracted from concrete rubbles) is collected from the stockpiles belongs to the United nations Development Program(UNDP) crushers in Palestine. Both kinds of aggregate were tested as following:

##### 1.4.1.3.1.Chemical test of aggregate

The all kinds of aggregates were tested for chloride, calcium carbonate and sulfate contents as shown in Table (1).At the same time since RCA has been exposed to explosives as mentioned above another chemical test was conducted for heavy metal contents as shown in Table (2).

Table (1): Chemical contents of all kinds of aggregates and sand (IUGaza,2015)

| Parameter | RA | Sand | NA | Crushed stone aggregate |
|---|---|---|---|---|
| CI % | 0.0799 | 0.01 | 0.0064 | 0.0107 |
| CaCo3 % | 50.05 | 9.6 | 96.6 | 98 |
| So4 % | 0.0089 | 0.0012 | 0.001 | 0.003 |

##### 1.4.1.3.2.Physical properties of aggregate

Table (2): Heavy metals in RCA(AlAzharU.Gaza, 2015)

| No. | Element | Result / ppm | No. | Element | Result / ppm |
|---|---|---|---|---|---|
| 1 | Copper (Cu) | 338.6 | 9 | Chromium (Cr) | 52.8 |
| 2 | Iron (Fe) | 24372.2 | 10 | Strontium (Sr) | 386.3 |
| 3 | Nickel (Ni) | 101.5 | 11 | Lithium (Li) | 10.8 |
| 4 | Lead(Pb) | 18022.2 | 12 | Sodium ( Na) | 887.6 |
| 5 | Zinc(Zn) | 10136.6 | 13 | Calcium (Ca) | 440 |
| 6 | Aluminum ( AL) | 20487.7 | 14 | Chloride (CI) | 1500 |
| 7 | Cadmium (Cd) | 14.6 | 15 | Magnesium (Mg) | 291.2 |
| 8 | Cobalt (Co) | 10.6 | 16 | Nitrate ( No3) | 339 |

#### 1.4.1.3.3.Sieve analysis

Sieve analysis of aggregate was arranged according to ASTM designation C136- 92 to fit the requirements for mix design according to ACI code. It should be noted that the crushed stone and sand was mixed with 3:2 ratio with a fine modulus 2.4. The following figures shows the sieve grading for all the kinds of aggregates used in this experimental program.

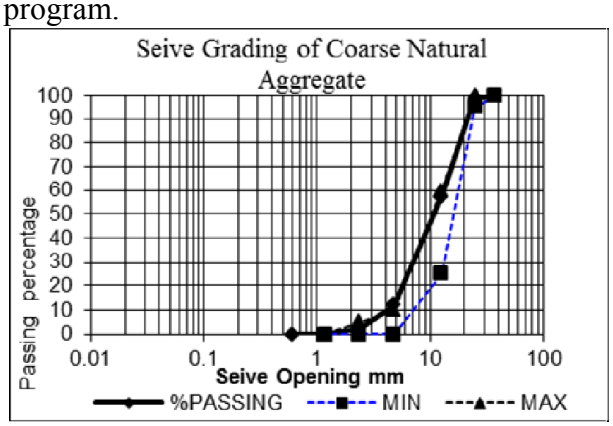



Figure (**1**):Sieve grading of natural aggregates

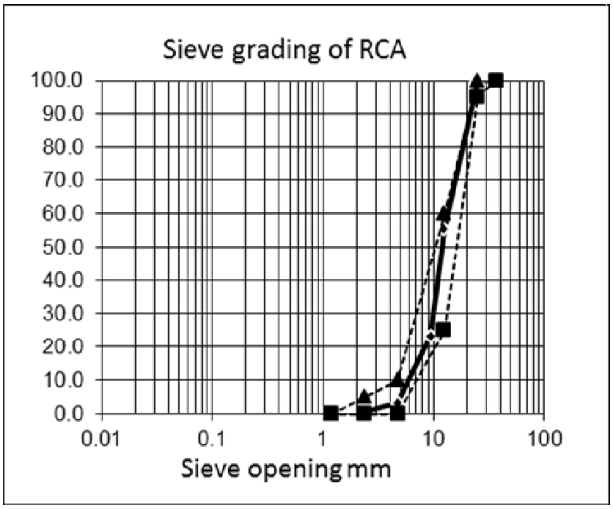



Figure (2):Sieve grading of RCA

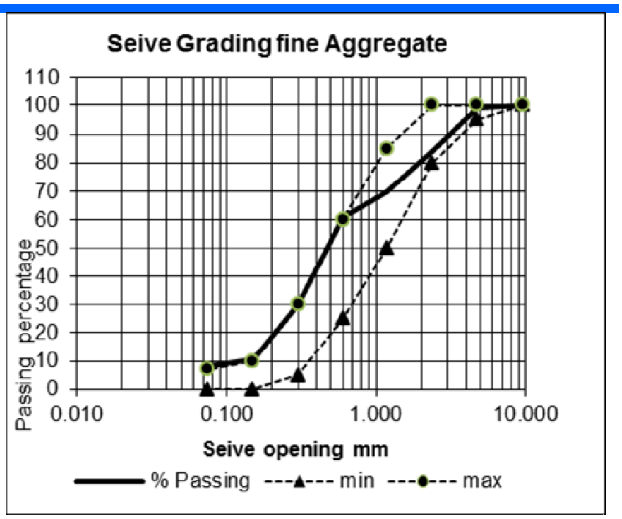



Figure (3):Sieve grading of fine aggregates

#### 1.4.1.4.Polypropylene(PP) Fibers

The fiber that used in this experimental program is polypropylene (PP) fiber .PP fiber is chemically non-active. Figure (4) is a photo of PP fibers that was used and Table (3) shows properties of PP according to Sika manufacturer (Sika Egypt, 2007).

The optimum percent of fibers by volume was achieved after trials of different percentages of PP fibers mixed with 100.0% RCA.percentage of 0.1% of PP fibers gave the maximum compressive and ST strength rather than 0.25,0.5,1.0,1.5%.

Figure (4): Photograph showing the discrete PP fibers.

Table (3): Index and parameters of PP fibers (Sika Egypt,2007)

| No | Behavior parameters | Values | No | Behavior parameters | Values |
|---|---|---|---|---|---|
| 1 | Color | Natural | 9 | Water absorption2 | None |
| 2 | Specific gravity | .91 g/cm3 | 10 | Softening point | 160° C |
| 3 | Fiber length | 12 | 11 | Ignition point | 365° C |
| 4 | Fiber diameter | 18 micron | 12 | Acid resistance | High |
| 5 | Tensile strength | 330-440 Mpa | 13 | Alkali resistance | 100% |
| 6 | Modulus of elasticity | 6000-9000 N/mm2 | 14 | Electrical and Thermal Conductivity | Low |

#### 1.4.1.5.Reinforcement Steel

The main reinforcement used for beam rebar (Ø8.0mm) is a hot mild steel ,fy=495.0Mpa and fu=520.0Mpa .The steel was used for stirrups is mild steel with fy=240Mpa.

### 1.5.Concrete mixtures

In this study; the mix proportions were prepared according to ACI 211.1 as shown in Table (4). One targeted group of samples was chosen in this study with a compressive strength, fc=25.0Mpa.

It has to be known that the design of mix was for N with 0.0% RCA and in the other mixes only the percent of RCA has been changed. The control mix for all batches is natural aggregate mix (0.0% RCA). After many trials of R(100.0%RCA) mixes with 0.1,0.25,0.5,1.0,1.5% of PP fibers .

the optimum percent was 0.1%by weight.0.1% percent of fibers was added to NR (50.0% RCA) samples which denoted by NRF and for R samples which denoted by RF.

Table (4): Mix proportions quantities

| Mix | Water (Kg) | Cement (Kg) | NCA (Kg) | RCA (Kg) | Fine Aggregate | |
|---|---|---|---|---|---|---|
| | | | | | Crushed stone (Kg) | Sand (Kg) |
| N(0.0 %of RCA) | 200 | 327.9 | 971 | 0.0 | 522.6 | 348.4 |
| NR(50.0%RCA) | 200 | 327.9 | 485.5 | 485.5 | 522.6 | 348.4 |
| R(100 %RCA) | 200 | 327.9 | 0.0 | 971 | 522.6 | 348.4 |

### 1.6.Tests

#### 1.6.1.Workability

Slump test was conducted to assess the workability of fresh control concrete and concrete containing recycled aggregate. The slump test was carried out according to ASTM C143,for each mix in the test program, sample of freshly mixed concrete is placed and compacted by rod in a frustum of cone mold. The slump value is equal to vertical distance between the original and displaced position of the center of the top surface of the concrete after raising a mold.

#### 1.6.2.Compressive and splitting tensile strength

Molding cylindrical samples (Cylinders150X300 mm)was carried out according to ASTM designation C470-92forcompressive and splitting tensile strength.A compression machine with a loading capacity 3000KNwasused in theexperiment. The loading rates were applied first to the compressive strength test with loading rate 10.6 KN/s, The tensile splitting strength test was carried out at loading rate 1.6 KN/s.

#### 1.6.3.Flexural test

Standard beam specimens (500X100X100 mm) were used for flexural test according to ASTM designation C31.

### 1.6.4.Moment strength of reinforced concrete beam

A beam mold was fabricated using plywood with smooth surface with dimensions of100X150X1200 mm to suit the size and the ability of the machine especially designed for this test. The concrete was reinforced with 2Ø8.0 mm bars as main bottom reinforcement and 2Ø6.0 mm as secondary top steel with stirrups of Ø5.0mm at 7.5 cm to ensure flexural failure behavior.

## 1.7.Sampling of test specimens and curing

Table (5) shows the number of samples used for every test for every type of concrete mix:

Table (5): Sampling of mix types and curing

| Mix type | After 28 day curing in fresh water | | | | After 8 months immersing in seawater | | |
|---|---|---|---|---|---|---|---|
| | Com. str. | Split. str. | Flex.str. | Ref. str. | Com.str. | Split. str. | Flex.str. |
| N | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| NR | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| R | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| NRF | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| RF | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

## 1.8.Results and discussion

### 1.8.1.Workability

As shown in Figure(5),as the percent of RA increased the workability of concrete mixes decreased, where it was decreased by 55% for 100% RA concrete mixes. Adding PP fibers to NR and R decreased the workability of concrete with 43 and48% respectively.

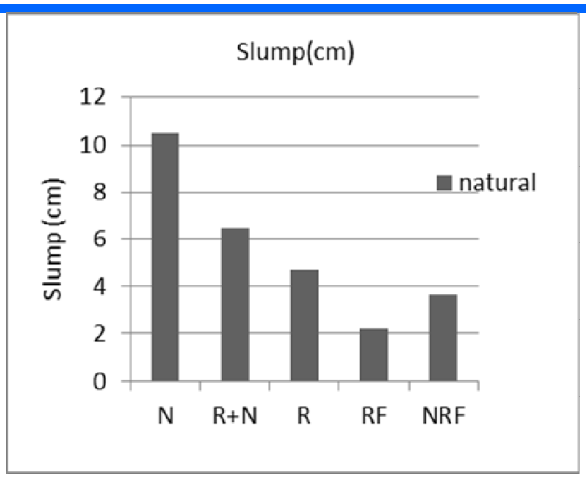



Figure (5):TheSlump of all mix types.

### 1.8.2.Compressive strength

From Table(6)and Figure(6), when the percent of replacing RCA instead of NCA increased the compressive strength of concrete reduced, A 50.0% RCA reduced the strength by 12.75% and100%RCA reduced the strength by 21.8%. Adding PP fiber to NR increased its compressive strength by 6.9% and increase compressive strength of R by7.2%. Adding PP fiber to RS increased the strength of RFS by 5.3%.From Table (7) and Figure (7) immersing N, NR and R in sea water increased the compressive strength by 16.5%,15.7% and 7.0% respectively, but immersing mixes with PP fiber reduces the strength of NRF and RF by 3.7% and 5.8% respectively.

Table (6):The compressive strength of all mix types after natural curing and immersing in seawater

| Mix type | Compressive stress (Mpa) | |
|---|---|---|
| | natural | SEA |
| N | 31.73 | 36.98 |
| NR | 27.70 | 32.06 |
| R | 24.82 | 26.56 |
| NRF | 29.62 | 28.52 |
| RF | 26.62 | 25.07 |

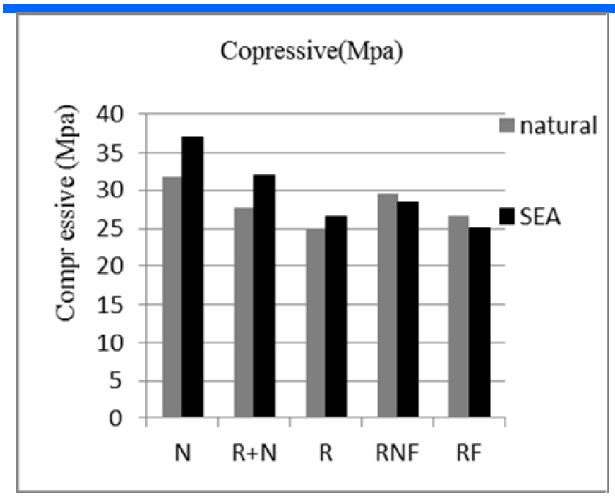


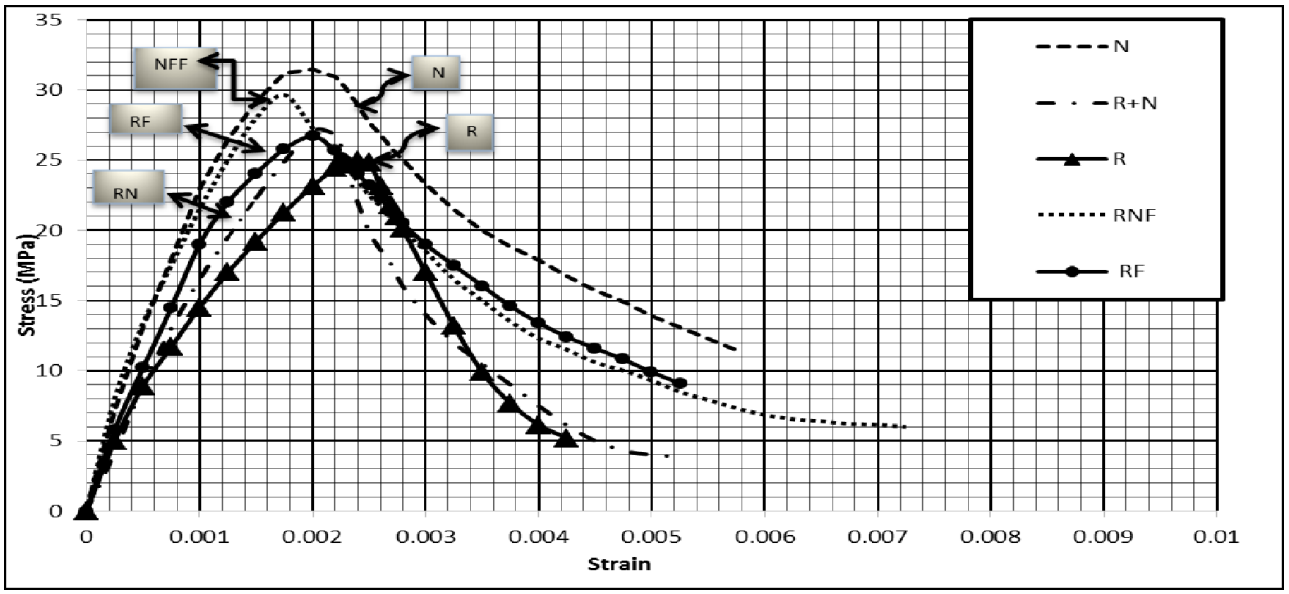

Figure (6):The compressive strength of all mix types after natural curing and immersing in seawater.

### 1.8.3.Stress –strain(SS) curves and modulus of elasticity (Ec)

From Table (7) and Figure(7) the Ec of concrete and the ductility reduced as the percent of RCA is increased but adding PP fibers has increased Ec and ductility of NRF and RF where the ductility of NRF and RF was better than that of N. Ecof NR and R decreased by 19.96% and 33.8%, but PP fibers enhanced Ec by 29.5% and 19.3% respectively.

Table(7):Mc of concrete mixes after 28 day curing in fresh water

| Type of Mix | Actual $E_c$(Mpa) From SSC curve | Comp. strength | Calculated $E_C$ according to ACI(Mpa) $4700\sqrt{f_c}$ |
|---|---|---|---|
| N | 25960 | 31.73 | 26474.81 |
| NR | 20775 | 27.70 | 24736.47 |
| R | 17183 | 24.82 | 23415.25 |
| NRF | 26910 | 29.62 | 25577.24 |
| RF | 20500 | 26.62 | 24249.45 |



Immersing concrete samples in seawater for 8 months increased the rigidity where Ec increases but the ductility decreases as shown in Table(8) and Figure(8) respectively, where Ec increased by 22.2, 24.4, 6.5, 25.6, 26.51 % for N, NR and R respectively. It has to be noted that immersing PP fibers concrete reduced Ec for NRF and RF by 15.33 and 14.5 % respectively. In spite off of decreased value of Ec of PP fibered concrete after immersing in sea water, ductility has not been affected .

From Tables(8-9) ,the Ec of concrete samples calculated according to ACI code 4700√fc is more than Ec calculated from SSC curves.

Table (8): Ec of concrete mixes after immersing of 8 months in seawater

| Type of Mix | Actual $E_c$(Mpa) From SSC curve | Compressive strength | Calculated $E_C$ according to ACI(Mpa) $4700\sqrt{f_c}$ |
|---|---|---|---|
| N | 33282 | 36.98 | 28581.26 |
| NR | 27480 | 32.06 | 26610.88 |
| R | 18387 | 26.56 | 24222.11 |
| NRF | 23334 | 28.52 | 25099.94 |
| RF | 17907.14 | 25.07 | 23531.94 |

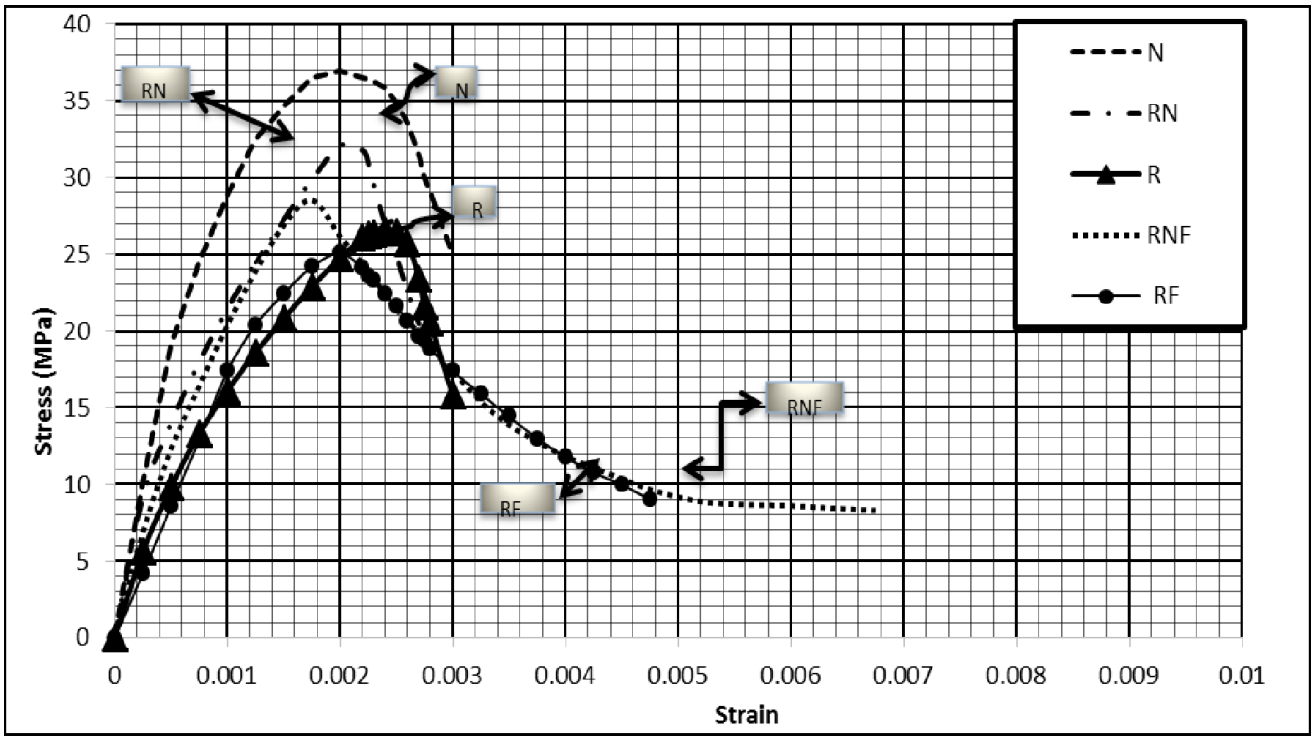
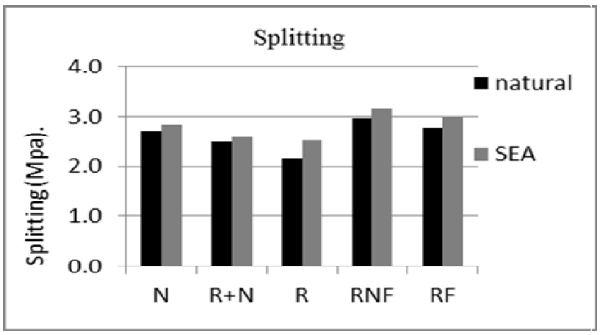



Figure (8): SSC of concrete mixes after immersing of 8 months in seawate

### Splitting tensile strength(STS) of concrete and correlation with compressive strength

From Table(9) and Figure(9) the STS is affected adversely by increasing the quantity of RCA in concrete mixes, where it was reduced by 7.5 and 20.5% for NR and R respectively, but STS for NR and R increased by 18.8 and 29.3% respectively when PP fibers was added. Immersing concrete samples in seawater enhances STS for all types of concrete mixes. It is worth saying that, adding PP fibers enhances STS about three times more than its effect on compressive strength. Salmon page 44says the correlation between compressive strength and splitting tensile strength ranges between 0.498√fc to.66√fc.All the correlations that are shown in Table (10) ranges between 0.498√fc to 0.66√fc.




Figure(9):Splitting tensile strength

Table (9):Splitting tensile strength(STS)

| Mix type | After 28 day curing in fresh water | | After immersing in seawater for 8 months | |
|---|---|---|---|---|
| | Splitting (Mpa) | Correlation with fc | Splitting(Mpa) | Correlation with fc |
| N | 2.71 | 0 .48*fc0 .5 | 2.85 | 0.47* fc0.5 |
| NR | 2.50 | 0.47* fc0.5 | 2.59 | 0.46* fc0.5 |
| R | 2.15 | 0.43* fc0.5 | 2.51 | 0.43* fc0.5 |
| NR F | 2.97 | 0 .55* fc0.5 | 3.15 | 0.48* fc0.5 |
| RF | 2.78 | 0.54* fc0.5 | 2.98 | 0.44*fc0.5 |

### 1.8.4.Flexural tensile strength(Fr) of concrete and correlation with compressive strength

From Table (10) and Figure (10)Fr is affected inversely by increasing the quantity of RCA in concrete mixes, where it was reduced by 20.34 and 30.83% for NR and R respectively, but Fr for NR and R increased by 62.6 and 74.3% respectively when PP fibers was added, this means PP fibers enhance Fr for NR and R to be larger than N .Immersing concrete samples in seawater enhances STS for all types of concrete mixes. It is worth saying that, adding PP fibers enhances STS about six times more than its effect on compressive strength. The correlation between compressive strength and Fris about0.623√fc according to ACI code, but according to Salmon ranges between 0.664√fc to 0.99√fc.All the correlations that are shown in Table (10), ranges between 0.664√fc to 0.99√fc but when PP fibers isused,t he correlation exceeds 0.99√fc and so when concrete samples are immersed in seawater.

Table(10):Flexural tensile strength(Fr)

| Mix type | After 28 day curing in fresh water | | After immersing in seawater for 8 months | |
|---|---|---|---|---|
| | Splitting (Mpa). | Correlation with fc | Splitting( Mpa). | Correlation with fc |
| N | 4.67 | 0 .83* $f'_c{}^{0.5}$ | 6.86 | 1.12* $f'_c{}^{0.5}$ |
| NR | 3.72 | 0.70* $f'_c{}^{0.5}$ | 6.04 | 1.07* $f'_c{}^{0.5}$ |
| R | 3.23 | 0.65* $f'_c{}^{0.5}$ | 5.40 | 1.04* $f'_c{}^{0.5}$ |
| NRF | 6.05 | 1.11* $f'_c{}^{0.5}$ | 8.02 | 1.5* $f'_c{}^{0.5}$ |
| RF | 5.63 | 1.09* $f'_c{}^{0.5}$ | 6.58 | 1.31* $f'_c{}^{0.5}$ |

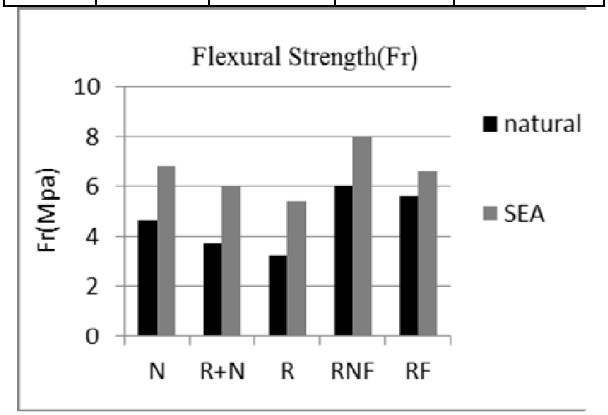



Figure (10):Flexural tensile strength(Fr)

### 1.8.5.Deflection and crack width of reinforced concrete

From Figure (11) the behavior of all concrete beams almost the same, but the deflection and load corresponds to first crack and that correspond to failure are different according to concrete type. As the percent of RCA increased the first crack load and ultimate load reduced and the deflection increases where the first crack moment is 22.4,17.2 and 14.3 KNfor N,NR and R with accompanying deflection 2.1,2.4, and 1.8mm respectively. At the same time the ultimate moment is 32.4, 27.8 and 23.2 KN with a deflection 4.8,4.95, and 6.4 mm for N,NR and R respectively. Adding PP fibers enhances the moment capacity and ductility of NR and R where crack load increased to be 19.2 and 17.5 KN with deflection 2.1 and 2.18 mm respectively .Ultimate momentload of NRF and RF increased with 5.0% and 14.2% with deflection 7.2 mm and 6.35 mm.

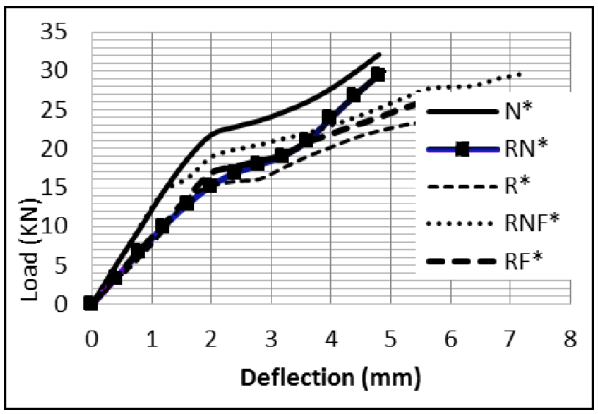
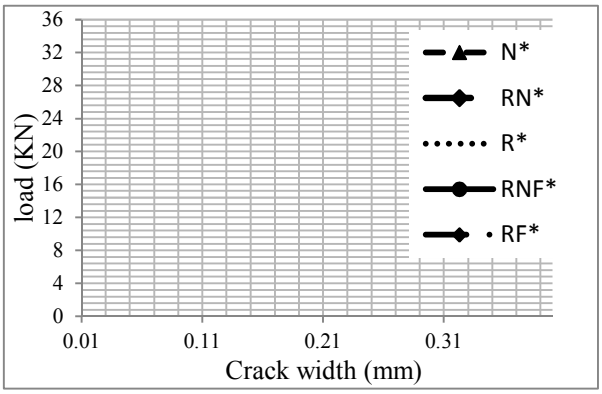



Figure (11): Load deflection curve of reinforced Concert Beam (Age 28 day ) without immersing in seawater

Adding PP fibers of concrete enhanced the ductility and reduced the crack width ,where the number of cracks is increased but its width obviously decreased as shown in Figure(12). The comparison between N and NRF shows at the same load the crack width of N is larger that of NRF by increment of about 13.3%, which meansadding PP fibers enhance the crack width to be smaller than any type of concrete of the same constituents. Adding RCA to concrete mixes increased the crack width according to increment percentage such that the crack width of NR and R is wider than N crack by average14.3 and 31.2% respectively.




Figure(12):Load crack width of reinforced concrete beam

### 1.8.6.Load deflection curve of plain concrete

From Figures (13-14) all types of concrete mixed with PP fibers wither after natural curing or immersing in seawater exhibit ductile behavior and have the highest value of Fr .From Figure (9) the behavior of N exhibits more ductility than NR and R where its failure occurred at a deflection of about 1.0mm . The failure of NR and R occurred at a deflection 0.72 and 0.6mm respectively but the failure of NRF and RF occurred at a deflection of 4.3 and3.1 mm respectively .As shown from Figure (10) ,the behavior of all mix types were less ductile than mix types not immersed in seawater where the deflection at failure was 0.6,0.5,0.47,3.15 and 2.1mm for N,NR,R,NRF and RF.

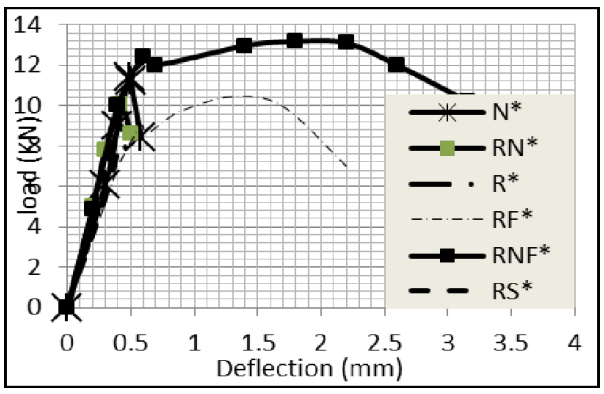
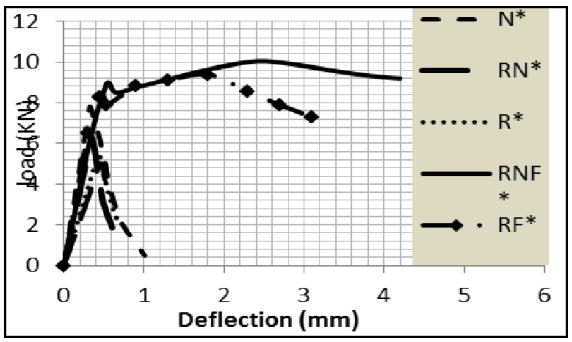



Figure (14):Load deflection curve of plain concrete beams after immersing8 months in seawater




Figure(13):Load deflection curve of plain concrete beams after 28 day curing in fresh water

## 1.9.Conclusion

In this study, the effects of RA with and without PP fibers on mechanical properties of concrete are presented.The relations between the mechanical and physical properties ofRCA concretes are also analyzed. Adding PP fibers enhanced the mechanical properties of concrete . Based on the above results, thefollowing conclusions can be drawn:

1) The workability of concrete mixes was affected adverselywhen the percent of RA was increased. Adding PP fibers to concrete mixesdecreased the workability of concrete.

2) RA (Recycled coarse aggregate): As the percentage of RCA increases the mechanical properties were adversely affected, where the compressive strength is reduced by 12.7 and 21.8% for 50.0%RCA(NR)and100.0%RCA(R).Splitting tensile strength is reduced by 7.5 and 20.5% for NR and R, also Fr is reduced by 20.34 and 30.83% for NR and R respectively.

3) PP fibers (Polypropylene fiber): Adding PP fibers enhance all the mechanical properties of RAC and RC where the compressive strength was slightly increased by 6.9% and 7.2% but splitting and flexural tensile strength was increased with considerable proportion where splitting tensile strength increased by 18.8 and 29.3% and Flexural strength by 62.6 and 74.3% respectively. The ductility of concrete enhanced as shown in stress-strain curves and load deflection curves also the width of cracks in concrete beams decreased when RCA mixed with PP fibers.

4) Immersing in seawater: immersing all concrete types enhanced their all mechanical properties except those types mixed with PP fibers the compressive strength only was reduced about 3.0% in average.

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# Mechanical Properties of Concrete with Partial Replacements of Cement by Paper Ash of Cement Pocket Waste

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**Abstract** This paper investigates the influence of the use of paper ash of cement pocket as a replacement for cement with 10%, 20% and 30% on the properties of concrete in the fresh and hard state. Performance of the paper ash–Portland cement mixture has been evaluated with respect to workability, compressive strength, split tensile strength and flexural strength. The results showed that with up to 20 % replacement, in each set, no major changes on concrete characteristics would occur, however, with further increase in replacement ratios considerable changes were observed.

Keywords paper ash of cement pocket, workability, compressive strength, split tensile strength and flexural strength.

## 1.0 INTRODUCTION

Cement consumption is increasing day by day as the main constituent of concrete which is the most widely used construction material. Increased use of cement poses environmental challenge as 5% of the global anthropogenic CO2 emission is originated from cement production [1]. While cement production in its beginnings only focused on ordinary Portland cement, later cements with several main constituents were produced by replacing parts of the clinker content by supplementary cementitious materials. Fly ash is used as a supplementary cementitious material in the production of Portland cement concrete. A supplementary cementitious material, when used in conjunction with Portland cement contributes to the properties of the fresh and hardened concrete through hydraulic or pozzolanic activity, or both its include hydraulic and pozzolanic material [2]

Several research programs have carried out to incorporate fly ash as a cement replacement material [4-11]. Results have indicated that fly ash can be effectively used as a cement replacement material for the production of structural grade concrete of acceptable strength and durability [4]. Malhotra and his associates replaced the cement with fly ash up to 55–58 mass percentage [5-9] and utilized various amounts of superplasticizer to maintain the workability. They reported 18, 30 and 42 MPa average cylinder compressive strength at 7, 20, 28 days, and 3 months, respectively. The water–cementitious material ratio of the concrete was in the range of 0.33, and contains 370 kg/m3 cementing materials. Lam et al. [10] replaced cement with 45% fly ash by mass to evaluate the degree of hydration of a fly ash cement paste. They reported 23.3, 58.9, 95 and 94.9 MPa 28-day compressive strength of fly ash paste made with 0.5, 0.3, 0.24 and 0.19 water–cementitious material ratios, respectively. Jiang et al. [11] replaced cement with 70% fly ash by mass and reported 26 MPa at 28 days and 36 MPa at 3 months cylinder compressive strength of concrete made with 0.37 water–cementitious material ratio. The concrete reported was containing 333 kg/m3 cementing material.

The present work deals with performance of concrete with 0%, 10%, 20 and 30% Portland cement replacement with paper ash of cement pocket. Performance of the paper ash–Portland cement mixture has been evaluate with respect to workability, compressive strength, split tensile strength and flexural strength.

## 2.0MATERIALS

The materials used in this study for producing the green concrete are described in the following subsection.

### 2.1 Materials used for concrete

Ordinary Portland cement (OPC) used as the main binder, whereas fly ash was used as a supplementary binder up to a replacement level of 30% as in figure 1. Natural river sand with a fineness modulus of 2.9, specific gravity of 2.67 and water absorption of 0.45% was used as fine aggregate, whereas crushed granite with a maximum size of 10 mm, specific gravity of 2.65, water absorption of 0.32% and bulk density of 1475 kg/m3 was used as coarse aggregate. Waste paper ash obtained from a cement pocket waste where pocket waste was born at air .It contains 42.5% CaO according to chemical analysis. The composition of normal and fly ash concrete are presented in Tables 1and 2.

Figure 1: cement pockets ash with cement.

1. Table 1: Mixture properties of normal concrete

| Unit | Cement | Water | Fine aggregate | Coarse aggregate |
|---|---|---|---|---|
| Weight (kg) | 340 | 180 | 670 | 1190 |
| Volume($m^3$) | 108 | 180 | 251 | 450 |

2. Table 2: Mixture properties of paper ash concrete

| Unit | Ash percent | Cement | Water | Fine aggregate | Coarse aggregate | Paper ash |
|---|---|---|---|---|---|---|
| Weight (kg) | - | 306 | 180 | 670 | 1190 | 32.4 |
| Volume($m^3$) | 10% | 97.2 | 180 | 251 | 450 | 10.8 |
| Weight (kg) | - | 272 | 180 | 670 | 1190 | 64.8 |
| Volume($m^3$) | 20% | 86.4 | 180 | 251 | 450 | 21.6 |
| Weight (kg) | - | 238 | 180 | 670 | 1190 | 97.2 |
| Volume($m^3$) | 30% | 75.6 | 180 | 251 | 450 | 32.4 |

### 2.2 laboratory test

#### 2.2.1 Slump Test

The workability property of concrete mixes measured by conducting slump cone test according to ASTM Standard C143 [12].

#### 2.2.2 Compression Test

For the compression tests, three cylinders of height 200mm and diameter 100 mm were used for each type, according to ASTM C 39-01 [13]. The specimens were cured accordance with ASTM C 192/C192M-06 [14]. The compression stresses were tested on the age of 28th day.

#### 2.2.3 Splitting Tensile Test

For the splitting tensile test on the age of 28th day, three cylinders of height 200mm and diameter 100 mm were used for each type and age, according to ASTM C 496-96 [15]. The specimens were cured accordance with ASTM C 192/C192M-06 [14].

#### 2.2.4 Flexural Test

The three-point static flexural strength tests were performed according to ASTM C78-94 [16]. The specimens were 100 mm wide, 100 mm deep and 500 mm long, with a loaded span of 400 mm. Three beams specimens were cure in accordance with ASTM C 192/C192M-06 [14]. The three-point static flexural stresses tested on the age of 28th day.

### 2.3 Experimental set-up and procedure

In order to determine the consistency of the paper ash–portland cement mixture mixtures, slump test executed according to ASTM C143 [12]. The slump was determined by measuring the vertical difference between the top of the inverted mould and the center of the top surface of the concrete specimen. Compressive test was conducted using (200 mm Height x 100 mm Diameter) concrete cylinders subjected to an axial load applied by a hydraulically operated machine with rate 0.3 N/mm2/s until the failure of the specimen. The test conditions were according to ASTM C39 [13] and at age of 28 days. For cubes specimens, the compressive strength tests conducted on a hydraulic compression-testing machine at 28 days. The tests results are average of three readings. The three-point static flexural strength tests were performed according to ASTM C78-94 [16]. The specimens were 100 mm wide, 100 mm deep and 500 mm long, with a loaded span of 400 mm. Three beams specimens were cured in accordance with ASTM C 192/C192M-06 [14].

The three-point static flexural stresses were tested on the age of 28th day.

## 3.0 RESULTS AND DISCUSSION

### 3.1 Slump test

The procedure of slump test was according to ASTM C143 [12]. The results of the slump tests illustrated in Figure 2. As 30% of cement is replaced by paper ash, the slump reduces to 90 mm only where it still within the designed slump for this concrete (75-100mm). The reduction in slump with the addition of ash to the concrete as cement replacement is also consistent with the earlier investigations [17].

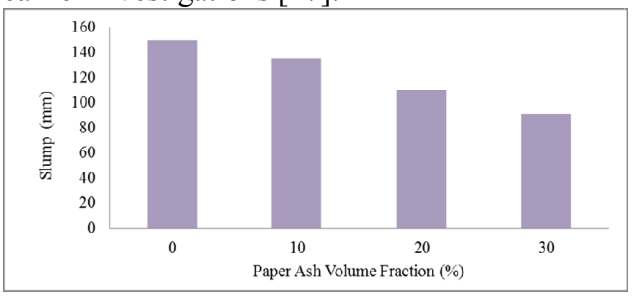


Fig. 2: Slump against volume fraction of paper ash

### 3.2 Compressive strength and splitting-tensile stress

Concrete cubes were tested at age 28 days. Results obtained presented in figure 3. The average compressive strength of normal concrete was determined to be 38.5 MPa at 28 days. Values obtained that, there is no significant change in the compression strength of concrete up to 20% of cement replacement by paper ash. At 30% paper ash, although a reduction observed, it is still higher than 35 MPa at 28 days.

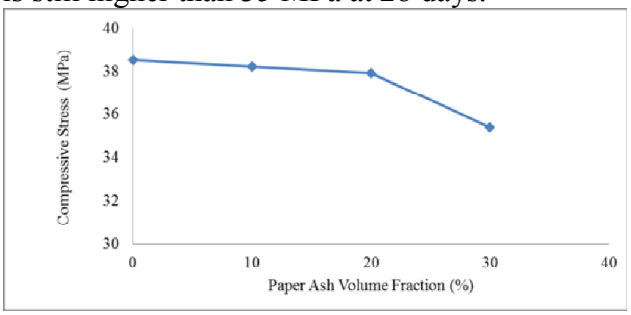


Fig. 3: Compressive stress against volume fraction of paper ash.

Figure 4 shows the result of splitting-tensile test, which indicates that the plain concrete is yielded at 3.9 MPa, while with the cement replacement by paper ash with 10, 20, and 30% of volumes, the splitting-tensile stress reduces by 3, 5 and 10% respectively. In general, the above results indicate that partial replacements of cement by paper ash cause decrease in both compressive and tensile strengths as also observed by the previous workers [17-18].

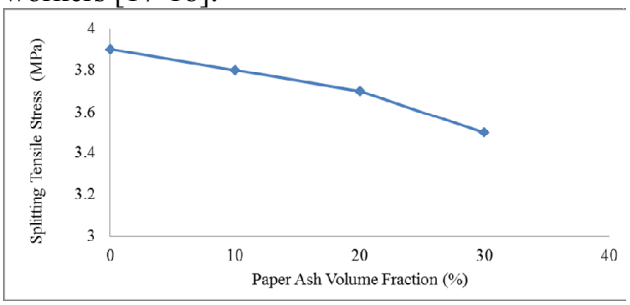


Fig. 4: Splitting tensile stress against volume fraction of paper ash.

### 3.3 Flexural strength

The results of the flexural strength of concrete containing paper ash presented in Fig 5, and show similar trends to those of compressive strength. The flexural strength decreases with increases in the paper ash content but at a slower rate than compressive strength. The 28-day flexural strength of samples containing 10% paper ash is 5.8 N/mm2, and it decreases to 4.9 N/mm2 at 30% paper ash content. The flexural strength magnitudes of paper ash concrete range between 84% and 97% of the control concrete at corresponding ages and additive levels.

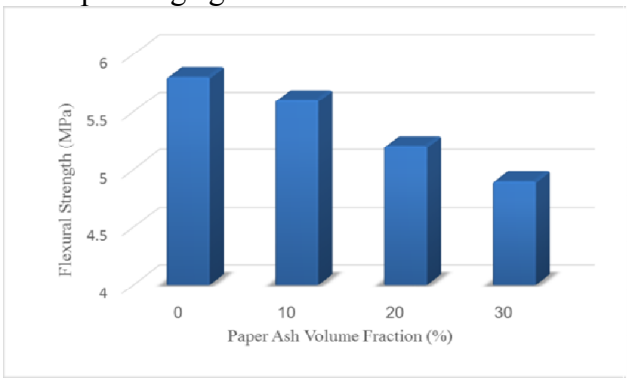


Fig. 5: Flexural strength against volume fraction of paper ash.

## 4. CONCLUSION

This study examined how different volume fractions of paper ash of cement pocket affect the mechanical properties of concrete. The following conclusions were found:

Inclusion of paper ash partial replacement of cement adversely affects the slump of the concrete.

Strength properties of concrete mixtures decreases marginally with increase in paper ash contents up to 20% replacement.

Paper ash can be used for making precast products and structural grade concrete.

## ACKNOWLEDGMENT

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# Performance of Concrete with High Volume Paper Ash as Cement Replacements and Sulfonated Naphthalene–Formaldehyde Condensate

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**Abstract** This paper investigates the influence of high volume of paper ash of cement pocket as a replacement for cement with 20%, 30%, 40%, 50% and 60% and sulfonated naphthalene–formaldehyde condensate on the properties of concrete in the fresh and hard state. Performance of the paper ash–Portland cement mixture evaluated with respect to workability, compressive strength, split tensile strength and flexural strength. The results showed that with up to 40 % replacement, in each set, no major changes on concrete characteristics would occur, however, with further increase in replacement ratios considerable changes observed.

**Keywords:** high volume of paper ash of cement pocket, sulfonated naphthalene–formaldehyde condensate, compressive strength, split tensile strength and flexural strength.

## 1.0 INTRODUCTION

While cement production in its beginnings only focused on ordinary Portland cement, later cements with several main constituents produced by replacing parts of the clinker content by supplementary cementitious materials [1]. Ecological or environmental benefits of alternative supplementary materials include (1) the reduction in the negative effects of producing cement powder, (2) the diversion of non-recycled waste from landfills for useful applications, (3) the reduction in the use of energy for cement production and (4) the corresponding emission of greenhouse gasses [2].

Xie et al. [3] replaced cement with 30% fly ash by mass, while they were optimizing the mix parameters of high strength self-compacting concrete with ultrapulverized fly ash. They reported a 38-MPa compressive strength of concrete at 28 days. The concrete reported made with 0.38 water–cementitious material ratio and 475 kg/m3 cementing material. Yin et al. [4] replaced cement with 53% fly ash while investigating on the compounding and application of C80–C100 high-performance concrete. They reported 37.2- and 95.2-MPa 7- and 28-day cube compressive strengths, respectively, of fly ash concrete made with 0.23 water–cementitious material ratio. The concrete reported was containing 580 kg/m3 cementing materials.

It known that fly ashes generally have negative effects on the concrete strength, particularly at early ages [5]. Using large quantities of this material in concrete seem to be in contradiction to the original aims of preparing high strength concrete. However, as observed by many researchers [7-10], fly ash concrete may have better strength performance when they prepared at lower w/b ratios. Lam et al. [11] demonstrated that at a w/b = 0.5, a 45% fly ash replacement resulted in about 30% reduction in 28-day compressive strength, but at a w/b = 0.3, the strength reduction reduced to 17%. In addition, the advances of concrete admixture technology allow concrete mixtures to be prepared with lower w/b ratios. It therefore believed that high strength concrete could obtained with large volumes of fly ash. There were numerous studies on the strength characteristics of concrete containing fly ash. However, there is little study in the literature regarding the strengths of very high volume fly ash concrete with very low and optimal water–cementitious material ratio (i.e., 0.28–0.29). Thus, the aim of this work is to provide more data for the strengths of very high volume fly ash concrete. Another aim of this work is to prove that a high-performance concrete with moderate and high

strength could be produced using very high volumes of fly ash as cement replacement. These achieved through designing an roller compacted concrete (zero slump) concrete and superplasticizer-workable concrete containing high volume fly ash for pavements and structural purposes, and measuring their strength properties cured at different relative humidity conditions. The present work deals with performance of concrete with high volume of paper ash of cement pocket as a replacement for cement with 20%, 30%, 40%, 50% and 60% and sulfonated naphthalene–formaldehyde condensate on the properties of concrete in the fresh and hard state. Performance of the paper ash–Portland cement mixture evaluated with respect to workability, compressive strength, split tensile strength and flexural strength.

## 2.0 MATERIALS

The materials used in this study for producing the green concrete described in the following subsection.

### 2.1. Materials used for concrete

Ordinary Portland cement (OPC) used as the main binder, whereas high volume of fly ash was used as a supplementary binder up to a replacement level of 60% as in figure 1. Natural river sand with a fineness modulus of 2.9, specific gravity of 2.67 and water absorption of 0.45% was used as fine aggregate, whereas crushed granite with a maximum size of 10 mm, specific gravity of 2.65, water absorption of 0.32% and bulk density of 1475 kg/m3 was used as coarse aggregate. Waste paper ash obtained from a cement pocket waste where pocket waste was born at air .It contains 42.5% CaO according to chemical analysis. The composition of normal and fly ash concrete are presented in Tables 1and 2. A sulfonated naphthalene–formaldehyde condensate in a powder form used in all the concrete mixtures.

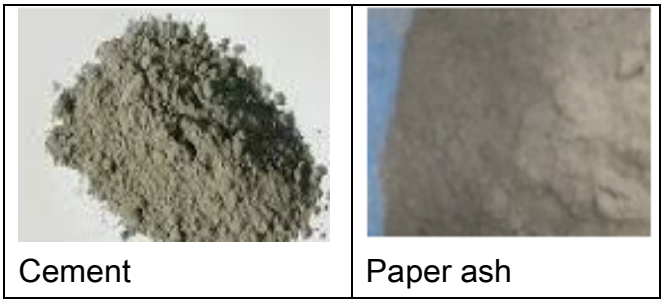


Figure 1: cement pockets ash with cement.

Table 1: Mixture properties of normal concrete

| Unit | Cement | Water | Fine aggregate | Coarse aggregate |
|---|---|---|---|---|
| Weight (kg) | 340 | 180 | 670 | 1190 |
| Volume(m3) | 108 | 180 | 251 | 450 |

Table 2: Mixture properties of paper ash concrete

| Unit | ash percent | Cement | Water | Fine aggregate | Coarse aggregate | Paper ash |
|---|---|---|---|---|---|---|
| Weight (kg) | - | 272 | 180 | 670 | 1190 | 65 |
| Volume (m3) | 20% | 86.4 | 180 | 251 | 450 | 21.6 |
| Weight (kg) | - | 238 | 180 | 670 | 1190 | 97 |
| Volume (m3) | 30% | 75.6 | 180 | 251 | 450 | 32.4 |
| Weight (kg) | - | 204 | 180 | 670 | 1190 | 130 |
| Volume (m3) | 40% | 64.8 | 180 | 251 | 450 | 43.2 |
| Weight (kg) | - | 170 | 180 | 670 | 1190 | 162 |
| Volume (m3) | 50% | 54 | 180 | 251 | 450 | 54 |
| Weight (kg) | - | 136 | 180 | 670 | 1190 | 194 |
| Volume (m3) | 60% | 43.2 | 180 | 251 | 450 | 64.8 |

### 2.2 laboratory test

#### 2.2.1 Slump Test

The workability property of concrete mixes measured by conducting slump cone test according to ASTM Standard C143 [12].

#### 2.2.2 Compression Test

For the compression tests, three cylinders of height 200mm and diameter 100 mm were used for each type, according to ASTM C 39-01 [13]. The specimens were cured accordance with ASTM C 192/C192M-06 [14]. The compression stresses tested on the age of 28th day.

#### 2.2.3 Splitting Tensile Test

For the splitting tensile test on the age of 28th day, three cylinders of height 200mm and diameter 100 mm were used for each type and age, according to ASTM C 496-96 [15]. The specimens were cured accordance with ASTM C 192/C192M-06 [14].

#### 2.2.4 Flexural Test

The three-point static flexural strength tests performed according to ASTM C78-94 [16]. The specimens were 100 mm wide, 100 mm deep and 500 mm long, with a loaded span of 400 mm. Three beams specimens were cure in accordance with ASTM C 192/C192M-06 [14].

The three-point static flexural stresses tested on the age of 28th day.

## 3.RESULTS AND DISCUSSION

### 3.1 Slump test

One of the problems when adding paper ash into the concrete is the reduction of workability of the concrete. Therefore, sulfonated naphthalene–formaldehyde condensate with 2% added to solve this problem. The procedure of slump test was according to ASTM C143 [12]. As shown in Figure 2 the slump of the concrete decreases with increase in paper ash content. As 60% of cement is replaced by paper ash, the slump reduces to 35 mm only where it still within the slump for the structural concrete. The reduction in slump with the addition of ash to the concrete as cement replacement is also consistent with the earlier investigations [10]. Generally, sulfonated naphthalene–formaldehyde condensate produced the same electrostatic charges on the cement particles surface. This resulted in the repulsion among the cement particles, prevented the coagulation and minimized the interior voids and the friction between the fresh concrete ingredients.

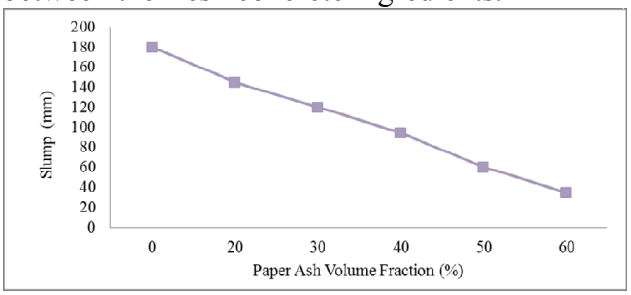


Fig. 2: Slump against volume fraction of paper ash

### 3.2 Compressive strength and splitting-tensile stress

The compressive strength tested according to ASTM C 39 [13]. Figure 3 shows the result of average compressive stress of the plain concrete is 41.5 MPa while the compressive stress is reduced by 5, 11, 16, 39 and 61% with the cement replacement by paper ash by 20, 30, 40, 50, and 60% of volumes, respectively. Values obtained that, there is no significant change in the compression strength of concrete up to 40% of cement replacement by paper ash. At 50% paper ash, although a reduction observed, it is still higher than structural concrete stress (17 MPa) at 28 days while it lower than it at 60 replacement.

In general, the above results indicate that partial replacements of cement by paper ash cause decrease in the compressive strengths as also observed by the previous workers [11].

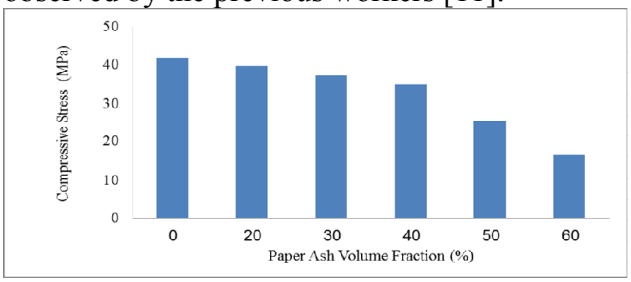


Fig. 3: Compressive stress against volume fraction of paper ash.

Splitting-tensile tested according to ASTM C 496-96 [15].

Figure 4 shows the result of average splitting-tensile stress of the plain concrete is 4.2 MPa while the it is reduced by 5, 10, 19, 40 and 70% with the cement replacement by paper ash by 20, 30, 40, 50, and 60% of volumes, respectively. Values obtained that, there is no significant change in the compression strength of concrete up to 40% of cement replacement by paper ash. In general, the above results indicate that partial replacements of cement by paper ash cause decrease in both compressive and tensile strengths as also observed by the previous workers [9-10].

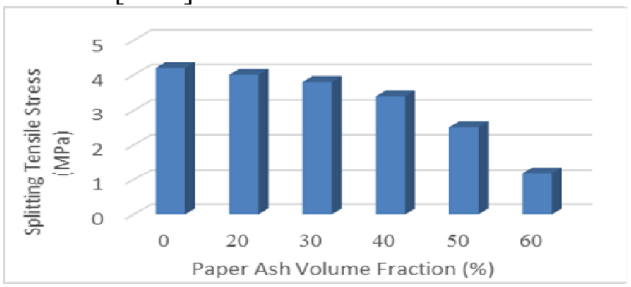


Fig. 4: Splitting tensile stress against volume fraction of paper ash.

### 3.3 Flexural strength

Flexural strength tested according to ASTM C78-94 [16]. Figure 5 shows the result of average flexural strength of the plain concrete is 5.8 MPa while the it is reduced by 7, 13, 20, 60 and 75% with the cement replacement by paper ash by 20, 30, 40, 50, and 60% of volumes, respectively. Values obtained that, there is no significant change in the compression strength of concrete up to 40% of cement replacement by paper ash. In general, the above results indicate that partial replacements of cement by paper ash causes decrease in flexural strength and this

result is consistence with both compressive and tensile strengths.

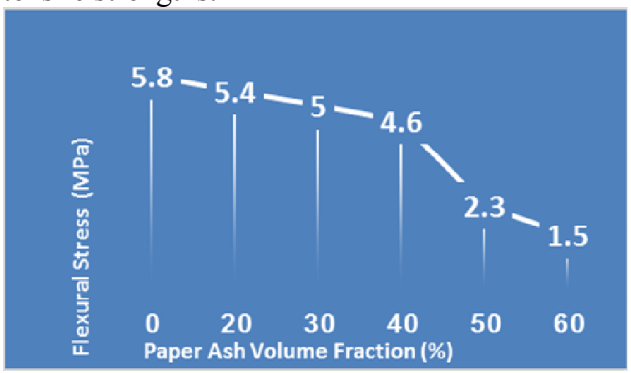


Fig. 5: Flexural strength against volume fraction of paper ash.

## 3 4. Conclusion

This study examined how high volume of paper ash of cement pocket with sulfonated naphthalene–formaldehyde condensate affect the mechanical properties of concrete. The following conclusions found:

- The slump of the high volume paper ash concrete decreases with increase paper ash as cement replacement. Sulfonated naphthalene–formaldehyde condensate with 2% will solve this problem.
- Strength properties of concrete mixtures decreases marginally with increase in paper ash contents up to 40% replacement.
- Values obtained that, there is no significant change in the compression strength of concrete up to 40% of cement replacement by paper ash. At 50% paper ash, although a reduction observed, it is still higher than structural concrete stress (17 MPa) at 28 days while it lower than it at 60 replacement.
- Further, the reduction in compression strength is lower than that in tensile and flexural strength.

## Acknowledgment

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# The Behevior of Lauryl Glucoside as Cement Paste Admixture

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**Abstract**:The use of air entraining agents have been accepted practice in cement technology for many years. A large number of uniform and stable micro bubbles is intentionally entrained to improve the durability and reduce the potential for damage from freezing and thawing, but these bubbles are inversely affected the hardened cement paste compressive strength. The Physiochemical and Mechanical Properties of cement pastes containing synthetic nonionic surfactant Lauryl glucoside (LG) as air-entraining agents are investigated. Different cement pastes with and without LG are prepared for five interval times (3, 7, 28, 90 and 360 days). The influence of the different surfactant concentrations on the air content of the pastes and accordingly the bulk density, compressive strength and microstructure of the hardened cement specimens is discussed. The optimal level of factors to achieve the desired goals are determined. The results show that LG causes a uniform distribution of small air voids in the cement paste, beside its ability to accelerate the hydration reaction, which may greatly improve the compressive strength of the pastes. The LG specimens show the highest compressive strength values (131,128,123, 115 N/mm2) at the concentrations (0.025, 0.035, 0.06 and 0.09 %, respectively). The optimal LG concentration is thus considered 0.025%.

**Keywords:** air-entraining admixtures, density, compressive strength, XRD, Lauryl glucoside, nonionic surfactant.

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## I. Introduction

It is well known that the pore structure of hardened cement pastes strongly influence their physical properties. The presence of an air-entraining agent (AEA) not only improves workability, but also enhances its freeze-thaw resistance (Lea's, 2004). Du and Folliard (2005) noted that there is a minimum dosage of AEA required to entrain air in the concrete. Rosen (2004) reported that the formed air bubbles in cement pastes are unstable and have limited lifetimes. Therefore, surfactants as AEAs are used in many cases to entrain air bubbles and stabilize them in the fresh cement pastes.

Whiting and Nagi, (1998) reported that an increase in air content leads to a reduction in the compressive and the flexural strengths. It is found that an increase in air content by a percentage point leads to an average reduction of 2 to 6 percent in the compressive strength and 2 to 4 percent in the flexural strength. Qaraman et al (2016) and Algurnon (2013) stated that a number of factors influences entrained air. Examples of such as factors include the duration of mixing and the nature and concentration of the surfactants used as air-entraining agents.

Carmel et al., (2003) and Qaraman, (2017) concluded that the processes of air entrainment and air void stabilization in cement pastes depend on the surface activity of the surfactant available in solution. Lauryl glucoside (figure 1) is a natural sugar based surfactant. This surfactant as example of nonionic surfactants have hydrophobic /hydrophilic balance wherein there is neither a negative nor a positive charge in either parts of the molecule, thus giving it the nonionic terminology. These surfactants have the advantage that they are not affected by water hardness or by pH changes as the anionic surfactants. They are considered medium to low foaming agents and especially advantageous

when a very low air- entraining agent is required.

**Figure 1: Lauryl glucoside (LG)**

The objective of this work is to study the effect of nature and concentration of the nonionic surfactant LG on the air content and accordingly on the bulk density and the compressive strength of the cement specimens. In addition, the microstructure of the hardened cement samples has to be examined using X-ray diffraction and SEM techniques.

## 2. EXPERIMENTAL:

### 2. a. Materials:

- Portland cement of mark CEM I 52.5N obtained from El-Arish cement factory. Its chemical composition is given in (Table (1)).
- Lauryl glucoside, a nonionic surfactant is supplied from Merck and used as such.

**Table (1): Chemical composition of the used ordinary Portland cement (OPC).**

| Oxide (%) | OPC |
|---|---|
| $SiO_2$ | 22.12 |
| $Al_2O_3$ | 5.56 |
| $Fe_2O_3$ | 3.69 |
| CaO | 62.87 |
| $Na_2O$ | 0.26 |
| $K_2O$ | 0.11 |
| $Cl^-$ | 0.02 |
| MgO | 2.36 |
| $SO_3$ | 0.91 |
| Free CaO | 0.92 |
| Ignition Loss | 1.22 |

### 2. b. Techniques and Instrumentation:

### 2. b. 1 Paste preparation:

The cement specimens are prepared by dissolving different concentrations of LG (W/C) is 0.43 as recommended (Carmel et al., 2003). The percentages of the surface-tent in 650 g H2O then adding to 1500 g cement. The water to cement ratio surfactants used range from 0.005 to 0.090 % by weight of cement.

The mixing are carried out under continuous and vigorous stirring for about three minutes (Carmel et al., 2003). After complete mixing the resulted pastes is poured into (12 ×4 ×4 $cm^3$) moulds. The moulds are kept at about 100% relative humidity at room temperature for one day. The hardened cement pastes are then removed from the moulds after they attained the final setting and cured under water for the rest of the hydration ages (up to 360 days).

### 2. b. 2 Compressive Strength:

Three specimens of each mix at different hydration times (3, 7, 28, 90 and 360 days) are used for examination the compressive strength of the pastes. The mean value of the three specimens at each hydration age is considered as the determined compressive strength. The strength test machine used is of point load taster (20063 cemasco S/N-Controls) type, Milano- Italy.

### 2. B. 3 STOPPING OF HYDRATION:

This is performed after doing the compressive strength test by taking about 10 g of the crushed hardened pastes and putting into a beaker containing 100 ml of acetone/ethyl alcohol (1:1 by volume) to stop the hydration process. The mixture is stirred for 0.5 hr. The residue is filtered off, washed with ethanol and dried at 50º C for about 24 hrs. The dried samples are then stored in a desiccator for the following physico-chemical analysis.

### 2. B. 4 DETERMINATION OF THE BULK DENSITY OF THE CEMENT PASTES:

The bulk density is determined by measuring the weight of the sample in air and under water. The density is then calculated as mentioned in (ASTM Standard C 138-08 – 2008).

2. B. 5 DETERMINATION OF THE AIR ENTRAINED IN THE CEMENT PASTES:

The percent of air entrained in pastes was determined by the difference in weight of a hard- ended cement paste in absence and in presence of surfactants by the equation:

$$\text{Percent of air entrained} = \frac{A - B}{A} \times 100\ \%$$

**Where:** A: The weight of hardened cement paste in absence of surfactant.

B: The weight of hardened cement paste in presence of surfactant.

2. B. 6 X-RAY DIFFRACTION ANALYSIS (XRD):

XRD patterns of the samples are recorded by using a Philips X Pert MPD diffractometer using copper target with nickel filter under working conditions of 40-kilo volts and 20 milliampers.

2. B. 7 SCANNING ELECTRON MICROSCOPIC (SEM) MEASUREMENTS:

The morphology and microstructure of the dried hydrated samples are studied using JEOL JXA 840 an electron Probe micro analyzer SEM. The specimens are coated with a thin film of gold, under vacuum evaporator with cathode rays then analyzed.

All laboratory tests were conducted at the Soil and Building Materials Laboratory at the Islamic University in Gaza and Ain Shams University in Cairo.

## 3. RESULTS AND DISCUSSION

### 3. a. Effect of the presence of surfactant on the air content and the bulk density of cement pastes.

Air content is a controlling factor, which affects many physical and mechanical properties of cement pastes (e.g., bulk density, compressive strength, workability, etc.).

On adding an air entraining surfactant to cement pastes, its molecules are inserted between adjacent molecules at the water surface; the mutual attraction between the separated water molecules is reduced. Lowering the surface tension stabilizes the bubbles against mechanical deformation and rupture, making it easier for bubbles to be formed.

The values of the air content entrained in Portland cement pastes hydrated for 90 days in presence of different percentages of LG are determined. It should be mentioned that the con- tent of air entrained in cement pastes show a slight change at the different hydration ages (From 3 up to 90 days). However, the air content exhibits the best value at 90 days of hydration. The results in Table (2) show a gradual increase in the air content with increasing surfactant concentration and reach a maximum value at a concentration of 0.09 %. However, the maximum air content is 11.81% on using the LG surfactant.

**Table (2): effect of LG concentration on the air content and the density of the hardened cement paste at 90 days**

| Surf. conc. (Wt %) | 0.00 | 0.005 | 0.025 | 0.035 | 0.06 | 0.09 |
|---|---|---|---|---|---|---|
| % of air entrained | 0.00 | 3.01 | 6.05 | 9.21 | 10.87 | 11.81 |
| ρ (g/ cm$^3$) | 2.00 | 1.94 | 1.91 | 1.82 | 1.79 | 1.77 |

The density of cement pastes is directly affected by the air content; they are inversely proportional to each other. The results show that the density decreases with increasing surfactant concentration, and reaches its minimum value at 0.09% wt of the surfactant. It is found that, the density decreases by about 0.3g/ cm3 when the air content is increased by about 14%. (Qaraman, 2016).

3. B. EFFECT OF SURFACTANTS ON THE COMPRESSIVE STRENGTH OF THE HARDENED CEMENT PASTES.

Compressive strength of hardened cement is an important criterion specified in the design of lightweight cement pastes and should be

considered equally important as density, (Feneuilet al., 2017) and (Algurnon, 2013). The properties of these pastes are time-dependent, therefore, any test method on the cement pastes should be performed at a certain hydration age.

In this work, the determined values of the compressive strength of Portland cement pastes in absence and in presence of the surfactant LG at different concentrations and different hydration ages are given in (figure (2)).

Generally, all mixes show an increase in the values of the compressive strength with increasing hydration time. This increase is believed to be due to progress of the cement hydration with time. In nearly most cases, the compressive strength increases on increasing surfactant concentration until reaches maximum at 0.025 % then decreases. The LG specimens show the highest compressive strength values (131,128,123, 115 N/mm$^2$) at the concentrations (0.025, 0.035, 0.06 and 0.09 %, respectively). The optimal LG concentration is thus considered 0.025%.

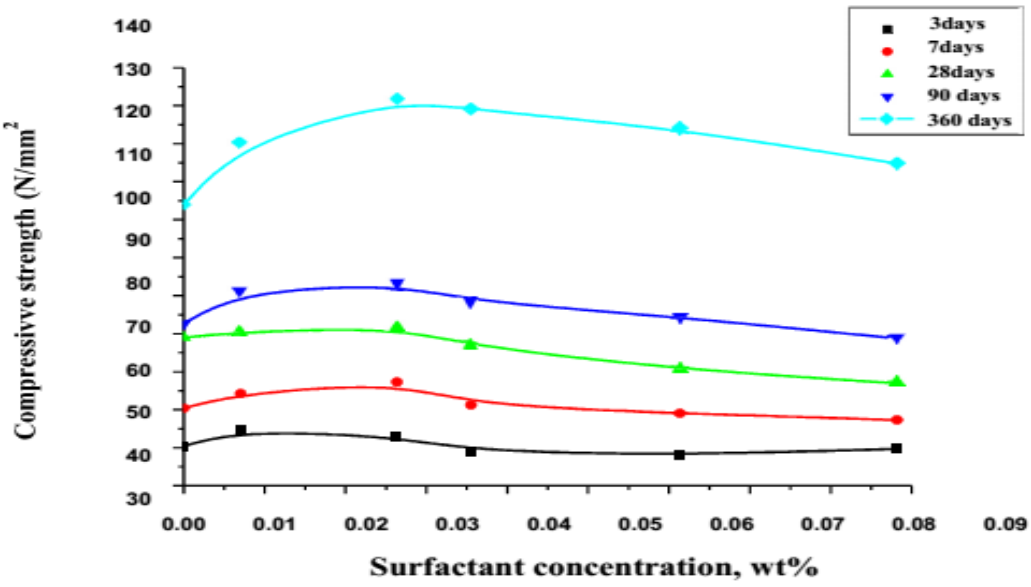


**Figure (2): The compressive strength of hardened cement pastes containing LG at 3, 7, 28, 90 and 360 days.**

### 3. C. Effect of surfactants on the phase composition of the hardened cement pastes.

The rates of change in physical and chemical properties of Portland cement pastes depend upon the rates of hydration of the components in cement. Both $C_3S$ (alite phase) and β-$C_2S$ (belite phase) react with water to form calcium silicate hydrate (CSH) and calcium hydroxide (CH). The CSH provides most of the strength developed by Portland cement. $C_3S$ hydration occurs more rapidly than $C_2S$ hydration. Therefore, $C_3S$ provides most of the early age strength while $C_2S$ contributes mostly to the later age strength (Gartner et al., 2002).

The phase composition of the various hardened Portland cement pastes in absence and presence of the surfactant LG is examined at the two hydration ages 7 days as an early hydration age and 360 days as a late age of hydration using

0.025 and 0.09% surfactant concentrations applying the X-ray diffraction technique. The reactants ($C_3S$ and $C_2S$) and products (CSH and CH) of cement hydration, (both for the control mix and on using LG) are shown in figure (3). It can be observed that, the intensity of the characteristic peaks of the reactants such as alite and belite phases decreases with increasing the hydration age.

At 7 days, it is found that the intensity of the peaks characteristic of calcium silicate hydrate (CSH) increases on adding either 0.025 or 0.09 % L G surfactant compared with the blank specimens. This indicates that L G accelerates the hydration of the cement pastes in early ages.

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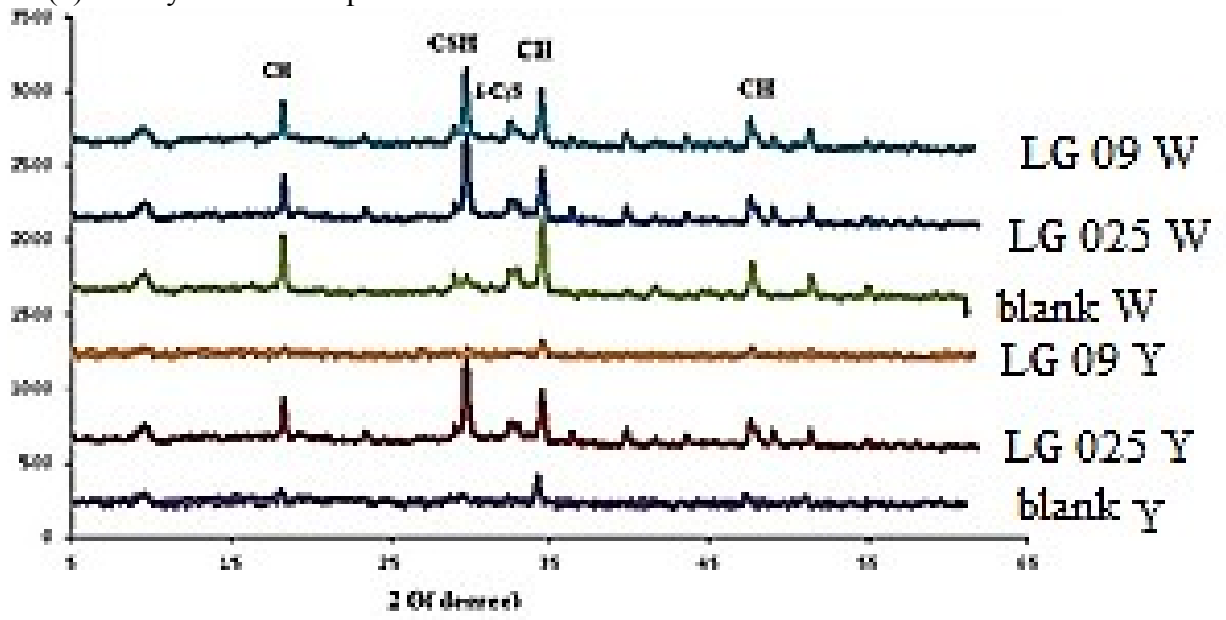
Figure (3): X-ray diffraction patterns of the control hardened cement paste and the hardened cement pastes with 0.025 and 0.09 % L G at 7 days (W) and 360 days (Y).




**3. f. Effect of surfactants on the microstructure and morphology of the hardened cement pastes.**

The scanning electron microscope (SEM) is a powerful tool for imaging and chemical analysis in cement research. With a high resolution and a large depth of focus, it enables a detailed study of surface topography of the rough surfaces of e.g. the formed calcium

After one year, the peaks characteristic of β-$C_2S$ (belite phase) disappeared completely and converted to the hydration products, calcium silicate hydrate (CSH) and calcium hydroxide (CH). The intensity of the CSH peak increases in the samples containing of 0.025 % L G, while in case of 0.09% concentration both CSH and CH peaks remain the same as in the blank.

Hence, it can be concluded that both 0.025 and 0.09 concentrations of LG accelerate the hydration reaction in the early age but after a year only the low dosage 0.025% accelerates the hydration reaction.

The ability of LG to accelerate the hydration reaction and accordingly improving the compressive strength may be refer to its ability to form hydrogen bonds with the CSH network silicate hydrate (CSH) and calcium hydroxide (CH).

The micrographs of the hardened cement pastes in absence and presence of the surfactants after 7 days are shown in Figure4 (a &b). Figure (4-a) illustrates the hydration products formed in absence of surfactants. Calcium hydroxide appears as hexagonal plates and the ettringite needles exist beside the fibrous CSH phase. Addition of L G (figure 4-b) shows an increase in the amount of calcium hydroxide, which has a layered structure, appears beside CSH crystals.

(Figure 5) (a & b) shows the micrographs of the hardened Portland cement pastes in absence

of surfactants and in presence of 0.025% LG after 360 days hydration. It can be noticed that the hydration products have more compact structure composed of calcium silicate hydrates, which explains the improvement in the strength after year for all mixes.

On other hand, the structure of cement paste with addition of LG produces consistent bubble structure with a uniform small air voids system (76.92 µm) it seems to be more compact. These findings may indicate that LG uniform the air void system beside its ability to accelerate the hydration reaction. This may help improving the compressive strength of the LG, these results are great confirm previous findings that nonionic surfactants uniform the air void system beside its ability to accelerate the hydration reaction (Qaraman ,2016).

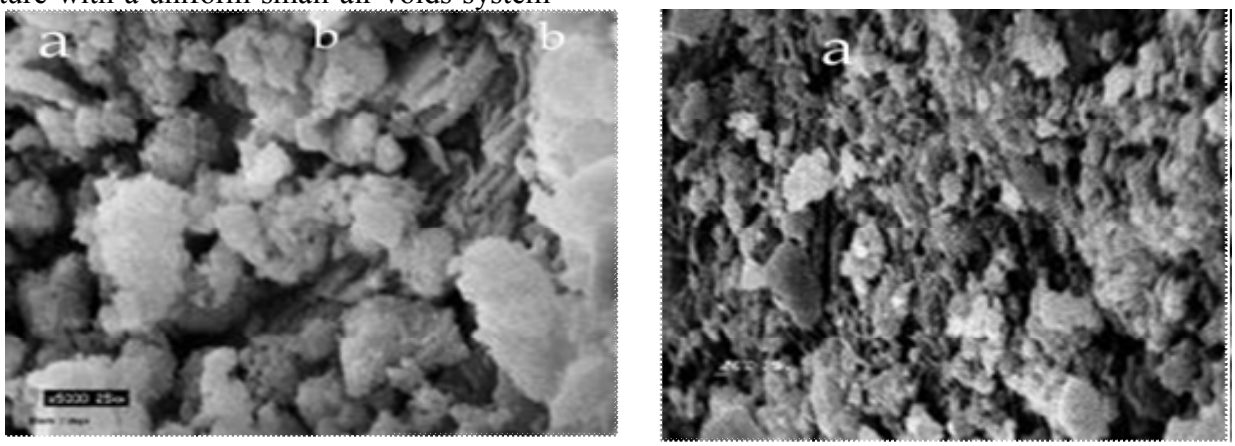



**Figure (4): SEM of hardened cement pastes after 7 days hydration (X = 5000).**

**a) Without surfactant b) With 0.025% L G**

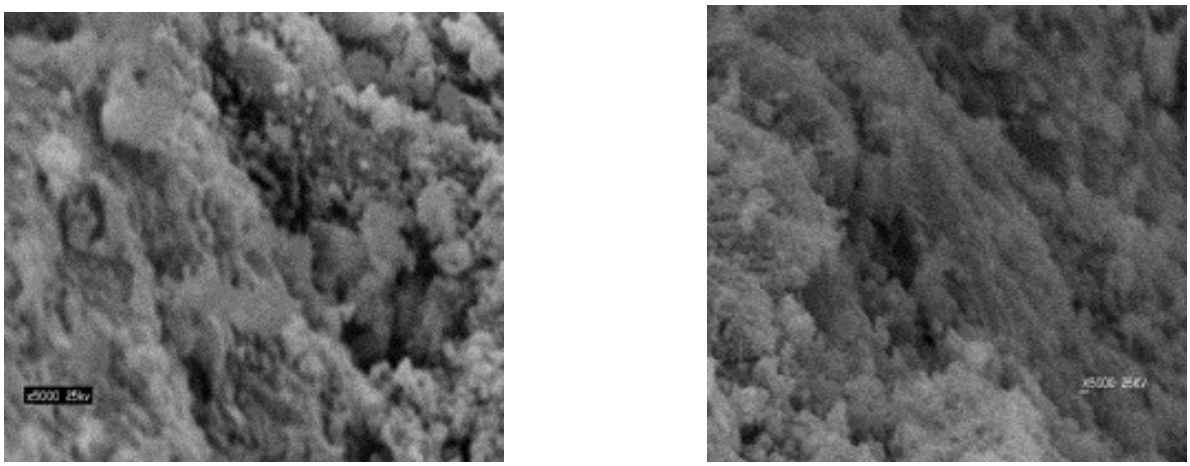


**Figure (5): SEM of hardened cement pastes after 360 days hydration (X = 5000).**

**a) Without surfactant b) With 0.02% L G.**

## Conclusion and Future Work:

**According to the obtained results, we can conclude that:-**

1. LG improves the compressive strength indicating due its ability to accelerate the hydration reaction.
2. The best compressive strength of LG specimens is attained at LG concentration of 0.025 % by weight of cement.
3. SEM shows that LG causes a uniform distribution of small air voids, which may greatly improve the compressive strength of the pastes.

In our future work, we may concentrate an in depth study of other surfactant types on the durability and compressive of concrete and mortar. In general, the subject is quite interesting and the results are valuable to using new surfactants as air-entraining agents to improve light-weight hardened pastes without significantly losing in compressive strength.

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# Effect of Siloxane Polymer and Sea Water on the Performance of Recycled Aggregate Concrete

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**Abstract**

With the rapid development of the construction industry which requires an excessive consumption of natural resources and may result in the deterioration of the natural environment, the conflicts between the desire to achieve sustainable development of the construction industry and the shortage of resources will become more and more serious, especially in developing areas like Gaza Strip. Two factors which need to be taken into consideration in the use of the recycled materials in the production of new concrete is their structural behavior and durability. The present work involved experiments to analyze the mechanical behavior of RA concrete in natural conditions and after immersing for 8 months in seawater .The test program also involved studying the mechanical behavior of RA concrete after coating the aggregate with Siloxane Polymer(SP) .The natural coarse aggregates (NA) was replaced by recycled coarse aggregate (RA) extracted from concrete rubbles with percentages 0.0, 50.0 and 100.0% which was called N,NR and R concrete mixes. One hundred nineteen specimens were casted ,about half of them were immersed in the seawater except reinforced concrete specimens. RA affected adversely the workability of concrete but coating RA with SP enhanced the workability. For NR specimens, the compressive strength (CS), splitting tensile (ST) and flexural tensile (Fr) were reduced by 12.7, 7.5 and 20.34% respectively. Increasing the percentage of RAled to more reduction in strengths, where forR specimens, the percentages became 21.8, 20.5 and 30.83% respectively. On the other hand, adding SP reduced the strength of RA concrete, where the compressive strength, ST and Fr of R were reduced by12.8,10.0 and 5.9% respectively .It was concluded also that replacing NA with RA reduced the modulus of elasticity(Es) where it was reduced by 17.4 and 44.7%for NR and R respectively. Treated RA with SP also reduced the Es by24.5 and 9.8 %for treated NR and R respectively. The failure load of reinforced concrete beams was affected inversely when the percent of RA was increased, where the failure load of N specimens was 32.0KN but for R was 24.0KNDeflection and crack width raised when the percent RA increased, where for R specimens deflection and crack width increased by 125.0 and 150.0 % in comparison with N beams. Immersing concrete specimens in seawater for 8 months enhanced the CS,ST , Fr and Es, where for R specimens they were enhanced by 7.0,16.7 ,67.0 and 7.0% respectively. Immersing treated RA by SP in seawater substituted the reduction of CS,ST and Fr where it was nearly the same and larger of that without SP. **Key words**

Siloxane polymer, seawater, treated RA , aggregates , recycled

## 1.1Introduction

Gaza Strip is a coastal district with a total area of 365 km2. It is well known that Gaza Strip is the most populated and poorest area in natural resources all over the world. There are no natural resources available to support its development demandsespecially rocks available to produce aggregate-coarse even sand that is available in Gaza Strip is poorly graded as a fine aggregate according to ASTM, (Zuhud,2008;Al Faqawi,2012).In this narrow strip, the accumulated amount of C&D wastes was about four million tons since June 12014(MPWH, 2014).

Since many decades till now, many researchers and investigators have engaged in studying the mechanical properties of RA concrete and also they studied the structural performance of R A concrete. Up to today, many national symposiums and international conferences about

the optimum use of R A as an alternative of natural aggregate have been conducted in many countries.

The C&D wastes in Gaza Strip has a special case where it was generated due to heavy explosives, so the produced RA in Gaza may differ than that of recycled aggregate concrete extracted usingmechanical demolishing or caused by natural crisis. In Gaza Strip, about 100% of C&D wastes exposed to heavy explosives with very high elevated temperatures, this explosives and elevated temperature may has affected the RA(especially adhered mortar) and consequently the chemical, physical and mechanical properties of RA concrete has been affected. The conditions of R A in Gaza Strip gives it a special case rather than other R A in the world.

The amount and quality of adhered mortar affect the physical properties of recycled aggregates, because the adhered mortar is a porous material, and its porosity depends on the w/c ratio of the recycled concrete employed[1][2]. The quantity and porosity of adhered mortar can greatly influence the final properties of the new concrete [1] [2]. As revealed from previous studies, the quality of aggregate is commonly classified according to the absorption rates. High absorption indicates high level of cement mortar attachment, which generally leads to concrete with inferior strength, durability and deformation and shrinkage properties[3].Absorption are observed in very rapid rates for recycle aggregate, where nearly 75% of the 24hour absorption capacity was attained in the first 30 minutes of the soaking period[4].

Workability of concrete with natural and recycled aggregate is almost the same if ―water saturated―surface dry recycled aggregate is used. Also, if dried recycled aggregate is used and additional water quantity is added during mixing, the same workability can be achieved after a prescribed time. Additional water quantity depends on the time for which the same workability has to be achieved[5] .Recycled concrete mixes require more water (increase of w/c ratio) than conventional concrete to maintain the same slump without the use of admixtures. This affects the quality and strength of the concrete, resulting in lower concrete strength [6].

The conclusions showed that even in the case of high-performance concrete, the interfacial transition zone (ITZ) is a zone of low resistance, because of the big porosity of adhered mortar. And as more porous is the concrete its ITZ will be less resistant [7]. After many tests on the mechanical properties of R A C, it has been revealed that the mechanical properties of new mortar matrix and relative mechanical properties between ITZs and mortar matrices play a significant role in the overall stress–strain relationship and failure patterns of RA concrete under both uniaxial compression and uniaxial tension loadings[8].

A significant influence was found on the stress–strain curve of different concrete mixes due to the use of different generations of repeated recycled coarse aggregate. Similar pattern of the stress–strain curves was found for all the repeated recycled concrete mixes [10].The strain increases with the increase of RCA contents Where for a RCA replacement percentage equals 100%, the peak strain was increased by 20%[9].

Elasticity modulus is one of the most affected properties of recycled concretes, even with low percentages of recycled aggregates. Recycled concretes with recycled percentages (RA-20%, 50% and 100%) have given average values of modulus of elasticity 10%, 20% and 40% lower than the corresponding natural aggregate concretes with the same dosage used in concrete mixes [11].A correlation between elastic modulus and compressive strength of recycled-aggregate concrete was found showing that, in general, 16% lower elastic modulus is achieved by using 30% coarse recycled aggregates, whatever the recycled aggregate grain size distribution [12].

Surrounding mortar on the aggregate tends to increase water absorption and reduce the density of RAC and becomes the governing criteria for the compressive strength of concrete with recycled aggregates [13]; [14]; [15];[16]. The variation between the compressive strength of recycled aggregates concrete and those of natural aggregates concrete are lower than 10 % independently to cement content[17].

The split tensile strength curve also shows the linear dropdown variation in the strength as the quantity of recycled aggregate increases in the concrete mix[18].After the flexural test, the same specimens were used for compression test, and the cubic compressive strength is also acquired. The ratio of flexural strength to cubic compressive strength is 0.12 for recycled aggregate concrete[19].After his experimental work in reinforced recycled aggregate concrete and natural reinforced concrete beams which includes the deflection and crack spacing, Ippei Maruyama et al concluded the following concluded that ,crack widths of reinforced recycled concrete (RRC) beams with wet curing are wider than those of conventional reinforced concrete (RC) ,when the stress in reinforced concrete beam is 20 N/mm2, while crack spacing of RRC beams are smaller than those of RC beams, Ippei Maruyama et al concluded the following also concluded that the deflections of RRC beams, when the stress in reinforced beam is 30 N/mm2are larger than those of conventional RC beams and at the same time the measured ultimate moments are larger than the calculated results by 10-20%. Many investigators investigated the effect of sea water on RA, Jianxiu Wang, et al established that the compressive strength of RC decreases with the replacement percentage, and the suitable replacement percentage should not exceed 30% in marine environment and it is time dependent as exposed to marine environments where it decreases 2% within 8 months exposure and 4% to 8% when corroding time exceeds 8months.The shape of the stress-strain curve of R A concrete was not affected by marine environment; it was as natural aggregate concrete irrespective of R A percentage but, increasing the percent of RA reduced the elastic modulus by about 7.5% when the replacement percentage is 60%, and it dropped by 2% and 9% when the corroding time is within or over 8 months, respectively[8].

There are many methods for improvements the physical properties of RCA by surface treatment. Katz introduced the surface treatment technique by impregnating RCA with a silica fume (SF) solution where the dried RCA was soaked in the silica fume solution to coat the surface of the RCA.with the silica fume particles[22]. The treatment by silica fume strengthened the structure of the aggregate, particularly the ITZ between the RCA surface and the cement paste, thus improving the mechanical strength of the concrete[22].Other alternative methods reported include treatment by soaking in other types of admixtures or solutions, such as nanosilica solution[23],polymer solution Kou SC,[24], and silane-based water repellent[25].Using of silicon based polymers was an effective solution of R A problems, impregnation R A with water repellent based emulsions particularly with siloxane and/or silane polymers appears to be the most successful method of protection from capillary water absorption[ 26] ;[27].

V.Spaeth, and A. Djerbi-Tegguer concluded after their investigations the following: (1)The general trend is an improvement of the water absorption resistance. The first results are very encouraging and confirm the interest of this kind of appropriate treatment. (2)The polymeric film developed in the pore network allows the significant reduction of water absorption capacity. Water repellent performance is achieved on RCA treated. The film formed is efficient and resistant in alkali environment. The polymer based treatments are easy to prepare.[28]

From the previous abbreviated literature, it was concluded following:1)The main problem with RA is the old cement paste layer on original aggregate.2) W/C ratio should be increased or using plasticizers to achieve same workability for RA concrete as NA concrete. 3) As the percent of RA increases the compressive, tensile, flexural strength decreases. 4)The modulus of elasticity of RA concrete is reduced by 40% than NA concrete.4)Marine effect is faster in RA concrete than NA concrete.5)Treating RA with polymers reduce water absorption.

**Research aim and objectives**

**1.1.1Research Aim**

Since the main problem of RA is the absorption of water, treating the surface of aggregates of water repellent like SP eliminates the amount of absorbed water. In general, this research aims to develop the performance of recycled aggregate (RA) extracted from concrete rubbles in marine

structures. This developed performance concentrates on re-using RA in concrete mixes as reinforced structural elements and subsidiary building ,matching the performance of natural aggregates concrete .The effect of immersing of RA concrete in sea water was also investigated which wasn't studied in previous studies also Any previous study doesn't study all the mechanical properties ,deflection and crack width of treated RA with SP.

### 1.1.2Research Objectives

The principal objectives of this research are as following :To provide a detailed review of the state-of-the-art in recycled aggregate concrete.

- To study the effect of silicon based polymers on physical properties of R A and the mechanical properties of recycled aggregate concrete using soaked RA in silicon based polymerslike SPwithdifferent percentages of recycled aggregate.
- To study the effect of sea water on the best mechanical properties mix during 12 months period.

### Test program

- The materialsused in this program were tested before beginning of any mix.The test program consisted of three main mixes 0.0,50.0 and 100.0% of RA.The mix was mainly designed using 0.0% RA then the NA was replaced by 50.0 and 100.0% RA.TheRA was treated using SP to minimize water absorption. The coated RA was used for concrete mixes with 50.0 and 100.0%.From every mix type ,18 standardcylinders,6 standardflexural prisms and 3 reinforced beams was casted. All mix types was immersed for 8 months in seawater except reinforced beams. All specimens was tested for workability,compressive strength,splitting strength and flexural strength.The modulus of elasticity was investigated for all concrete specimens,the deflection of beams and the crack width was investigated.

### Experimental StudiesMaterials

All the materials used in thisexperimental program has satisfied all the specificationsrequiredspecially the aggregate comply with the ASTM specifications and the other materials was used according to the manufacturer directions.

The main problem was with RAwhether in water absorption or chemical contents. Water absorption of RAwas about two times of NA and its weight was lighter than of NA.That was poor property as a reason of old cement paste layer attached with origin aggregate ,which may affect the workability and mechanical propertiesRA concrete .The chloride (CI) content ofRA was about ten times of NA and the content of sulfates was0.0089% for RA but the content of sulfates(SO4) was 0.001 for NA.Theincrease amount of CI and SO4 have bad effect on concrete since this increase fastens the deterioration of concrete and oxidation of steel reinforcement.

#### Cement

Type I Ordinary Portland Cement (OPC) was used in this experimental program.which has a chemical composition, and also satisfies standard specification for Portland cement of ASTM *designation* C150-92 .

### Water

Ordinary tap potable water is to be used in the concrete mixes.

### Aggregates

The used aggregate in this program classified to two types; natural aggregatewith both kinds coarse and fine (N A) and recycled coarse aggregate (R A).Only coarse RA was used in this experimental program where the fine RA were excluded.The NA used is a mix ofcrushed lime stone and dolomite, collected from stockpiles belongs to the Ministry of General Work and Housing and the RA (extracted from concrete rubbles) is collected from the stockpiles belongs to the United nations Development Program(UNDP) crushers in Palestine.Both kinds of aggregate were tested as following:

Chemical test of aggregate

All kinds of aggregates were tested for chloride, calcium carbonate and sulfate

contents as shown in Table (1).At the same time since RCA has been exposed to explosives as mentioned above another chemical test was conducted for heavy metal contents as shown in Table (2).

Table (1): Chemical contents of all kinds of aggregates and sand (IUGaza,2015)

| Parameter | Recycled aggregate | Sand | Naturalaggregate | Crushed stone aggregate |
|---|---|---|---|---|
| Cl % | 0.0799 | 0.01 | 0.0064 | 0.0107 |
| CaCo3 % | 50.05 | 9.6 | 96.6 | 98 |
| So4 % | 0.0089 | 0.0012 | 0.001 | 0.003 |

Table (2): Heavy metals in RCA (Al- AzharU.Gaza, 2015)

| No. | Element | Result / ppm | No. | Element | Result / ppm |
|---|---|---|---|---|---|
| 1 | Copper (Cu) | 338.6 | 9 | Chromium (Cr) | 52.8 |
| 2 | Iron (Fe) | 24372.2 | 10 | Strontium (Sr) | 386.3 |
| 3 | Nickel (Ni) | 101.5 | 11 | Lithium (Li) | 10.8 |
| 4 | Lead(Pb) | 18022.2 | 12 | Sodium ( Na) | 887.6 |
| 5 | Zinc(Zn) | 10136.6 | 13 | Calcium (Ca) | 440 |
| 6 | Aluminum ( AL) | 20487.7 | 14 | Chloride (CI) | 1500 |
| 7 | Cadmium (Cd) | 14.6 | 15 | Magnesium (Mg) | 291.2 |
| 8 | Cobalt (Co) | 10.6 | 16 | Nitrate ( No3) | 339 |

Physical properties of aggregate

| Physical Property | NCA | RCA | Crushed Stone | Sand |
|---|---|---|---|---|
| Unit Weight | 1.436 | 1.3532 | 1.82 | 1.656 |
| Water content | 0.025 | 0.01914 | 0.0267 | 0.0316 |
| Bulk Gs (SSD) | 2.61 | 2.44 | 2.7 | 2.66 |
| Bulk Gs (DRY) | 2.55 | 2.334 | 2.65 | 2.64 |
| Bulk Gs (Apparent) | 2.7175 | 2.613 | 2.81 | 2.68 |
| Water Absorption % | 2.45 | 4.62 | 2.17 | 0.48 |

## Sieve analysis

Sieve analysis of aggregate was arranged according to ASTMdesignation C136- 92 to fit the requirements for mix design according to ACI code. It should be noted that the crushed stone and sand was mixed with 3:2 ratio with a fine modulus 2.4. The following figures shows the sieve grading for all the kinds of aggregates used in this experimental program.

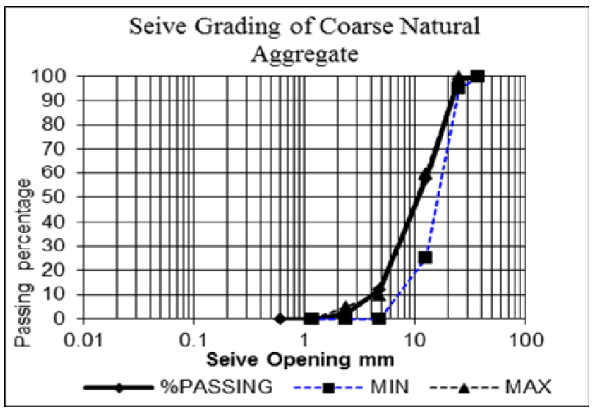



Figure (1):Sieve grading of natural aggregates

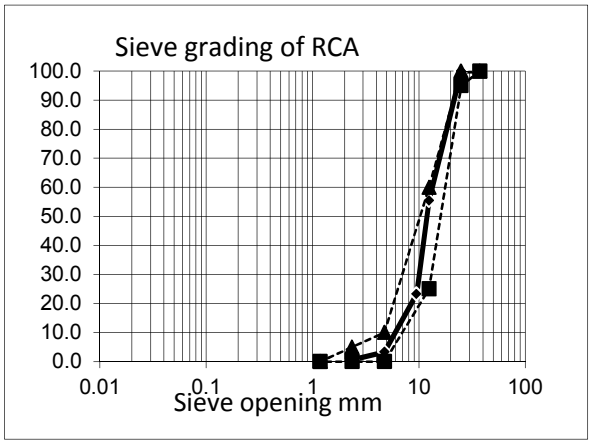



Figure (2):Sieve grading of RCA

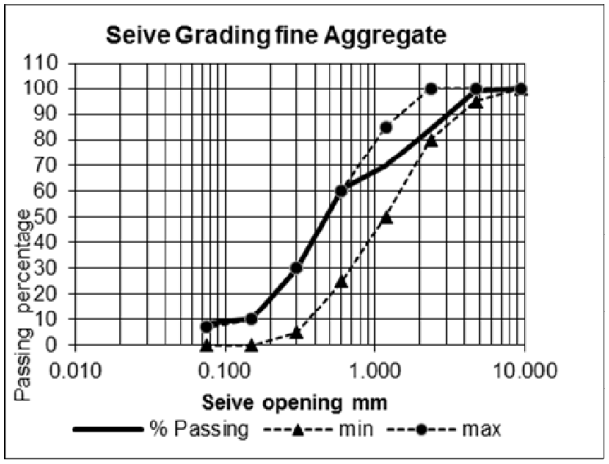



Figure (3):Sieve grading of fine aggregates

**Silicon based polymer**

The silicon based used in this program is Siloxane based water repellent impregnation used to reduce RA absorption water. The Siloxane penetrates well into the open pores of the aggregate providing durable water repellence, while still allowing water vapors diffusion in both directions. It is applied on aggregates before mixing its density 0.8kg/liter and flash point 36-40 °C

**Reinforcement Steel**

The main reinforcement used for beam rebar (Ø8.0mm) is ahot mildsteel ,fy=495.0Mpa and fu=520.0Mpa .The steel was used for stirrups is mild steel with fy=240Mpa.

## Concrete mixtures

In this study; the mix proportions were prepared according to ACI 211.1 as shown in Table (3). One targeted group of samples was chosen in this study with a compressive strength, fc=25.0Mpa.All the aggregates recycled and natural usedarein saturated surface dry (SSD) situation except the treated aggregate with Siloxane polymer it is not SSD but dry .It has to be known that the design of mix was for N with 0.0% RCA and in the other mixes only the percent of RCA has been changed.Siloxane polymer(SP) was added also for NR samples, denoted NRS and R samples denoted RS. Samples of R coated with SP and mixed with PP denoted RFS.

Table (3): Mix proportions quantities

| Mix | Water (Kg) | Cement (Kg) | NCA (Kg) | RCA (Kg) | Fine Aggregate | |
|---|---|---|---|---|---|---|
| | | | | | Crushed stone (Kg) | Sand (Kg) |
| N(0.0% of RCA) | 200 | 327.9 | 971 | 0.0 | 522.6 | 348.4 |
| NR(50.0%RCA) | 200 | 327.9 | 485.5 | 485.5 | 522.6 | 348.4 |
| R(100 %RCA) | 200 | 327.9 | 0.0 | 971 | 522.6 | 348.4 |

## Tests

### 1.1.3Workability

Slump test was conducted to assess the workability of fresh control concrete and concrete containing recycled aggregate. The slump test was carried out according to ASTM C143,for each mix in the testprogram,asample of freshly mixedconcrete is placed and compacted by rod in a frustum of cone mold. The slump value is equal to vertical distance between the original and displaced position of the centerof the top surface of the concrete after raising a mold.

### 1.1.4Compressive and splitting tensile strength

Molding cylindrical samples (Cylinders150X300 mm) was carried out according to ASTM designation C470-92 for compressive and splitting tensile strength.Acompression machine with a loading capacity 3000KNwasused in theexperiment.The loading rates were applied first to the compressivestrength test with loading rate 10.6 KN/s, The tensile splitting strength test was carried out at loading rate 1.6 KN/s.

### 1.1.5Flexural test

Standard beam specimens ($500 \times 100 \times 100$ mm )were used for flexural test according to ASTM designation C31.

### 1.1.6Moment strength of reinforced concrete beam

A beammoldwas fabricated using plywood with smooth surface with dimensions of100X150X1200 mm to suit the size and the ability of the machine especially designed for this test. The concrete was reinforced with 2Ø8.0 mm bars as main bottom reinforcement and 2Ø6.0 mm as secondary top steel with stirrups of Ø5.0mm at 7.5 cm to ensure flexural failure behavior.

## Sampling of test specimens and curing

Table (5) shows the number of samples used for every test for every type of concrete mix:

Table (5): Sampling of mix types and curing

| Mix type | After 28 day curing in fresh water | | | | After 8 months immersing in seawater | | |
|---|---|---|---|---|---|---|---|
| | Com. str. | Split. str. | Flex. str. | Renf. str. | Com .str. | Split. str. | Flex. str. |
| N | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| NR | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| R | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| RNS | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| RS | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Total No. | 24 | 24 | 24 | 24 | 24 | 24 | 24 |

## Results and discussion

### 1.1.7Water Absorption of RA with and without SP

TheASTM C-127-15procedure ofwater absorption test was usedfor treated RA withSPand RA without treatment.The water absorption of treated RA was calculated to be0.52% whichwas about one ninth of RA without treatment.This result emphasize the importance of surface repellent of RA where the water absorption of treated RA was about one ninth of water absorption of not treated RA.

### 1.1.8Workability

As shown in Figure (5) , as the percent of RA increased the workability of concrete mixes decreased, where it was decreased by 55% for 100% RA concrete mixes.The decrease of workability was due to water absorption of RA and due to the angular shape. Excessive water absorption and angular shape prevent sliding between constituents of RA concrete, then subs consequently the concrete mix wasn't arranged under its load.When SP was used in concrete mixes,the workability of NR and R enhanced where it was 120 and 127% greater than concrete mixes without SP .The increase of workability after treatment RA with SP was due to decrease of water absorption and smooth surface which made easier sliding between constituents of concrete ingredients.

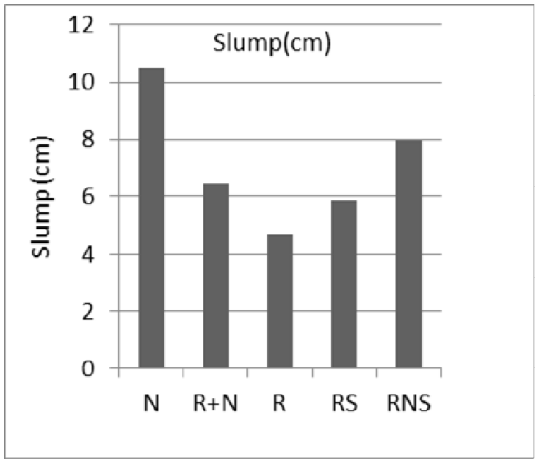



Figure (5):TheSlump of all mix types.

### 1.1.9Compressive strength

From Table(6)and Figure(6), when the percent of replacing RA instead of NA increased the compressive strength of concrete reduced, 50.0% RA reduced the strength by 12.75% and100%RA reduced the strength by 21.8%.Treating RA with SP reduced the strength of NRS and RS by 13.4% and 12.8% respectively. From Table (7) and Figure (7) immersing N, NR and R in sea water increased the compressive strengthby16.5%,15.7%and7.0%respectively, alsoimmersingtreated mixes with SP in seawater NRS and RS increased their strength by15.2% and 19.1% respectively.

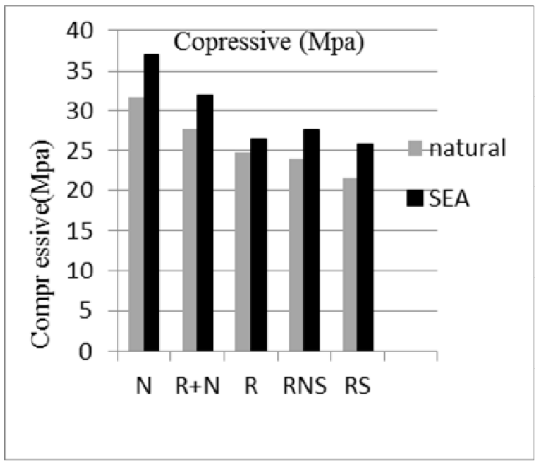



Figure (6):The compressive strength of all mix types after natural curing and immersing in seawater

Table (6):The compressive strength of all mix types

| Mix type | Compressive stress (Mpa) | |
|---|---|---|
| | natural | SEA |
| N | 31.73 | 36.98 |
| NR | 27.70 | 32.06 |
| R | 24.82 | 26.56 |
| NRS | 23.98 | 27.63 |
| RS | 21.65 | 25.78 |

### 1.1.10Stress –strain(SS) curves and modulus of elasticity (Ec)

From Table (7) and Figure(7) the Ec of concrete and the ductility reduced as the percent of RCA is increased but using SP for treatment of RCA has decreased Ec for NR and R by 25.7% and 29.1% respectively and it was noted that the curve of NRS and RS exhibits brittle behavior after reaching the ultimate compressive strength with a rapid descending curve.

Table(7):Ec of concrete mixes after 28 day curing in fresh water

| Type of Mix | Actual $E_c$(Mpa) From SSC curve | Comp. strength | Calculated $E_C$ according to ACI(Mpa)4700$\sqrt{f_c}$ |
|---|---|---|---|
| N | 25960 | 31.73 | 26474.81 |
| NR | 20775 | 27.70 | 24736.47 |
| R | 17183 | 24.82 | 23415.25 |
| NRS | 15414 | 23.98 | 23015.61 |
| RS | 12178 | 21.65 | 21868.89 |

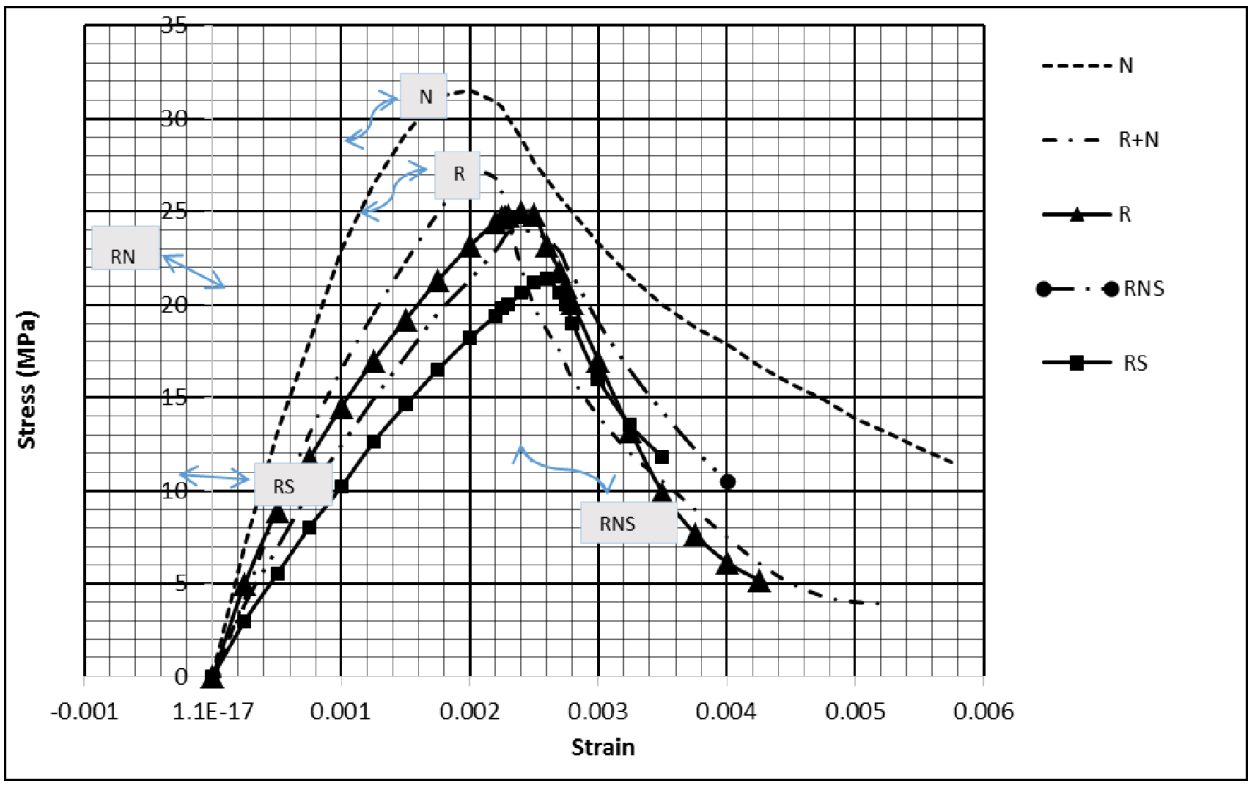



Figure (7):SSC of concrete mixes after 28 day curing in fresh water

Immersing concrete samples in seawater for 8 monthsincreased the rigidity where Ec increases but the ductility decreases as shown in Table(8) and Figure(8) respectively, where Ec increased by 22.2, 24.4, 6.5, 25.6, 26.51 % for N, NR, R, NRS and RS respectively. The Ec of concrete samples calculated according to ACI code 4700√fc is more than Ec calculated from SSC curves.

Table (8): Ec of concrete mixes after immersing of 8 months in seawater

| Type of Mix | Actual $E_c$(Mpa) From SSC curve | Compressive strength | Calculated $E_C$ according to ACI(Mpa)4700$\sqrt{f_c}$ |
|---|---|---|---|
| N | 33282 | 36.98 | 28581.26 |
| NR | 27480 | 32.06 | 26610.88 |
| R | 18387 | 26.56 | 24222.11 |
| NRS | 20722.5 | 27.63 | 24705.20 |
| RS | 16572 | 25.78 | 23863.78 |

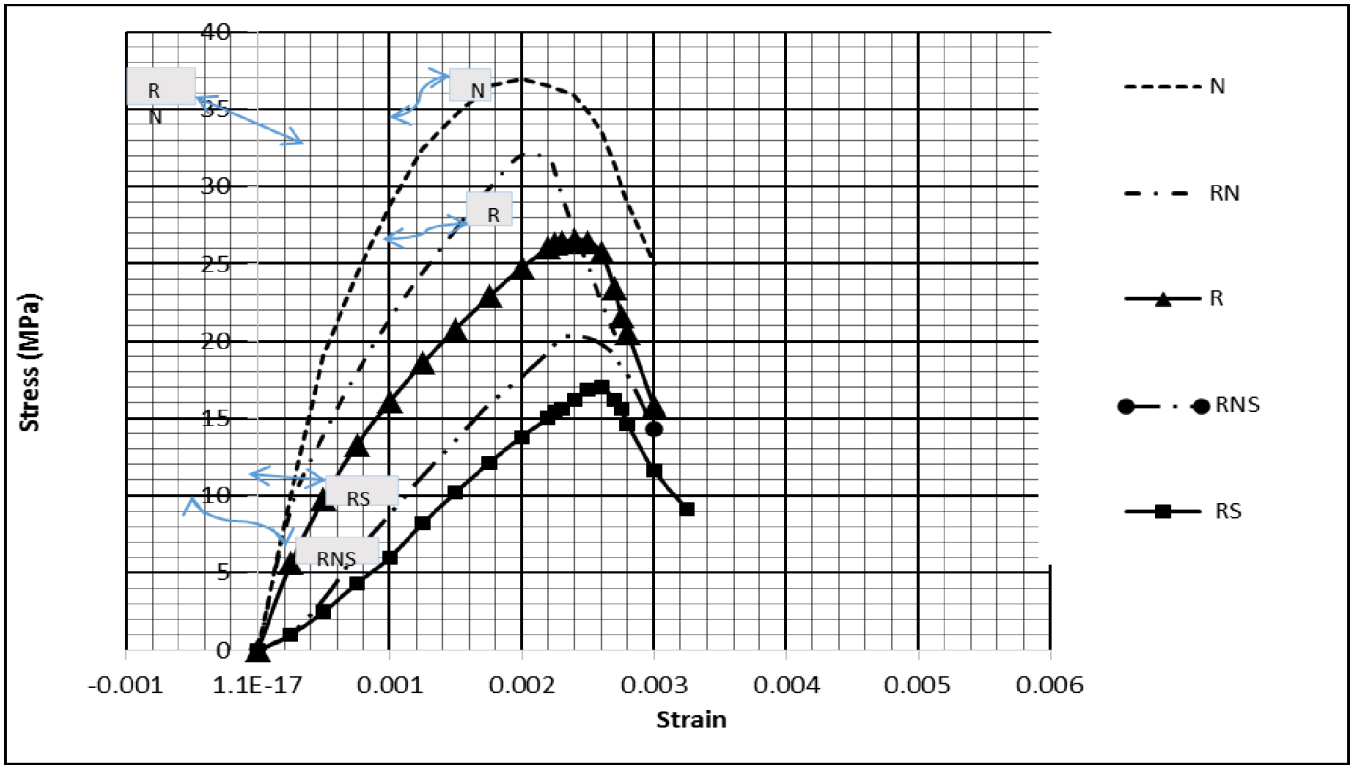



Figure (8): SSC of concrete mixes after immersing of 8 months in seawater

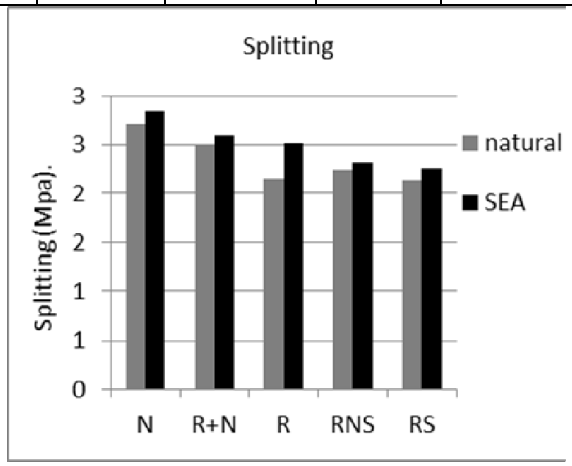
### 1.1.1Splitting tensile strength(STS)

From Table(9) and Figure(9) the STSis affected adversely by increasing the quantity of RA in concrete mixes, where it was reduced by 7.5 and 20.5% for NR and R respectively.IN spite oftreating RCA with SP reduces STS for RN and R by 10.4 and 1.0% .Immersing concrete samples in seawater enhances STS for all types of concrete mixes. Salmon page 44(Reference)says the correlation between compressive strength and splitting tensile strength ranges between 0.498√fc to.66√fc.All the correlations that are shown in Table (10)

ranges between 0.498√fc to.66√fc but when SP wasused to treat RA the correlation reduced to .37√fc.

**Table (9):Splitting tensile strength(STS)**

| Mix type | After 28 day curing in fresh water | | After immersing in seawater for 8 months | |
|---|---|---|---|---|
| | Splitting (Mpa) | Correlation with fc | Splitting (Mpa) | Correlation with fc |
| N | 2.71 | 0 .48*fc0.5 | 2.85 | 0.47* fc0.5 |
| NR | 2.50 | 0.47* fc0.5 | 2.59 | 0.46* fc0.5 |
| R | 2.15 | 0.43* fc0.5 | 2.51 | 0.43* fc0.5 |
| RNS | 2.24 | 0..457* fc0.5 | 2.32 | 0.38* fc0.5 |
| RS | 2.13 | 0 .45* fc0.5 | 2.25 | 0.37* fc0.5 |




Figure(**9**):Splitting tensile strength

### 1.1.2Flexural tensile strength(Fr) of concrete and correlation with compressive strength

From Table (10) and Figure (10)Fr is affected inversely by increasing the quantity of RA in concrete mixes, where it was reduced by 20.34 and 30.83% for NR and R respectively, in spite of treating RA with SP reduces ST for RN and R by 3.7 and 5.9%.Immersing concrete samples in seawater enhances STS for all types of concrete mixes. The correlation between compressive strength and Fris about0.623√fc according to ACI code, but according to Salmon ranges between 0.664√fc to 0.99√fc.All the correlations that are shown in Table (10), ranges between 0.664√fc to 0.99√fc .

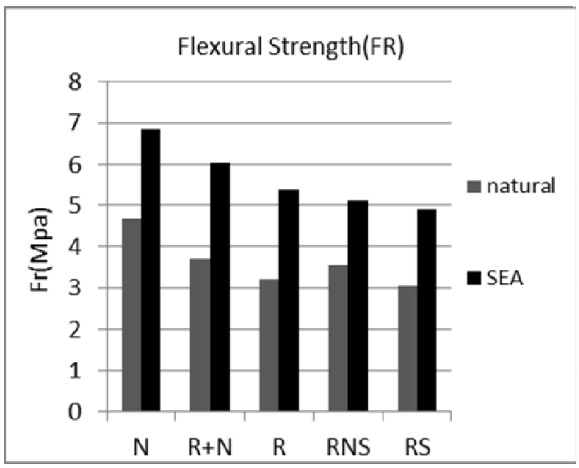



Figure (10):Flexural tensile strength(Fr)

***Table(10):Flexural tensile strength(Fr)***

| Mix type | After 28 day curing in fresh water | | After immersing in seawater for 8 months | |
|---|---|---|---|---|
| | Splitting (Mpa). | Correlation with fc | Splitting (Mpa). | Correlation with fc |
| N | **4.67** | **0 .83* $f'_c{}^{0.5}$** | **6.86** | **1.12* $f'_c{}^{0.5}$** |
| NR | **3.72** | **0.70* $f'_c{}^{0.5}$** | **6.04** | **1.07* $f'_c{}^{0.5}$** |
| R | **3.23** | **0.65* $f'_c{}^{0.5}$** | **5.40** | **1.04* $f'_c{}^{0.5}$** |
| RNS | **3.58** | **0.73* $f'_c{}^{0.5}$** | **5.12** | **0 .97*$f'_c{}^{0.5}$** |
| RS | **3.04** | **0.65* $f'_c{}^{0.5}$** | **4.90** | **0 .97* $f'_c{}^{0.5}$** |

### 1.1.3Deflection and crack width of reinforced concrete

From Figure (11) the behavior of all concrete beams almost the same, but the deflection and load corresponds to first crack and that correspond to failure are different according to concrete type. As the percent of RA increased, the first crack load and ultimate load reduced and the deflection increases where the first crack moment is 22.4,17.2 and 14.3 KNfor N,NR and R with accompanying deflection 2.1,2.4, and 1.8mm respectively. At the same timethe ultimate moment is 32.4, 27.8 and 23.2 KN with a deflection 4.8,4.95, and 6.4 mm for N,NR and R respectively. Treating RCA with SP weakened the reinforced concrete momentsuch that cracking load and ultimate load of RS is reduced

by 30.0% at deflection of 1.1 mm and 13.8% at deflection of4.4mm respectively.

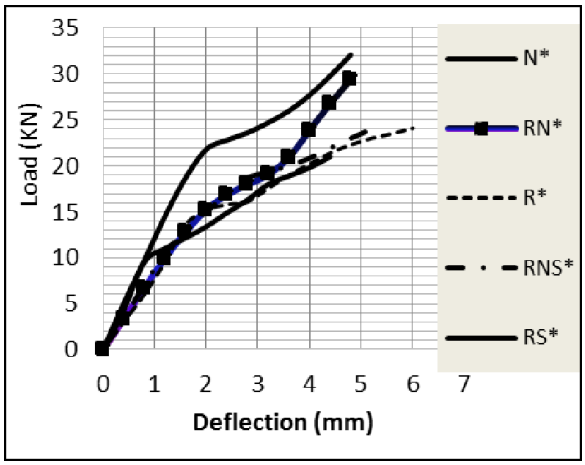
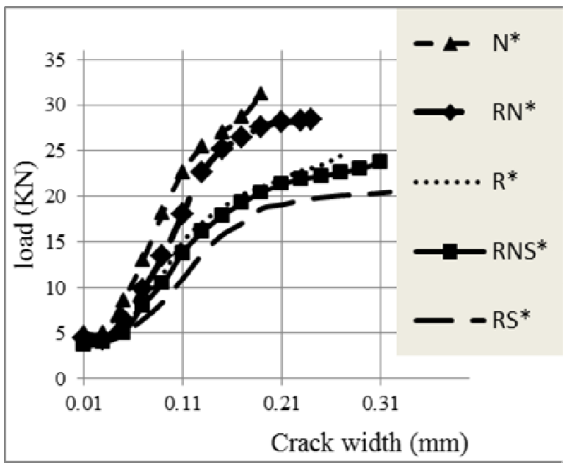



Figure (11): Load deflection curve of reinforced Concert Beam (Age 28 day ) without immersing in seawater

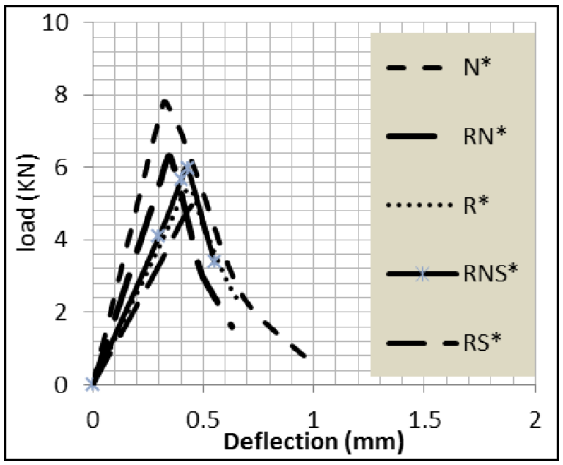
Adding RCA to concrete mixes increased the crack width according to increment percentage such that the crack width of NR and R is wider than N crack by average14.3 and 31.2% respectively.Treated aggregate with SP increased the crack width with percentage of about 28.4%.



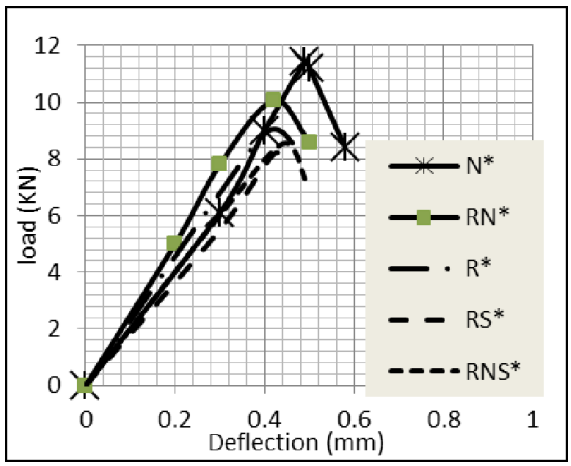

Figure(12):Load crack width of reinforced concrete beam

### 1.1.4Load deflection curve of plain concrete

From Figures (13-14) all types of concrete mixed with SP fibers wither after natural curing or immersing in seawater exhibit ductile behavior and have the highest value of Fr .From Figure (9) the behavior of N exhibits more ductility than NR,R,NRS and RS, where its failure occurred at a deflection of about 1.0mm . The failure of NR, R, NRS and RS occurred at a deflection 0.72, 0.6,0.55and 0.48 mm As shown from Figure (10) ,the behavior of all mix types were less ductile than mix types not immersed inseawater where the deflection at failure was 0.6,0.5,0.47,0.44 and0.4 mm for N,NR,R,NRS and RS.




Figure(13):Load deflection curve of plain concrete beams after 28 day curing in fresh water




Figure(14):Load deflection curve of plain concrete beams after immersing8 months in seawater

### 1.2Conclusion

In this study, the effects of RA with and without SP on mechanical properties of concrete are presented.The relations between the mechanical and physical properties ofRCA concretes are also analyzed. treating RA with SP affects adversely the mechanical properties of RA concrete but immersing concrete casted with treated RA enhanced the mechanical properties of RA concrete. Based on the above results,thefollowingconclusions can be drawn:

5) The workability of concrete mixes was affected adverselywhen the percentage of RA was increased butt treating RA withSP enhanced the workability of RA concrete mixes.

6) RA (Recycled coarse aggregate): As the percentage of RA increases the mechanical properties were adversely affected, where the compressive strength is reduced by 12.7 and 21.8%

for 50.0%RAand100.0%RA.Splitting tensile strength is reduced by 7.5 and 20.5% for NR and R, also Fr is reduced by 20.34 and 30.83% for NR and R respectively.

7) Treating RA with SP(Siloxane polymer) affects adversely the mechanical properties of NRSand RSwhere the compressive strength were reduced by 13.4 and 12.8%, splitting tensile strength by 10.4 and 10.05 and flexural tensile strength by 3.7 and 5.9% respectively.

8) Immersing in seawater enhanced all concrete typesmechanical properties .The specimens that used treated RA with SP showed best enhancement of mechanical properties when immersed in sea water.

9) Modulus of elasticity: The rigidity of RA concreteand treated RA with SP concrete has been affected adversely .

10) Deflection and crack widths: Deflection and crack width propagation increased as the percent of RA increased. Treatment with SP has increased the deflection and crack width.

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# Exploring the Use of Building Information Modeling (BIM) in Construction Projects in Gaza Strip

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**Abstract**

**4**Building Information Modeling (BIM) is a process for designing and collaborating using an intelligent 3D model across the planning, design and construction of buildings and infrastructure. It is one of the most promising recent developments in the Architecture, Engineering, and Construction (AEC) industry. The objectives of this study are to investigate and explore the knowledge implementation of BIM technology in Gaza Strip (GS) among contracting companies. To achieve this aim, the research reviews the literature related to BIM includes; definition of BIM technology, its benefits and disadvantages implementation in construction industry. The study used a questionnaire that was administered by contracting companies classified at the Palestinian Contractors Union. Fifty-five questionnaires were distributed in Gaza strip and 40 questionnaires were received which makes the response rate 72.7%. The results confirm the existence of several reasons for challenges in implementing BIM in construction projects in the Gaza Strip: (1) Unawareness of BIM benefits, (2) Lack of training, (3) Lack of qualified staff to work with the software. Furthermore, results explored key factors that can promote applying BIM in the Gaza Strip construction projects, including; (1) Training of construction staff, (2) Workshops about importance of applying BIM, (3) Provide free and trial versions of the software. Finally, the study recommended several suggestions on the use of BIM technology by contractors in the Gaza Strip construction industry.

**Keywords**

Building Information Modeling (BIM), Construction Projects, Contractors, Gaza Strip (GS).

## 1.0 INTRODUCTION

Building Information Modeling (BIM) is an advanced stage for studying and implementing construction projects, thus, it has been rapidly deployed in construction industry. In particular, the increased demands for such technology were laid behind the use of one integrative software package instead of employing several different incompatible software. It was also driven by the fact that all participants in the project can access the engineering model at the same time; allowing them to work together transparently, and make necessary changes.

With BIM technology, an accurate virtual model of a building is digitally constructed. It can be used for planning, designing, constructing, and operating the facility [1]. Obviously, it helps architects, engineers, and constructors visualize what is to be built in a simulated environment to identify any potential design, construction, or operational issues [2].

BIM technology is no longer just an addition, it is an integral part of the design process on a large scale and offers multiple and faster solutions to design and construction problems in a way that is closer to reality. It allows all stakeholders to access project information based on a single database, which enables parties to be involved throughout the project life cycle, design, construction, operation and maintenance phases. Consequently, it reduces re-work on the design process, reducing the effort, cost and time required to make decisions on the project [2, 3].

Therefore, this study aims to investigate the knowledge of Building Information Modelling (BIM) technology in Gaza Strip (GS) construction industry. In addition, to study and analysis willingness the contracting companies to implement BIM technology. Finally, to

explore the various strategies that contributes to enhance the use of BIM in Gaza Strip construction Industry.

## 2.0 BUILDING INFORMATION MODELLING (BIM)

Building Information Modelling (BIM) is defined a digital representation of a building's geometric and non-geometric data, and is used as a reliable, shared knowledge resource to make decisions on a facility throughout its lifecycle [4]. BIM represents a new paradigm within AEC, one that encourages integration of the roles of all stakeholders on a project [5]. Globally, BIM is argued to be a useful tool for reducing the construction industry's fragmentation, improving its efficiency, and lowering the high costs of inadequate interoperability [6]. In effect, BIM has changed the way construction projects are designed, constructed and operated [5]. BIM can be viewed as a single respiratory system that supplies and receives any information in digital form related to construction projects [7].

### 2.1 BIM Adoption in Construction Industry

There are many benefits to be derived from the adoption of BIM technology in the construction industry that could be used in all stages of the construction. The construction sector in developed economies has observed a growing interest in using BIM due to the myriad of benefits found through its implementation [8]. For example, in 2010 UK Government announced BIM requirements, and from 2016 onwards, the government of UK funded construction projects to use BIM as part of the design, construction, operation، maintenance and recycling of the building [9,10]. Notably, Dubai Municipality (DM) was the first authority to command BIM Implementation in UAE [11]. On the other hand, Singapore Government has a policy to lead the implementation of BIM, whereas clients in private sector are evaluating the value and cost of BIM [12]. In addition, Singaporean Government has a policy to reduce foreign workers in construction industry by implementing BIM to design and construction process. Although the adaption of BIM in countries such as USA, UK, Sweden, Australia, France, and Hong Kong are widely used [13,14], yet some studies confirmed that BIM adoption rate in other countries as, Jordan, Lebanon, Iran ,Turkey and Iraq, is still slow [15,16,17,18,19].

## 3.0 METHODOLOGY

In order to collect the needed data for this research, the secondary resources were used in collecting data such as books, journals, papers, and web pages. In addition to primary data were obtained through distributing questionnaires among the on study population in order to get their opinions about using the BIM technology in GS construction projects. The questionnaire was designed to be simple and direct yet specific to capture the current state of BIM practice in Gaza Strip. Research methodology depends on a descriptive the analysis of data, which depends on the poll and use the main program (SPSS).

### 53.1 Sample Size

The sample size for population will be determined by using Kish formula [20];

$$n = n'/ [1+ (n'/N)] \qquad (1)$$

Where: N is total number of population, n is sample size from finite population, n' is sample size from infinite population.

And

$$n' = S^2/V^2 \qquad (2)$$

Where: V= Standard error of sample population equal 0.05 for the confidence level 95 %, t =1.961.

$S^2$= Standard error variance of population elements,

$S^2$= P (1-P); maximum at P = 0.5

The study is limited to Gaza Strip contracting companies that are classified as first and second categories, which have a valid registration in Palestinian Contractor Union (PCU). Based on the PCU recent list in 2017, the population size is 130 companies. So

n= n'/ [1+ (n'/N)]
n'= $S^2/V^2$ = (0.5)2 / (0.051)2 = 96.12
N = 130
n= 96.12/ [1+ (96.12 / 120)] = 55

Consequently, fifty-five copies of the questionnaire were handed over to contractors companies in Gaza Strip. As shown in Table 1, forty questionnaires were received, which represents 72.7% response rate. Therefore, the slight low responses rate can be attributed to participants being unfamiliar with BIM term or lack of knowledge of BIM technology.

Table1: Population and Response Rate

| Population | Total Population | Calculated Sample Size | Distributed Questionnaire | Number of Respondents | Response Rate |
|---|---|---|---|---|---|
| Contractors Companies | 130 | 55 | 55 | 40 | 72.7% |

### 3.2 Relative Importance Index

Relative importance index is calculated using the following equation:

**Relative Importance Index**

$$RII = \Sigma W / AN \quad (3)$$

$$= \frac{5n_1 + 4n_2 + 3n_3 + 2n_4 + 1n_5}{5N}$$

Where: W is the weight given to each factor by the respondent, $n_1$= number of respondents for very important, $n_2$= number of respondents for the answer of important, $n_3$= number of respondents for the answer of moderate, $n_4$= number of respondents for the answer of not important, and $n_5$ = number of respondents for least important. (A) is the highest weight and (N) is the total number of respondents. The relative importance index range is from zero to one.

## 4.0 Results & Discussion:

### 4.1 Respondents Profiles

Table 2 show distribution of respondents according to their location, 20% of the respondents located in North Governorate, 55% in Gaza Governorate, 7.5% in Central Governorate, 15% in Khan Younis Governorate and 5% in Rafah Governorate. Respondents' profiles were classified according to the number of projects implemented during the last five years. 45% of the respondents companies implemented above 15 projects followed by 37.5% of the respondents companies implemented 11-15 projects, the least respondents were found in two categories with 5-10 projects (12.5%) and less than 5 projects (5%). In terms of cost of projects executed by the company, respondents were having varied costs. About 47.5% of respondents had cost more than 1.5 Millions followed by 40% of respondents had between $ 1.1 to 1.5 Million. Only 10% had between $ 0.5 to one Millions projects cost, while 2.5% had less 0.5 Millions of projects cost.

Table 2: Characteristic of Organization

| General Information | Categories | Freq | Percent |
|---|---|---|---|
| Organization Location | North Governorate | 8 | 20% |
| | Gaza Governorate | 22 | 55% |
| | Central Governorate | 3 | 7.5% |
| | Khan Younis Governorate | 6 | 15% |
| | Rafah Governorate | 2 | 5% |
| Number of projects implemented during the last 5 years | Less than 5 projects | 2 | 5% |
| | 5-10 projects | 5 | 12.5% |
| | 11-15 projects | 15 | 37.5% |
| | 15 and above | 18 | 45% |
| Cost of projects executed by the company in the last 5 years | Less than $ 0.5 M | 1 | 2.5% |
| | from $ 0.5 – 1.0 M | 4 | 10% |
| | from $ 1.1 - 1.5 M | 16 | 40% |
| | More than $ 1.5 M | 19 | 47.5% |

With respect to the respondent's job position, 20% of them were Administrator, 10% of them were Project Manager, 25% of them as Site Engineer, 30% of them as Design Engineer, 15% of them were Quantity surveyors. With respect to respondent's work experience, they were divided according to years of experience to 12.5% less than 5 years, 62.5% from 5 years to less than 15 years, and 25% with more than 15 years.

Table 3: Characteristics of the respondents

| General Information | Categories | Freq | Percent |
|---|---|---|---|
| Job Position | Administrator | 8 | 20% |
| | Project Manager | 4 | 10% |
| | Site Engineer | 10 | 25% |
| | Design Engineer | 12 | 30% |
| | Quantity Surveyors | 6 | 15% |
| Years of Experience for Respondents | Less than 5 years | 5 | 12.5% |
| | 5-15 years | 25 | 62.5% |
| | More than 15 years | 10 | 25% |
| Scientific Qualification | Bachelor Degree | 31 | 77.5 % |
| | Master Degree | 8 | 20% |
| | Doctor Degree | 1 | 2.5% |

However, the respondents' scientific qualification varied from 77.5% for Bachelor's Degree holders, followed by 20% with Master degree, and only 2.5% with PhD degree. Summary of the respondents' characteristics is presented in Table 3.

### 4.2 Knowledge of BIM and its Application in Projects

Figure 1 indicates the respondent's answer to knowledge level about BIM. The result of the questionnaire analysis indicates that 27.5% of the respondents never heard about BIM, 55 % of the respondents are aware of BIM but not applying it, 12.5% of the respondents used it but limitedly and 5% of the respondents used it regularly.

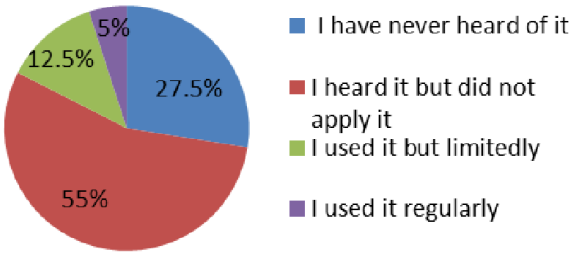


Figure 1: Knowledge about BIM

Next, respondents were asked to determine the number of projects that used BIM in recent times as shown in Figure 2. The result of the questionnaire analysis indicates that 72.5% of respondents not used it, 15% of the respondents have applied BIM in one project while 7.5% of the respondents have implemented BIM in 1-3 projects. This indicates that BIM implementation is not very common but is occasionally applied by the organizations. This may be due to unawareness of potential benefits of the BIM implementation in construction project.

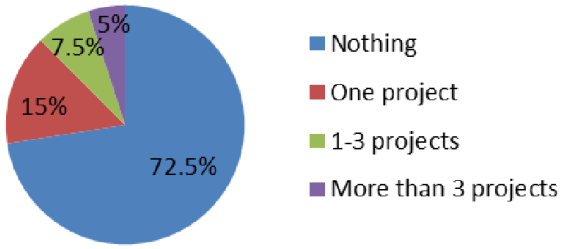


Figure 2: Number of projects that applied BIM in recent times

Figure 3 indicate the respondents answer to the implementation of BIM in their future projects. The result of the questionnaire analysis indicates that 7.5% of the respondents believed that BIM reduces time, 15% of the respondents noted that BIM improves quality, 5% of the respondents believed that BIM determines responsibility more broadly. Moreover, 7.5% of the respondents hold the view that BIM increases communication and cooperation between project partners. 65% of the respondents agreed that all previous factors were considered important for implementation of BIM projects.

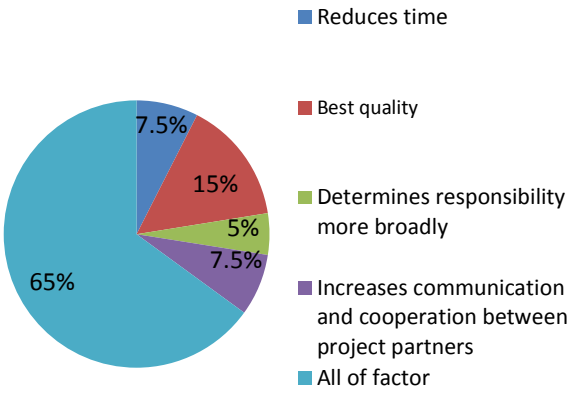


Figure.3: Implementation of BIM in your future projects

### 4.3 Causes for Not Implementing BIM in Construction Industry

The questionnaire included a set of obstacles to the implementation of BIM. Participants were asked to identify the options that could be related to their companies; results are shown in Table 4.

From the statistical analysis of the questionnaire, results show that the factor "Unawareness of BIM benefits" with relative importance index (RII= 0.85) was ranked in the first place on the overall ranking for the causes for not implementing BIM in construction industry in Gaza Strip. "Lack of training" (RII= 0.80) was ranked in the second position within this group. On the other hand, "Lack of competent staff to work with the software" and "Unawareness of the technology" was ranked in the third and fourth positions with relative importance index (RII= 0.79) & (RII= 0.68) respectively. Fifth place on the overall ranking for the causes for not implementing BIM are "Take longer time to develop model" (RII= 0.66), while the respondents ranked the "Difficult to learn" (RII= 0.60) at the last position within this group. It is the lowest factor affecting the implementation of BIM in the industry.

Table 4: Rank of factors causing for not implementing BIM

| NO | Item | Mean | S. D | Proportional mean | Rank |
|---|---|---|---|---|---|
| 1 | Unawareness of BIM benefits | 4.29 | 0.84 | 85.9% | 1 |
| 2 | Lack of qualified staff to work with software | 3.97 | 0.59 | 79.4% | 3 |
| 3 | Unawareness of modern technology | 3.42 | 1.06 | 68.5% | 4 |
| 4 | Non-availability of parametric library | 3.24 | 0.96 | 64.7% | 9 |
| 5 | Cost of new software and updates | 3.25 | 0.80 | 65% | 6 |
| 6 | Take longer time to develop model | 3.31 | 0.90 | 66.3% | 5 |
| 7 | Difficult to learn | 3.00 | 0.95 | 60% | 10 |
| 8 | Lack of training | 4.00 | 0.72 | 80% | 2 |
| 9 | Lack of hardware support | 3.25 | 0.84 | 65% | 6 |
| 10 | The size and complexity of BIM | 3.25 | 0.98 | 65% | 6 |

### 4.4 Strategies for Implementing BIM in Construction Industry

Table 5 shows the opinion of the respondents about the ranking of different suggested strategies enhance the implementation of BIM in GS construction industry. Based on the findings "Training of construction staff" with importance index (RII= 0.89) is the most effective strategy to enhance the implementation of BIM in GS construction industry. Based on overall ranking, the second most effective strategy is "Workshops about importance of applying BIM" with importance index (RII= 0.87). "Provide free and trial versions of the software" (RII= 0.86) has been ranked at the third position while "provision and legislation of laws relating to the use of BIM" (RII= 0.75) is the least ranked effective strategy.

Table 5: Rank of strategies to enhance the implementing BIM

| NO | Item | Mean | S. D | Proportional mean | Rank |
|---|---|---|---|---|---|
| 1 | Provide free and trial versions of the software | 4.32 | 0.81 | 86.5% | 3 |
| 2 | Training of construction staff | 4.47 | 0.56 | 89.4% | 1 |
| 3 | Reducing the price of BIM software | 3.82 | 0.80 | 76.5% | 4 |
| 4 | Provision and legislation of laws relating to the use of BIM | 3.79 | 0.91 | 75.9% | 5 |
| 5 | Workshops about importance of applying BIM | 4.35 | 0.88 | 87.1% | 2 |

## 5.0 CONCLUSION

This study investigated implementation of BIM in construction project in Gaza strip. From the study, it can be concluded that: The extent of BIM implementation in GS construction industry is very low, so it needs attention and more effort to support its application in construction project. Unawareness of BIM benefits and lack of training are major barriers to implementing BIM. Other factor include unawareness of technology, lack of qualified staff to work with the software, take time scale to develop model, cost of new software, needed updates and difficult to learn. Also highlighting the results of the questionnaire documented various strategies to implementing BIM as follow: training of construction staff, workshops about importance of applying BIM, provision of trial software, providing free and trial versions of the software, provision & legislation of laws relating to the use of BIM.

With particular attention to training of construction staff, organizing workshops about importance of applying BIM are considered the most effective strategies in enhancing the implementation BIM. It can be concluded that top management of contracting companies is invited to encourage implementation BIM. By selling incentives schemes for their staff members to attend training courses in application BIM and its software. In Addition, government, contractors union, engineering associations and universities have to do more efforts to using BIM and learning benefits in different situation through conducting workshops and specialized training courses related to the BIM techniques.

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# Mitigative Methods to Respond Risks Effects in Construction Projects in Egypt "Contractor's Perspective"

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**ABSTRACT**
The main aim of this paper is to investigate the mitigative methods used to respond risks that may face construction projects in Egypt to help contractors better manage risks of construction projects at the bidding cost estimate stage. The objectives of this research have been achieved through studying ninety questionnaires distributed to practitioner contractors. The research findings indicate that the most important mitigative methods are the following: Avoid or reduce risks through available alternatives - Accept risks but ensure that there is a risk reserve, which is a buffer of money and time - Transfer or share risks to/with other parties according to contract agreement and Transfer risks to insurance companies according to contract agreement. The results of this paper recommended contractors to determine the convenient mitigative method to respond risk effects early, and to select and use an appropriate construction contract, to transfer or allocate risks properly.

**Keywords:** Risk factors, Construction Projects, Mitigative methods, Contractors, Risk Management, Risk Allocation.

## 1.0 INTRODUCTION

A risk is the probability that an event or series of events may occur and which result(s) in failure to achieve a situation required in the future. Risks may mean that the target of the project cannot be achieved or that its intentions cannot be accomplished, or that time and /or cost restrictions are exceeded (PMP, 1999). On the other hand, (Elkjaer, 2000) defined a risk as a normally unwanted event. It can be identified and quantified through the impact and probability of occurrence. Often when no reliable data are available, one has to use subjective judgment to evaluate the consequences of certain risks, which inevitably involves uncertainty. Risks are inevitable in every

project and because of risks, uncertainty influences project cost calculations. (PMP, 1999) stated that uncertainty is not the same thing as ignorance. The magnitude of the uncertainty depends on the accuracy of given information. The accuracy of the information depends on, in which phase of the project you are. Examples of general uncertainties are such as: quality on calculation assumptions, quality on cost estimates. Examples of special uncertainties are such as: labor market situation, poor competition, weather, transports, tight time schedule, quality of the project organization, competence to make decisions, environmental etc...

The aim of risk management is to help project parties in avoiding effects of risk on contract profits. (Oztas & Okmen, 2004) stated that risk management can be defined as a systematic controlling procedure of risks that are predicted to be faced in an investment or a project. (Barrie & Paulson, 1992) mentioned that insurance and bonding could cover some of the risks; others can be transferred to another party by the construction contract. (Ward & Chapman, 1995) stated that shortcomings in the project-management process can be main sources of project risks. They explained that the project life cycle consists of four phases: conceptualization, planning, execution, and termination. (Enshassi & Mayer, 2001) developed a model that placed risk management in the context of project decision-making, while considering the overlapping context of behavioral responses, organization structure and technology. With this model emphasis is placed on how to identify and manage risks before, rather than after, they materialize into losses or claims.

The processes of the model are: Risk identification, Risk analysis, Risk response, and

Risk control and monitoring. The risk identification process is probably the most important phase of risk management; it deals with the estimated events or things that can go wrong in the project. Numerous areas can cause construction project risks. (PMP, 1999) stated that the risk analysis is a process of identifying hazards and estimating the risk regarding individual or populations, property or environment by using the available information. (Barrie & Paulson, 1992) point that risks can be categorized into internal and external, predictable and unpredictable, and technical and non-technical factors. (Leung et al, 1998) summarized the sources of these external and internal risk factors in construction project as follows:

**1.1** The external risk factors:

- Unforeseen (acts of God) : such as the common risks under this category are those related to physical damages and personal injuries due to earthquakes, floods, fires, landslides, etc.
- Political and environmental: such as changes in laws and regulations, permit Requirements andgovernment approvals, changes in pollution laws, and public consultation.
- Financial and Economic: such as inadequate sources of project funds by an owner or funding agent may create time delays and financing problems. Capital costs of projects are also influenced by fluctuations in the exchange rates of foreign currencies against the dollar, inflation, and many other financial and economic factors.

**1.2**The internal risk factors:

- Tender documents risks (design): such as incomplete design scope, defective design, Errors and omissions, inadequate specifications, different site conditions.
- Job-site-related risks: these risks are generally related to the availability and productivity of labor, site and other changed conditions.
- Operational and managerial risks: These risk factors include insufficient precaution, lack of examination, lack of coordination, lack of techniques, equipment damage, shortage of resources, etc. (Leung et al, 1998).

**1.3** Risk Response

This stage deals with the strategies or the procedures that could be prepared by the contractor to deal with risks. (Issa, 2008) and (Youssef, 2011) stated that when the risk analysis has been completed, a discussion is held on how the risks should be handled. In principle, (PMP, 1999) added that there are four different ways of dealing with a risk as follows:

1. Eliminate the Risk

This means that measures are taken to completely eliminate the risk, for example:

- Reduce the level of ambition and thereby ensure the accomplishment.
- Make full-scale tests before the accomplishment phase is started if unknown
- Technology is being used.

2. Reduce the Risk For example:

- Test new solutions before the full-scale accomplishment is started,
- Lower the level of ambition,
- Reject uncertain parts of the project.
- Reducing or eliminating risks will always cost something, e.g.:
- Direct costs in order to be fully certain,
- More expensive design,
- Lower future profits,
- Prolong time schedule.

3. Transfer the Risk

Usually to a supplier or contractor. This generally costs something.

Either somebody is paid in some way to assume responsibility for the risk, and both Parties are aware of the risk,

- Or the risk can be transferred to another party/company who is not aware of what it involves. In such a situation this party will usually make some kind of demand if the event occurs, which may lead to a conflict. This will almost always lead to a delay. The aim of the behavior in one or more of these three approaches is to reach a situation where we can use the next alternative **4** below.

4. Accept the Risk

Accept the risk but ensure that there is both time and money in reserve in case the risk event occurs fully or partly, (PMP, 1999). So, when risks are identified and recognized by the contractor, he will prepare the responsive plans. (Enshassi and Mayer, 2001) mention that the aim of this stage is to minimize the risks, and to maximize the profit. They also mention that the response process can be conducted in five ways. These ways are; risk avoidance, risk reduction, risk retention, risk transfer and insurance. (Nicholas and Stein, 2011) stated that not all

risks' impacts are severe or fatal, and if the cost of avoiding, reducing, or transferring the risk is estimated to exceed the benefit, then "do nothing" might be the best alternative. Of course, this response would never be chosen for risks where the impacts or consequences are potentially severe.

### 1.4 Risk Control and Monitoring

This phase is the final one of the risk management process. In this phase, the whole process of risk management must be monitored and reviewed to examine the targets set and contract strategies employed as a result of risk evaluation periodically, if the management plan remains appropriate, and if deviations would occur. If there are any deviations, corrective actions will be devised and evaluated (Enshassi and Mayer, 2001).

## 2.0 METHODOLOGY

The researcher conducted a comprehensive literature review to explore the most important risk factors associated to construction projects. A structured interview was also used to determine those important risk factors that impact construction projects as well. A sample of the most- experienced qualified contractors in Egypt were the targeted experts. The panel respondents (contractors) were requested to determine the most important risk factors associated to construction projects. The targeted contractors are those who are classified under the first class in the various types of work fields by the Egyptian Contractors Union. A total of 90 questionnaires were randomly distributed to targeted contractors. Only, 60 of them have fully completed the questionnaires accordingly. The questionnaire was designed mainly according to previous studies related to the subject of this research, (Youssef, 2011) and (Abu Mousa, 2005).

The respondents were asked to give their perceptions regarding the importance of the main risk factors and its allocation or transfer on five-point Likert scale (1 for the strongly disagree to 5 for the strongly agree).

The questionnaire has been validated by the criterion-related reliability test, and structure validity test (Pearson correlation coefficients). In order to be able to select the appropriate mitigative method to respond risks, the level of measurement must be understood. For each type of measurement, there is an appropriate methods that can be applied and not others. Inthis research, interval scales were used. The respondents were asked to give their perception and practice regarding the relative usage of the main risk mitigative methods on five- points Likert scales (5 means very often and 1 means never), as shown in Table 1, which was used in the questionnaire.

Table 1: Relative usage of main mitigative methods

| No. | Mitigative methods to respond risks effects | Never | Rarely | Sometimes | Often | Very often |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| 1 | Avoid or reduce risks through available alternatives | | | | | |
| 2 | Transfer or share risks to/with other parties according to contract agreement | | | | | |
| 3 | Transfer risks to insurance companies according to contract agreement | | | | | |
| 4 | Accept risks but ensure that there is a risk eserve, which is a buffer of money and time | | | | | |

**2.1**Statistical Manipulation

To achieve the research goals, researchers used the statistical package for the Social Science software, i.e., (SPSS) for manipulating and analyzingthe questionnaires collected data.

**2.2**Mitigative methods to respond Risks validity

As shown in Table 2, and using SPSS for analysis, the p-value for every mitigative method is less than 0.05 or 0.01, so the correlation coefficients of this domain (mitigative methods to mitigate risk effects) are significant at α = 0.05 or at α = 0.01, so it can be concluded that the test is highly consistent and valid as a tool for the study.\

Table 2: Pearson Correlation coefficient for every mitigative method to mitigate risk effects with the total degree of this domain

| Mitigative methods to respond risks effects | Pearson correlation | p-value |
|---|---|---|
| Avoid or reduce risks through available alternatives | 827.0** | 82888 |
| Transfer or share risks to/with other parties according to contract agreement | **0.656 | 8288. |
| Transfer risks to insurance companies according to contract agreement | *0.548 | 828.. |
| Accept risks but ensure that there is a risk reserve, which is a buffer of money and time | **0.678 | 82880 |

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed)

## 3.0 RESULTS

Statistical Tests for every Mitigative methods to respond risks effects

As shown in Table 3, the means and proportional means of all mitigative methods to respond risks effects range from 4.25 (85%) to 2.43 (48.6%), with P-values equal to 0.00 which are smaller than the level of significance α = 0.05. Meanwhile, the sign of the (one sample T test) is positive for all mitigative methods,

so this result proves that the means of all mitigative methods to respond risks effects are significantly greater than the hypothesized value 3. So, it can be concluded that the respondents' sample already accepted these items as a significant mitigative methods to respond risks effects that should be taken into account at the pricing stage of construction projects' bids.

Table 3: Arithmetic mean, proportional mean, one sample T test p-value and rank of each mitigative method to respond risks effects

| No. | Mitigative methods to respond risks effects | Mean | Proportional mean % | T value | P value | Rank |
|---|---|---|---|---|---|---|
| 1 | Avoid or reduce risks through available alternatives | 4.25 | 08 | 54.85 | 0 | 0 |
| 2 | Transfer or share risks to/with other parties according to contract agreement | 3.58 | 7027 | 31.93 | 0 | 3 |
| 3 | Transfer risks to insurance companies according to contract agreement | 2.43 | 6027 | 21.64 | 0 | 6 |
| 4 | Accept risks but ensure that there is a risk reserve, which is a buffer of money and time | 3.93 | 78.6 | 42.91 | 0 | . |

The surveyed contractors ranked " Avoid or reduce risks through available alternatives " and " Accept risks but ensure that there is a risk reserve, which is a buffer of money and time " mitigative methods at the 1st and 2nd ranks with proportional means of 85% and 78.6% respectively. They also ranked the "Transfer or share risks to/with other parties " and " Transfer risks to insurance companies "mitigative methods at the 3rd and 4th ranks with proportional means of 71.6% and 48.6% respectively. These results conform to the results of (Yossef, 2011) and (Kartam, 2001).

These results highlights on the high importance of the mitigative methods to respond risks effects particularly, at the bidding stage and before beginning of the project. So, when risks are identified and recognized by the contractor, he will prepare the responsive plans. (Enshassi and Mayer, 2011) mention that the aim of this stage is to minimize the risks, and to maximize the profit. These ways are; risk avoidance, risk reduction, risk retention, risk transfer and insurance. (Nicholas and Stein, 2011) stated that not all risks' impacts are severe or fatal, and if the cost of avoiding, reducing, or transferring the risk is estimated to exceed the benefit, then "do nothing" might be the best alternative. Of course, this response would never be chosen for risks where the impacts or consequences are potentially severe.

The " accept risks but ensure that there is a risk reserve, which is a buffer of money and

time" mitigative method or (strategy), would be chosen for risks that categorized as less significant ones with low consequence except when the risk impact is potentially catastrophic. Sometimes nothing can be done to avoid, reduce, or transfer a risk, in which case the risk must be accepted, regardless of the consequence. Fortunately, such cases are scarce. (Nicholas and Steyn, 2011) stated that response to a risk sometimes creates a new, secondary risk. Having planned a risk response, the project management team should check for possible secondary risks before executing the plan.

## 4.0 CONCLUSION

This study has successfully detected and analyzed the most important mitigative methods to respond risks in construction projects in Egypt. The study outcomes of this research point out that the most important mitigative methods to respond risks effects that contractors use to respond risk factors to better manage risks of construction projects at the bidding cost estimate stage, are the following: Avoid or reduce risks through available

alternatives - Accept risks but ensure that there is a risk reserve, which is a buffer of money and time - Transfer or share risks to/with other parties according to contract agreement and Transfer risks to insurance companies

according to contract agreement. The results of this research recommended contractors to determine the convenient mitigative method to respond risk effects early, and to select and use an appropriate construction contract, to transfer or allocate risks properly.

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# Modeling Disputes-Rmfa- as Decision Support System to Proceed Through Arbitration

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## Abstract

Although the scale size of disputes in construction projects mainly follows the claim amount disputed, going through arbitration is considered as a one scale from the client point of view. So, study of foreseen risks for current and future situations is worthwhile to move in effective claim. Actually, due to the multivariate nature of construction contracts, things never go as planned. Thus, humans have developed many methods to resolve disputes and arbitration is one of them. The study focused on modeling disputes occurring in construction industry field especially in Gaza Strip. Mathematical model, Regret Model for Arbitration (RMFA), has been built as a Decision Support System which will recommend the user (contractor) to proceed to arbitration or not. The developed model depends on Regret Approach mainly and two logical and mathematical methods; Net Present Value (NPV) and Multi Criteria Analysis (MCA) to obtain more accuracy. This required survey thirty questionnaires for identifying the effluent evaluation criteria that need to be input into the model. The selected evaluation criteria have been weighted in order to measure their relative importance and impacts for the three probability values (Pe, Pf and Po) winning, current loses and future losses probabilities respectively which will be determined automatically by the RMFA. The weight values range of the selected ten evaluation criteria was (3.62 – 5). The Contract criterion is the highest and the Time criterion is the lowest. Results of the model were tested in comparison with actual four disputes cases and the efficiency of the model achieved to 75%.

**Keywords:** Arbitration, Modeling, Regret approach, RMFA, MCA and NPV.

## 1. Introduction

The nature of human relationships is harmony or difference stimulating the disputes usually, so we face various disputes in our life; social disputes, financial disputes, political disputes, job disputes, etc. But the adorable thing that humanity has legislated different lawful effective methods to resolve these disputes. This paper focused on the dispute which occurs between the contractor and the client or the owner in engineering construction projects. The followed approach to solve such dispute is Arbitration based on legal references.

The importance of arbitration increases as the projects sizes increase. Primarily, classification of the projects size depends on the budget. Recently, Palestine as a developing country has got many funds to implement vital projects in various fields especially after the last sequent three wars 2008, 2012 and 2014 years which have been triggered by Israel against Gaza Strip. Actually, dueto the multivariate nature of construction contracts, things never go as planned. So, many conflicts were raised by some contractors as official claim that is considered a very first critical step which most of contractors try to avoid it. The method of resolving conflicts and disputes may have differing consequences. Going to arbitration to resolve construction disputes may not be an easy thing to do because the consequences may be dire. A contractor‟s reputation may be affected by the arbitration case. Even if the contractor is certain to win an arbitration case, it may lose any potential future projects with the same client or even others in the market. Therefore, the long- term losses to the contractor may overweigh its immediate benefit in going through the arbitration. Therefore, going through arbitration may be a reason of regret [1]. This paper illustrates a mathematical Regret Model For Arbitration (RMFA) proposed as a decision support system for going through

arbitration using a regret theory approach including some uncertain factors that will be extracted accurately by two mathematical logical methods; Net Present Value (NPV) and Multi Criteria Analysis (MCA) used to obtain more accurate results.

## 2. Modelling Dispute -RMFA

### 2.1 Research Concept

Regret Model For Arbitration (RMFA) has been built as a decision support system advising the user to proceed to arbitration or not. Figure (1) shows the framework of this mathematical model which consists of three stages (Input, Analysis and Output) and using mainly the Regret Approach method which has been developed by two mathematical logical methods (Multi Criteria Analysis MCA and Net Present Value NPV) in order to obtain more accuracy in the results. In which, results of a mathematical model depend on efficiency of entered data, in other words, rubbish input equals rubbish output produced by analysis stage in any mathematical model. The developed mathematical model RMFA has taken in into the consideration the flexibility of the required data that need to be input into the model. Some of these variable data are factors in regret approach method as probable percentages, these probabilities will be error source if the user could not estimate them professionally. so, this model has been adjusted and regulated to help the user to avoid uncertain data and enter confirmed data related to financial data mainly, then the probable variables in regret approach will be calculated automatically during analysis stage. Based on that, there are two classes of variables that need to be input into the model by the user (evaluation criteria and historical data) as shown in table (1). Finally, the predicted outcome of the model allows the decision-maker to understand whether or not raising a claim is worth the risk.

Table 1: Input data into the Model

| CLASS | REQUIRED DATA | INPUT |
|---|---|---|
| EVALUATION CRITERIA | Crit. 1 | 1 – 5 |
| | Crit. 2 | 1 – 5 |
| | Crit. 3 | 1 – 5 |
| | Crit. 4 | 1 – 5 |
| HISTORICAL DATA | Net Cost of Projects with Client yearly (Cc) - $ | |
| | Payments from Client yearly (Bc) - $ | |
| | Internal Rate (i) - % | |
| | Budget of Project (A) - $ | |
| | Cost of the Claim (C) - $ | |

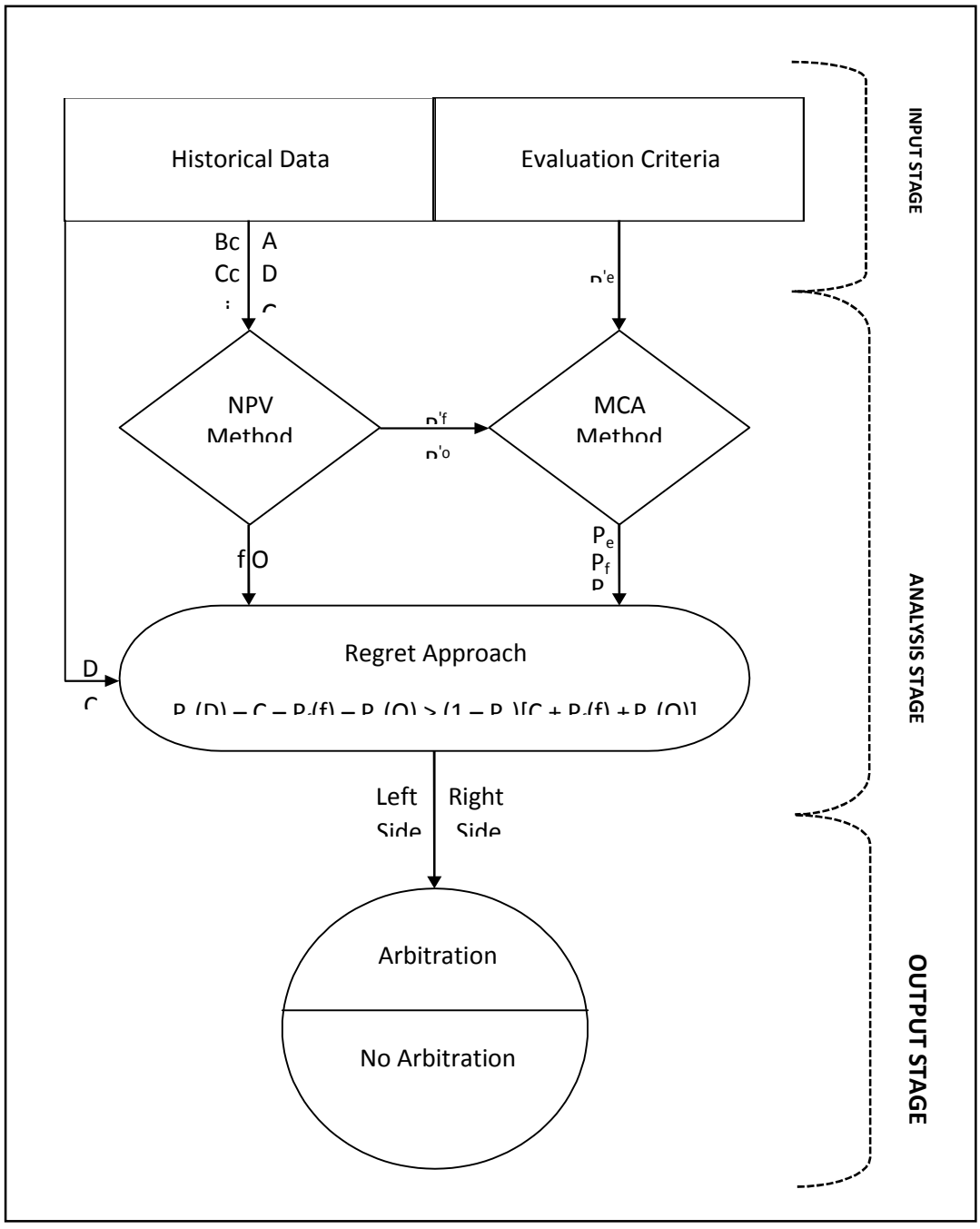


**Figure 1: Framework of Mathematical Model RMFA**

Practically, this model, RMFA, has been programmed and enhanced by specific programming language to be presented simply as shown the interface of the model in figure (2) in order to facilitate dealing with it at all steps; data entry, analyzing processes and results presentation. In addition to that, the model was tested to calibrate its results by four real previous disputes cases which were projected to the model and analyzed, then the results of actual disputes were compared for each case study and they were almost matched.

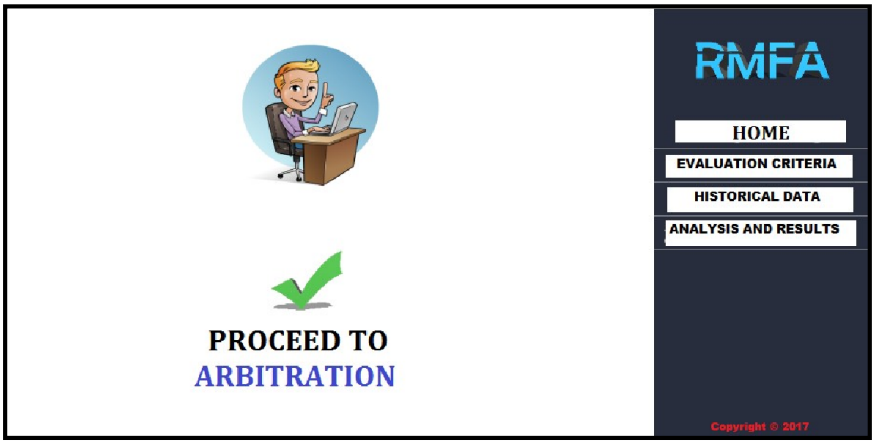


**Figure 2: RMFA Interface**

## 2.2 Materials and Methods

As shown in the previous section-figure (1), The improved mathematical model, RMFA, using regret theory approach which has utilized two methods (MCA and NPV) in order to support decision more accurately for going through arbitration. These methods will be discussed as follow:

- **Regret Theory Approach**

Theoretically, the being regret could be interpreted simply by the following famous exa mple; During winter season, the chance for rain is 50%, so taking an umbrella or not will be referred to traditional decision-theory completely. There are four different scenarios that may be decided in these events. Respectively, the first two scenarios have positive outcomes and the other two scenarios have positive outcomes, 1) the person who does not take an umbrella and it does not rain or, 2) the person who takes an umbrella and it rains, 3) the person who may decide to take the umbrella, but it does not rain, causing the person to regret his choice, and 4) the person may choose not to take an umbrella and it rains. However, due to uncertainty, the person cannot truly predict the outcome. Hence, just as there is a 50% chance of positive or negative outcome equally. Although the chances of the outcomes are equal, the person will regret one of those outcomes more than another [2]. Therefore, it does matter which choice the person makes even though the chances are equal, due to regret. Since arbitration may cause uncertain consequences on how both parties react to the procedure, then it is evident that a regret model is better for decision-making The Regret Approach depends on different factors which are taken into consideration in dispute resolutions and arbitration cases. Since arbitration takes a long time costly, then different factors need to be assessed to understand the overall risk of going through arbitration, the predicted results, and the benefits. The following factors are input into the regret equation as shown in equation [3] (1):

$$P_e(D) - C - P_f(f) - P_o(O) > (1 - P_e)[C + P_f(f) + P_o(O)] \quad (1)$$

_ Disputed claim amount (D)
_ Cost of arbitration (C)
_ Probability of winning (Pe)
_ Amount of possible effects on current projects‟ losses (f)
_ Probability of current projects‟ losses (Pf)
_ Amount of future opportunity loss (O)
_ Probability of future opportunity loss with the same client or others (Po)

Where; the probability of winning (Pe), probability of current (Pf) and future opportunity loss (Po) are ranged between (0-1). The probability of winning depends on having strong evidence. Also, the costs that will be estimated by contractor within this model must be dependent on real present values of the future costs or benefits [1]. The outcome of Regret Approach will advise the user to proceed to

arbitration if the left-side value is higher than the right-side value,

- Net Present Value-NPV

Net Present Value method is considered as a financial indicator to study the feasibility of the financial step which will be decided. Theoretically, NPV is the difference between the present value of cash inflows and the present value of cash outflows as the following equation (2) [4].

$$NPV = \sum_{t=1}^{T} \frac{Ct}{(1+r)^t} - Co \qquad (2)$$

where;
Ct = Net cash inflow during the period t
Co = Total initial investment costs
r = Discount rate, and
t = Number of time periods So, this method has been utilized to extract accurately some financial factors which were included in regret theory approach. These factors are the amount of possible effects on current projects‟ losses and the amount of future opportunity loss. Actually, the results of NPV method may be net positive or negative revenue for limited period, this value will be translated to the lost value currently or in future if the contractor decides to go through arbitration. and the Cash Flow Diagram (CFD) illustrated in figure (3) presents expected current and future losses related to NPV for going through Arbitration.

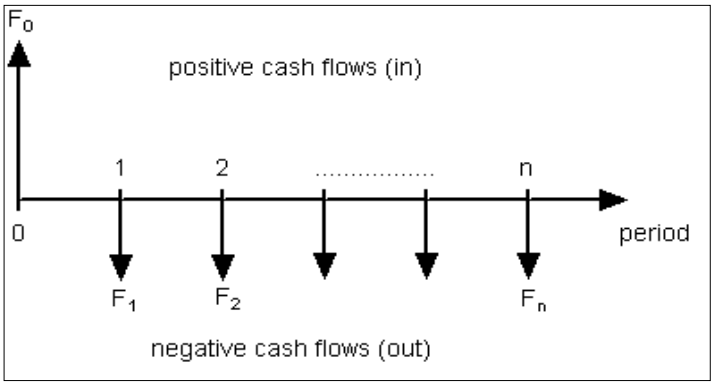


Figure 3: CFD for going through Arbitration

The NPV method helps to measure the value of future cash flows. Because of the time value of money (TVM), money in the present is worthy more than the same amount in the future. This is both because of earnings that could potentially be made using the money during the intervening time and because of inflation. In other words, a future opportunity loss in the future won‟t be worthy as much as one lost in the present.

- Multi Criteria Analysis-MCA

In general, Multi-criteria analysis is undertaken to make a comparative assessment between heterogeneous measures. In the evaluation field, multi-criteria analysis is usually an evaluation tool, and is particularly used for the examination of the intervention's strategic choices. In this study, MCA was used to expect the accurate values of probability of the following measures: 1- Current projects‟ losses (Pf), 2- Future opportunity loss (Po) and 3- Winning (Pe). whereas these probabilities will be crucial factors used in regret theory approach. The influent criteria on these values was studied well and determined by questionnaire survey developed and designed in Arabic language to be more understandable to the targeted population then was analyzed by Statistical Package for Social Sciences (SPSS). The generated evaluation criteria were weighted as a first
step in multi-criteria analysis in order to measure their relative importance and impacts for the three probability values (P'e, P'f and P'o) which will be determined by the NPV method then will be expected Pe, Pf and Po values accurately by the following equations (3) and (4) [5].

$$Impac = \sqrt{\frac{C^2+B^2+T^2+R^2+S^2+SE^2+M^2+TI^2+P^2+IC^2}{10}} \quad (3)$$

Where; table 2 shows all variables have been generated as evaluation criteria which are considered the most impact on the expected values for (Pe, Pf and Po).

**Expected Values %** (Pe, Pf ,Po) = Probability of (P'e, P'f ,P'o)* Impact (4)

Table 2: Evaluation Criteria

| No. | ID | Evaluation Criteria |
|---|---|---|
| 1 | C | Contract |
| 2 | B | BoQ |
| 3 | T | Time Schedule |
| 4 | R | Reports |
| 5 | S | Specifications |
| 6 | SE | Correspondences |
| 7 | M | Minutes of Meetings |
| 8 | TI | Time |
| 9 | P | Attitude of claim |
| 10 | IC | Independence and truthful of the arbitration Institution |

## 1. -Evaluation Criteria

According to the literature review and after interviewed experts in arbitration and all the information that could help in achieving the study objectives were collected, reviewed and organized to be suitable for the study survey, a questionnaire was developed with closed and open-ended questions. The question follows a scale as in the following table (2) Likert quintuple criterion used in the study [6].

Table 2: Scale of Questions

| Level | Scale |
|---|---|
| Strongly agree | 5 |
| Agree | 4 |
| Neutral | 3 |
| Disagree | 2 |
| Strongly disagree | 1 |

The utilized analysis by Statistical Package for Social Sciences (SPSS) for questionnaires data targeted to obtain the Evaluation Criteria which have been ranked according to their effects on the extent of arbitration as a dispute resolution indicator.

## 2. -Weighting Criteria

One of the rules in multi-criteria analysis is to weight these criteria using the relative important index and the mean values were used in this study. the relative index techniques have been widely used in construction study for measuring attitudes with respect to surveyed variables. Triple scaling was used for ranking questions that have an agreement levels. The respondents were asked to give their perceptions in group of questions on five-point scale which reflects their assessment regarding the arbitration procedures. The importance index was computed using Formula Relative Importance Index (5) [7]:

$$\frac{\sum w}{AN} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{5N} \quad (5)$$

Where w is the weighting given to each factor by the respondent, ranging from 1 to 5, (n1 = number of respondents who Strongly disagree, n2 = number of respondents who disagree, n3 = number of respondents for neutral, n4 = number of respondents who 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 [8].

## 2.1 Matrix and Analysis

The presented model in this paper provides the user final result for Regret Approach which is to proceed through arbitration or not. Regret approach consists of main four steps to reach the final step 5th called Regret Approach as shown in equation (1) with taking into consideration additional two significant factors as follows: 1) Total contract amount (A) and 2) Acceptable negotiated amount (N). Also, the developed model has a basic step (step 0) in order to determine the probability of winning (Pe) automatically using MCA and NPV methods then going ahead in the other steps sequentially (from 1st step, 2nd step, 3rd step and 4th step) as shown in figure (4). Each step has a specific result recommending user to do necessary action. These sub results are considered very important for the decision-maker to understand the risks involved to make a decision whether or not to raise a claim without current or future losses. According to decision theory, the following would describe the typical decision flow of going to arbitration.

-STEP 0: Expecting the Probability of winning MCA & NPV methods, then

-STEP 1: Decision to raise a claim
Pe(D) > C? If yes, then

-STEP 2: Decision to negotiate
Pe(D) – C > N? If yes, then

-STEP 3: Decision to accept an amicable settlement Is ((Pe(D) – C)/A) significant? If yes, then

-STEP 4: Decision to arbitrate.
Pe(D) > C + Pf(f) + Po(O)? If yes, then proceed to arbitration.

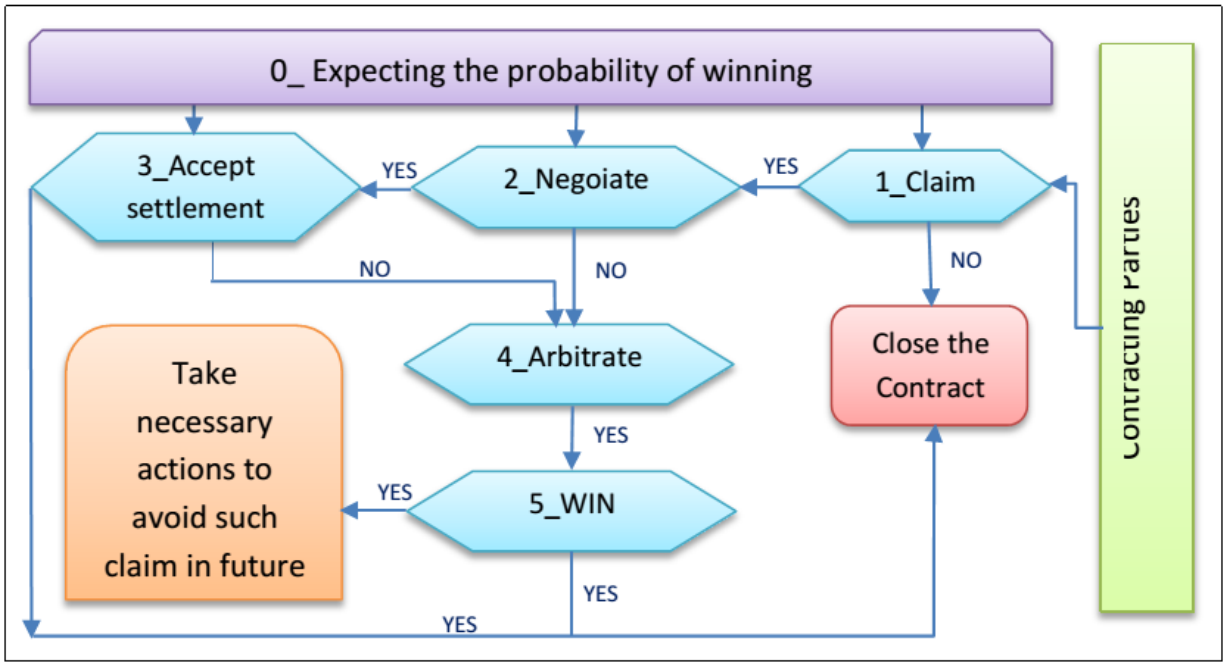


Figure 4: Claim"s flowchart

However, when looking at it from a regret theory approach, the maximum regret coincides with the maximum loss, which would be due to losing the arbitration case or losing the opportunity of winning the claim if the case went to arbitration. In such a case, the reputation of the contractor falls through in addition to loss of future opportunity with the same client. Therefore, an additional step needs to be included to understand the cost that would be least regretted. [1]

The best outcome is Pe(D) – C – Pf(f) – Po(O). and on the other hand, the worst outcome is the total cost of C + Pf(f) + Po(O).

-STEP 5 (Regret Approach): Decision of arbitration

Pe(D) – C – Pf(f) – Po(O) > (1 – Pe)[C + Pf(f) + Po(O)] ? If yes, then proceed to arbitration.

In the extra step above, it is important to predict the outcome whether or not regretting the decision of proceeding with arbitration and losing or not proceeding to arbitration and winning. The last step for a regret approach may be adaptable to any other model available, as the principle of regret is a major factor in realistic decision-making. [1]

## 3. Results and Discussion

The results which have been obtained by the developed mathematical model RMFA almost were expected and satisfied. As mentioned above that this model depends on some evaluation criteria related to the disputed issue that need to be estimated by contractor within scale (1-5). These evaluation criteria have been determined by questionnaire distributed to thirty dispute parties of questionnaires then analyzed by Statistical Package for Social Sciences (SPSS) and the results were as shown in the following table (3):

Table 3: Evaluation Criteria Analysis

| Criteria | Freq. | mean | Relative Index (%) | Evaluation | Weight |
|---|---|---|---|---|---|
| Contract | 98 | 4.7 | 93.33 | Strongly agree | 5.00 |
| BOQ | 71 | 3.4 | 67.62 | Agree | 3.62 |
| Time Schedule | 76 | 3.6 | 72.38 | Agree | 3.88 |
| Drawings | 65 | 3.1 | 61.90 | Neutral | 3.32 |
| Specifications | 81 | 3.9 | 77.14 | Agree | 4.13 |
| Correspondences | 91 | 4.3 | 86.67 | Strongly agree | 4.64 |
| Witness | 62 | 3.0 | 59.05 | Neutral | 3.16 |
| Truthful of company and market reputation | 60 | 2.9 | 57.14 | Neutral | 3.06 |
| Correlation between others | 60 | 2.9 | 57.14 | Neutral | 3.06 |
| Time | 71 | 3.4 | 67.62 | Agree | 3.62 |
| Attitude of claim | 78 | 3.7 | 74.29 | Agree | 3.98 |
| Independence and truthful of the arbitration Institution | 85 | 4.0 | 80.95 | Agree | 4.34 |
| Project Budget | 51 | 2.4 | 48.57 | Disagree | 2.60 |
| Disputed claim amount | 56 | 2.7 | 53.33 | Neutral | 2.86 |
| Previous technical problems with client | 53 | 2.5 | 50.48 | Disagree | 2.70 |
| Previous financial problems with client | 47 | 2.2 | 44.76 | Disagree | 2.40 |
| Reports | 91 | 4.3 | 86.67 | Strongly agree | 4.64 |
| Minutes of Meetings | 95 | 4.5 | 90.48 | Strongly agree | 4.85 |

As illustrated in the previous table, the weight value is considered by comparison. The highest weight value is (contract) and the lowest weight value is (Previous financial problems with client), So there are ten influent criteria highlighted by gray color and which have been identified
according to the weighting analysis. In descending order, these selected criteria have been presented in chart (1) with their weight values which are arranged between (3.62 – 5), minimum value for (Time) and maximum value for (Contract).

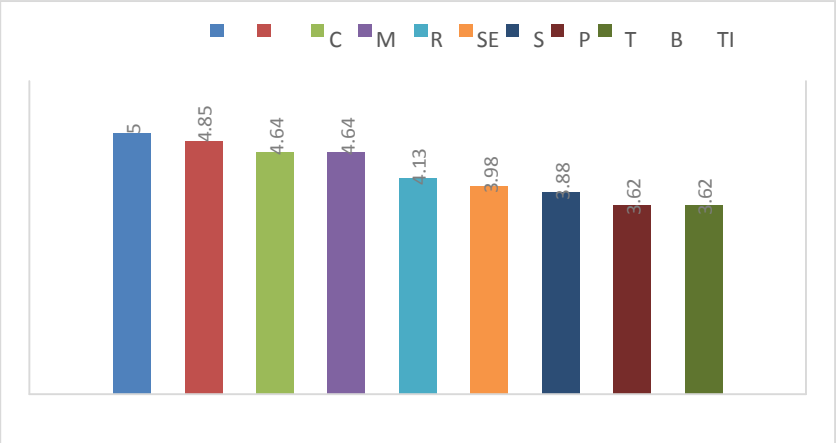


Chart 1: Weight of Evaluation Criteria

Simply, the evaluation criteria support the user to utilize regret approach in expecting the probability of winning then going ahead through other steps.
The final result will be recommended by the model (RMFA) as follows "Arbitration" or "No Arbitration", But what will happen if the contractor goes through the opposite way. For this, the accuracy of the model results was tested by setting four real previous disputes cases into the developed model as several cases studies in transportation, structural buildings, infrastructure fields (Source: Association of Engineers in Gaza Governorates), then by comparison between actual actions and the model recommendation for each case study. the results have almost matched as shown in detailed table (4) that evidences high accuracy in the model efficiency which is 75% at least. This percent is dependable relative to easy and quick action using the model (RMFA).

Table 4: Comparison between results of the mathematical model and real actions

| No. | Project | Location | Client/Owner | Disputed Amount | Real Action | Model Recommendation | Efficiency |
|---|---|---|---|---|---|---|---|
| 1 | Construction of Residential Tower | Gaza Strip, Palestine | Individual | 100,000 $USD | Arbitration | Arbitration | 100% |
| 2 | Upgrading and Installation of Solid Waste Equipment | | Municipality | 70,000 $USD | No Arbitration | No Arbitration | 100% |
| 3 | Construction of Mosque | | Local Institution | 34,080 $USD | Arbitration | Arbitration | 100% |
| 4 | Construction of Highway | | International Institution | 32,000 $USD | Arbitration | No Arbitration | 0% |
| **Overall Efficiency** | | | | | | | **75%** |

## 4. CONCLUSION

Modeling Regret Approach utilizing two logical and mathematical methods; Net Present Value (NPV) and Multi Criteria Analysis (MCA) produces accurate results for some probability values (Pe, Pf and Po) winning, current loses and future losses probabilities respectively which will be determined automatically by the model. This required survey thirty questionnaires for identifying the effluent evaluation criteria that need to be input into the model. The selected evaluation criteria were weighted in order to measure their relative importance and impacts for the three. The weight values range of the selected ten evaluation criteria was (3.62 – 5) the Contract criterion is the highest and the Time criterion is the lowest. Results of the model was tested in comparison with actual four disputes cases and the efficiency of the model achieved at least 75%, Whereas this percent is dependable with the multivariate nature of construction contracts. Thus, using Regret Model For Arbitration, RMFA, is considered abridged and quick action to make decision for going to arbitration or not to save time, cost and thinking.

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# Identification of Benefits and Challenges Facing New Engineering Programs Seeking ABET Accreditation in Developing Countries

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**Abstract** ABET accreditation of the engineering programs is becoming increasingly adopted in developing countries and newly established departments. The goal of this paper is to identify the benefits and discuss the challenges facing the new Engineering programs that are in the process of preparing the Self-Study Report (SSR) as the first stage in applying for the accreditation. The study uses the results and findings that the researchers reached when they have been in charge of preparing the Industrial Engineering bachelor program at the Islamic University - Gaza for the ABET accreditation. Findings indicate that challenges faced at the local level are relatively similar to those faced in most developing countries but to different degrees of magnitudes.

**Keywords**

Accreditation, Engineering Education, Quality, ABET

## 1.0 INTRODUCTION

Engineering education is one of the most trending issues around the world since the 1990s. Convictional engineering education is no longer a merit in the evolutionary world of changing nature. In the one hand, the market requires engineers with skills in areas of communication, team work, lifelong learning and technical writing in addition to other professional capabilities, but in the other hand, universities put the main focus on theoretical knowledge and engineering practice. One of the problems resulting from this phenomenon is that graduates need many years after graduation to build and build their soft skills as well as to enhance their knowledge in

engineering, in other words, graduates are not capable of building their own businesses nor to

fulfill the real need of the market. Many societies are engineering education, such as the Accreditation Board for Engineering and Technology (ABET), the American Society for Engineering Education (ASEE), International Federation of Engineering Education Societies (IFEES), European Network for Accreditation of Engineering Education (EAEE). All accreditation committees used to base their evaluation criteria on input until the 1990s; that was when ABET has led the change towards outcome based evaluation, (Augusti, G. Heitmann, G. & Freeston, I, 2007).

ABET is the recognized accreditor for college and university programs in applied science, computing, engineering, and technology. It accredits academic programs at institutions preparing graduates for entry into disciplines of applied science, computing, engineering, and engineering technology, (ABET website, 2017).

ABET accreditation provides assurance that a college or university program meets the quality standards of the profession for which that program prepares graduates, (ABET website, 2017).

Accreditation is a voluntary process that institutions choose to undertake. Programs that have produced at least one graduate are eligible for accreditation. First, an institution requests an

evaluation of its program(s). Each program then conducts an internal evaluation and completes a self-study questionnaire. The self-study documents that students, curriculum, faculty, administration, facilities and institutional support meet the established criteria. While this is being conducted, the appropriate ABET Commission forms an evaluation team to visit the campus. A team chair and one or more program evaluators make up the evaluation team. Team members are volunteers from academe, government and industry as well as from private practice. During the on-campus visit, the evaluation team reviews course materials, student projects, sample assignments and interviews students, faculty and administrators. They ensure that the criteria are met and answer any questions raised by the self-study. A written report of the evaluation is given to the institution. This allows the institution to correct any misrepresentations or errors of fact. Finally, the evaluation report is presented to the appropriate ABET Commission with a recommended accreditation action. Based on the findings of the report, the Commission votes on the action and the institution is notified of the decision. The information the school receives identifies strengths, weaknesses, deficiencies, and recommendations for improvements. Accreditation is granted for a maximum of six years. To renew accreditation, the institution must request another evaluation (ABET website, 2017).

The existence of well-designed and linked strategic system, performance measurement system and quality system accelerates quality processes, (Abou-Dagga, S. & El-Holy, A., 2013). Benchmarking is one the most powerful tools towards the setting of performance metrics in education on institutional, program and course levels, (Jain, R., Chandrasekaran A. and Gun A., 2010).

To date, over 3,800 programs at more than 770 colleges and universities in 31 countries have received ABET accreditation. Approximately 85,000 students graduate from ABET-accredited programs each year, and millions of graduates have received degrees from ABET-accredited programs since 1932 (ABET website, 2017).

Quality assurance efforts in Palestine had begun in 2002 with the establishment of the Palestinian Accreditation & Quality Assurance Commission (AQAC). IUG, being one of the biggest higher education institutions in Palestine, established its quality unit immediately and worked in linking its internal quality procedures with external national ones managed by AQAC, (Abou-Dagga, S. & El-Holy, A., 2013). In 2015, the industrial engineering department at the Islamic University of Gaza started preparing the program for the accreditation process, (Abushaban, A. Kaware, B. & AbuAbdAllah, N., 215). On November 2016, the program has submitted the readiness review which indicated that the program is eligible for the accreditation. On February 2017, the program has submitted the preliminary self-study report which was reviewed by ABET evaluators and the results showed that the program is accepted and can go on for the last phase of accreditation which includes submitting the complete self-study report in addition to the accreditation visit, when the program becomes officially accredited, (Preliminary Self-Study Report: BSc. Degree program Industrial Engineering, 2016).

This paper is organized as follows: Section I is an introduction, while section 2 introduces the methodology, ABET accreditation criteria are given in section 3, ABET accreditation benefits and challenges are given in sections 4 and 5 respectively. The paper concludes with recommendations for departments aspiring to apply for the accreditation process.

Methodology

The paper uses the descriptive methodology through literature review starting from general ABET accreditation and going through ABET accreditation process in developing counties. The ABET team held group discussion to identify the benefits and challenges faced during the preparation process. Further, those benefits and challenges were compared with those in developing counties. It was the authors intent to write about local universities experience, yet, unfortunately authors could not locate any literature related to the topic and thus decided on writing on their own experience where the need for such a topic is very relevant given the fact the many local universities are in the process to apply for ABET accreditation.

## 2.0 ACCREDITATION CRITERIA

ABET determines the following eight general criteria in addition to the program specific criteria:

students, program educational objectives, student outcomes, continuous improvement, curriculum, faculty, facilities, and institutional support.

### 2.1Students

In evaluating engineering programs, ABET focuses on the nature of admitted students in addition to the processes of evaluating student performance and advising and career guidance and finally on the graduation process. This requires that institutions establish clear, fixed and strict procedures for all processes that concern students.

### 2.2Program Educational Objectives:

The program must first identify its constituencies who will participate in setting the program educational objectives. Those objectives are then reviewed based on input from constituencies. According to ABET, the program must have published program educational objectives that are consistent with the mission of the institution, the needs of the program's various constituencies, and these criteria. There must be a documented, systematically utilized, and effective process, involving program constituencies, for the periodic review of these program educational objectives that ensures they remain consistent with the institutional mission, the program's constituents' needs, and these criteria. Establishing and managing an advisory board to involve all constituencies is essential but somehow challenging due to many factors described later.

### 2.3Student Outcomes:

The program must have documented student outcomes that prepare graduates to attain the program educational objectives. Program outcomes must be in line with those outcomes specified by ABET. ABET identifies student outcomes (a) to (k) for engineering graduates:

*a)* an ability to apply knowledge of mathematics, science, and engineering

*b)* an ability to design and conduct experiments, as well as to analyze and interpret data

*c)* an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

*d)* an ability to function on multidisciplinary teams

*e)* an ability to identify, formulate, and solve engineering problems

*f)* an understanding of professional and ethical responsibility

*g)* an ability to communicate effectively

*h)* the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

*i)* a recognition of the need for, and an ability to engage in life-long learning

*j)* a knowledge of contemporary issues

*k)* an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

As shown in Figure 2, Student Outcomes are formed at the interface between mission, courses, and program educational objectives. Programs must give evidence how course learning objectives are aligned and in turn serve in achieving ABET eleven student outcomes.

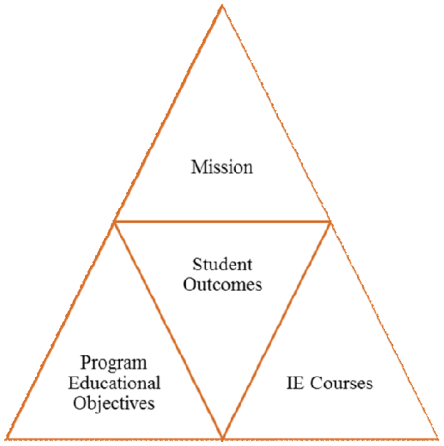


Figure 4: Relationship between the main ABET components

### 2.4Continuous improvement

This criterion is the most important but also most challenging one because it requires evidence of adapting a strategy of systematic results based decision making.

The program must regularly use appropriate, documented processes for assessing and evaluating the extent to which the student outcomes are being attained. The results of these evaluations must be systematically utilized as

input for the continuous improvement of the program. Other available information may also be used to assist in the continuous improvement of the program.

### 2.5Curriculum:

"Curriculum" includes a number of requirements on the minimal amounts of time allocated to different bodies of knowledge. Further, courses must be aligned and arranged in a manner that guarantees the achievement of program outcomes.

### 2.6Faculty:

This represents the backbone of the educational process for any program. It ensures that there is sufficient faculty members in terms of numbers, specializations, backgrounds, and professional development activities. In addition, there must be transparent and effective hiring and retention procedures.

### 2.7Facilities:

Facilities include all the halls, labs, computers, libraries and things required for the program to deliver its outcomes.

### 2.8Institutional Support:

In this criterion, the program must provide information on how financial matters are managed, how excellent faculty are retained and how their professional development is encouraged.

### 2.9Program specific criteria:

These criteria have been specified by ABET for each program to reflect special requirements needed for this program to guarantee attaining necessary outcomes in terms of faculty, curriculum, knowledge and skills.

## 3.0ABET ACCREDITATION BENEFITS

ABET Accreditation has many benefits for students, faculty, universities and the society

### 3.1Benefits to students

The quality of education students receive makes a big difference in their career success. For students, ABET accreditation:

- Verifies that their educational experience meets the global standard for technical education in your profession.
- Enhances student employment opportunities—multinational corporations require graduation from an accredited program.
- Supports student entry to a technical profession through licensure, registration, and certification—all of which often require graduation from an ABET-accredited program as a minimum qualification.
- Establishes their eligibility for many federal student loans, grants, and/or scholarships.
- Paves the way for students to work globally, because ABET accreditation is recognized worldwide through international agreements, and many other countries' national accrediting systems are based on the ABET model.

### 3.2Benefits to university and program

More than 2,000 professionals from academia, industry, and government carry out every aspect of ABET accreditation. They know their profession's dynamic and emerging workforce needs and review academic programs to ensure they provide the technical and professional skills graduates need to succeed.

ABET accreditation tells program's prospective students, peers, and the professions served by the program that this program:

- Has received international recognition of its quality
- Promotes "best practices" in education
- Directly involves faculty and staff in self-assessment and continuous quality improvement processes
- Is based on "learning outcomes," rather than "teaching inputs"
- Can more easily determine the acceptability of transfer credits

### 3.3Benefits to society

Because of the fact that ABET standards are applied and promoted around the globe, the opportunity of Middle-Eastern students to compete in global workforce is enhanced, (El-Sherbeeny, A. & Al-Tallaq, K., 2009). This has a great impact on the mitigation of unemployment rates. Further, ABET accreditation, through establishing shared objectives of the program and

the industry, lessens the gap between industry requirements and graduates' qualifications and improves program graduates opportunities in employment in local industries.

## 4.0CHALLENGES

Despite all its benefits, there has always been a resistance to ABET accreditation in the developing countries, (El-Sherbeeny, A. & Al-Tallaq, K., 2009). This resistance is mainly attributed to the following reasons:

### 4.1Additional effort on faculty members with no equivalent incentives: (Faulty concerns)

ABET accreditation requires changes in several teaching concerns; these include: removing redundancies that result from excess covering of some student outcomes to the detriment of other necessary outcomes. Further, some adjustments may be needed in evaluation and assessment processes in addition to increased analysis and documentation which requires time and effort from faculty. However, many software programs were developed recently to help in analyzing assessment data and documenting course folders such as course syllabi, student work examples, analysis results and corrective decisions.

### 4.2Relationship between industry and academia (Industry concerns).

The relationship between industry and academic institutions is integrated as industry requires graduates with certain skills while academic institutions need industry input and feedback to adjust their program educational objectives and to guide students to their future careers. However, the relationship between industry and academic institutions has never been smooth or even integrated especially in the developing countries. Bringing together requirements of both academic institutions and industry is essential to ABET especially to develop and upgrade shared program educational objectives; this may be managed through industrial advisory boards that involve industry and academic representatives, (Jackson, A., Johnson M. & Horton, D.).

### 4.3Underestimating the efforts of the evaluating team responsible for preparing ABET documents and lack of full understanding of the accreditation procedures in local universities (External evaluators team).

In order for programs to be ready for ABET accreditation, universities need to hire an external evaluating team to prepare the self-study report and relevant documents and to facilitate the change. Huge effort is needed from this team to prepare ABET documents and prepare the program for accreditation. This team must have solid experience in accreditation procedures. The problem arises when universities underestimate the efforts of such teams or when universities try to add all these tasks to existing staff.

### 4.4Lack of financial support:

The cost of preparing programs for ABET accreditation is dependent on the status of the program to be evaluated. Preparation costs include hiring an external evaluating team for preparing the self-study report and relevant documents necessary for the accreditation, training faculty on ABET outcomes and how to design program courses to match them, hiring an ABET officer to analyze assessment data and maintain all records and documents. In some cases, there is a need to make improvements on facilities, curriculum depending on ABET committee recommendations. Sometimes, it is necessary to install software programs for the sustainability of assessment improvement. Further, ABET accreditation fees which are paid as accreditation fees and travel expenses are costly.

## 5.0RECOMMENDATIONS:

The following will shed some lights on the obstacles and the corresponding recommendations for departments seeking ABET accreditation especially those in environments similar to that in Gaza. The recommendations are divided into two levels: operational and managerial.

As for the operational level, Figure 3 mainly shows the road map of the operational level. As can been seen from the figure, an expert in ABET accreditation is recommended to hold a presentation/orientation sessions for the department. These orientation sessions should

include one for upper management, one for academic staff, one administrative staff, one for students, one for graduates, and one for stakeholders. The department is then asked to formulate its vision, mission, and program educational objectives based on consulting with ABET experts and stakeholders.

Academic staff are further asked to design their respective course outlines in the ABET required format and thus making it easier for data collection. It is recommended that an academic/administrative staff member be assigned to supervise and facilitate the data collection phase through contacting all respective departments and stakeholders. Once all needed data are collected and analyzed the Self-Study Report (SSR) is prepared including discussions about all the criteria along with recommendations on program improvement strategies and techniques.

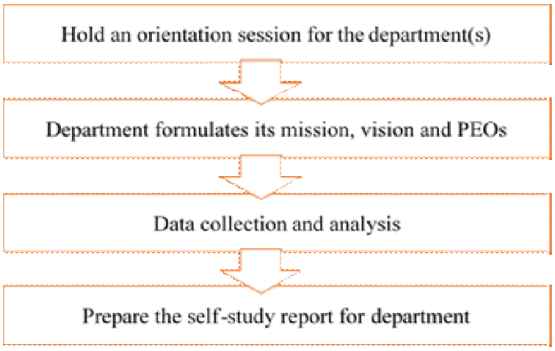


Figure 5: Road map for preparing the department for ABET accreditation

On the other hand as for the managerial level, the following recommendations are given in order to efficiently and effectively identify sources of strength and overcoming the weakness during the SSR preparation.

Commitment on the part of top management in the university to the ABET accreditation in addition to facilitating data gathering performed by the ABET team through communicating the importance of the accreditation to all university administrative and academic levels,

- Establishing a national center to train academic and administrative staff for the purpose of applying and guaranteeing the continuity of academic quality assurance program;
- Departments should have a greater share of autonomy and independence with respect to organizational, financial, and academic fields;
- Offering incentives for the ABET committee members in exchange of their time and efforts preparing the department for the accreditation. These incentives may take the form of monetary, reduction of teaching and research work load.

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# Understanding Continuous Intention Usage of Mobile Services in the Palestinian Higher Education Institutions

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**Abstract:** Nowadays, mobile services are considered the most preferred option among students in higher education institutions (HEIs). Long term relationship and continuance behavior may be different from initial acceptance and temporary use. This study aims to understand the factors affecting the continuous usage of mobile services among Palestinian students in HEIs. The study extends the expectation of continuous model into more effective and cognitive factors to predict the continuous usage of mobile services in HEIs. The proposed research model has developed based on Expectation Confirmation Model (ECM-IT) in Information Technology (IT) context. ECM-IT research model was extended to comprise three independent factors that are perceived ease of use, familiarity, and facilitating conditions. 349 students from five different Palestinian universities have successfully responded to answer the questionnaire. Results show that the proposed research model has some modification. Two independent factors (i.e. Ease of Use and Familiarity) have been merged. There are no significant differences between all student groups even based on gender, age, study level, Education Background, and universities on all research factors. The new proposed research model needs to verify and examine its hypotheses. The initial theoretical contribution of this study is that it provides a new perspective model to understand students' post adoption behavior with the introduction of the ECM-IT. However, these theoretical and practical implications could encourage Palestinian HEIs management and mobile developer to pay more attention on such factors to keep continuous intention usage of mobile services.

**Keywords:** Mobile Services in Higher Institutions, Mobile Usage Continuous, Cognitive Factors, Expectation- Confirmation Theory, Mobile Learning.

## I. INTRODUCTION

Mobile services, and their internet based services, have widely emerged to daily life since 1999. Such services have been widely used in many areas such as education, health, entertainment, marketing, and banking. The occasional and sustained usage of such services in higher education institutions (HEIs) could encourage students to keep in touch with their education environment. As we entered 2017, most HEIs are offering some type of mobile solutions even in Arab countries [1], [2] or Palestinian HEIs [3], [4]. Understanding the students' relationship with the digital technology is important because student preference is crucial to his/her motivation and attention to their academic work [5].

Although their preferences can be driven by technology trends, under the right circumstances students are quite capable of reflective choices about the technology that helps them in education. Long-term usage makes Information System (IS) continuance very crucial since its success depends on its continuous use rather than first- time use [6], [7].

Furthermore, long-term relationship and continuance behavior may be different from initial acceptance and temporary use. The relationship between a priori user expectations, a posteriori evaluations (experiences), and key outcomes associated with information systems implementations have been a topic of interest for nearly three decades [8]. Research on expectation and confirmation has also been conducted in other fields, and impressive progress has been made in understanding of the phenomenon in general and within the Information System (IS) context in particular.

Adopting the Expectation Confirmation Theory [9], empirically proved that the decision of IS continuance was influenced by the user's

satisfaction with the IS, which was a direct result of the confirmation or disconfirmation of the user's expectation. However, students who will potentially discontinue using mobile services can be identified based on their confirmation/ satisfaction and usage level of the mobile services during the initial adoption. Several technology acceptance theories such as Technology Acceptance Model (TAM) and Expectation Confirmation Model (ECM) have been successfully utilized. However, these models do not fully explain the factors that influence students to continue using specific mobile services [7], [10]. This study attempts to fill this gap by adopting a new theoretical perspective to investigate an emerging mobile service in HEIs. This study also expects the findings to provide new insights to inform managerial practices in mobile services industry.

## II. CONTINUANCE INTENTION

The concept of IS continuance has been examined a variety of aspects such as incorporation, routinization and confirmation [7], [11]. Drawing attention to the substantial differences between initial adoption and continued usage behavior in information Technology (IT) context, ECM was developed and empirically tested for IT continuance usage [9]. Nevertheless, ECM-IT had its roots in expectancy-confirmation paradigm. The model predicts users' intentions to continue using IT with three antecedent constructs: user satisfaction with the IT; extent of user confirmation; and post-adoption expectations, represented by perceived usefulness. In ECM-IT model, perceived performance was not included as the assumptions have been made such that the effects of perceived performance are already captured by the confirmation construct.

Based on the logic of ECM-IT, confirmation is the congruence of the expectation and the actual performance [6], [9]. If the actual performance cannot meet the expectation, users will feel disconfirmed. If the actual performance is better than expectation, users will feel satisfied and regarded it as a bonus. IS continuance research has moved to the focus from cognition-oriented factors to emotional factors other than task-oriented systems [7], [12].

## III. THEORETICAL RESEARCH MODEL AND HYPOTHESES

The research model utilizes ECM-IT as theoretical base model (see Figure 1). The research model is shown in Figure 2, configured based on nine hypotheses. Next sections discuss the theoretical base for each hypothesis


Figure 1: Theoretical base of proposed research model

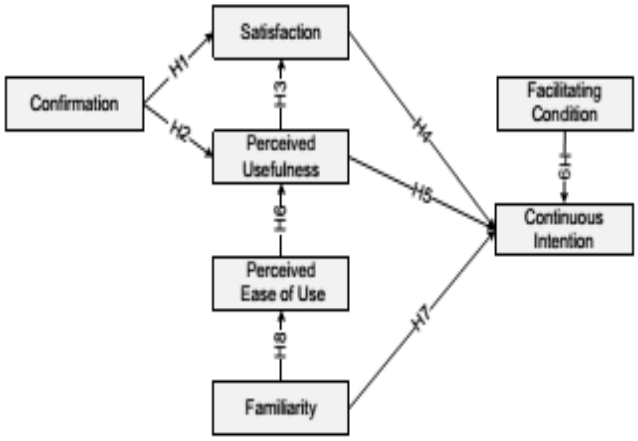


Figure 2: The proposed research model

### A. Confirmation, Satisfaction, Perceived Usefulness, and Continuance Intention

ECM-IT model shows that while post-acceptance usefulness perception continues to influence users' continuance intention, user satisfaction with prior use has a relatively stronger effect on the dependent variable. User satisfaction, in turn, is determined primarily by user's confirmation of expectation from prior use and secondarily by perceived usefulness. Further, confirmation also has a significant influence on post- acceptance perceived usefulness. ECM-IT factors in the proposed model have been previously investigated in numerous ECM-IT studies [9], [13], and have now become well established in the literature of ECM-IT [13– 15]

According to ECT, satisfaction depends on the extent to which users perceive their initial expectations of a service to be confirmed or disconfirmed during actual use [16]. Moreover, prior marketing studies have found that the higher of the users' expectation leads to the higher is their satisfaction [17], [18]. This implies that confirmation of initial expectations of a web-

based service leads to subsequent satisfaction, while the reverse leads to dissatisfaction and discontinuance intentions.

Satisfaction is generally defined as a positive effective state resulting from a global evaluation of performance based on past services' use and consumption experience [7]. The ECT suggested that satisfaction with a product or service is the primary motivation for its continuance [16]. Following the ECM, users' satisfaction with IT has a positive effect on their IS continuance intention.

Moreover, satisfaction is one of the most important concepts in IS services. Ease of use is an important determinant of system usage through perceived usefulness in TAM [19], [20]. Davis suggests that perceived ease of use may actually be a causal antecedent to perceived usefulness. Since many studies have investigated and reported findings that support TAM, details are omitted in this paper.

However, there is an expectation that these relationships to hold in the context of mobile services usage for four reasons: First, a student's satisfaction has positive influence on student intention to continue using mobile services in HEIs. Second, a student's extent of confirmation and perceived usefulness are two key determinants of satisfaction. Third, perceived usefulness is the most important factor in determining students' adoption intentions. Finally, the extent of confirmation resulting from the usage experiences is hypothesized to positively affect perceived usefulness [21], [22]. Hence:

Hypothesis 1 (H1): Students' extent of confirmation is positively associated with their satisfaction with mobile services use.

Hypothesis 2 (H2): Students' extent of confirmation is positively associated with their perceived usefulness of mobile services use.

Hypothesis 3 (H3): Students' perceived usefulness of mobile services use is positively associated with their satisfaction with mobile services use.

Hypothesis 4 (H4): Students' level of satisfaction with initial mobile services use is positively associated with their mobile services continuance intention to use.

Hypothesis 5 (H5): Students' mobile services continuance intention to use is positively associated with their perceived usefulness of mobile services use.

Hypothesis 6 (H6): Students' perceived ease of use of mobile services is positively associated with their perceived usefulness with mobile services use.

### *B.* Familiarity

Familiarity is defined as "one's understanding of an entity, often based on previous interactions, experience, and learning of what, who, how, and when of what is happening" [7]. It is affected by quantity of priorinteractions and occurs through the repeated interaction [23]. Especially, familiarity can be divided into affective and subjective familiarity. This study focuses on affective familiarity which is a student's feeling of familiarity.

Previous IS research has concluded that cognitive familiarity has a direct influence on usage. A study [24] examined that degrees of familiarity with a specific e- commerce vendor and its procedures will increase people's willingness to purchase products on that vendor's website. Psychologists have long observed that repeated exposure to a stimuli results in an increase in positive effect [7].

Furthermore, higher level of affective familiarity leads to higher level of preference. Since such emotions influence for formation and maintaining human relationships, affective familiarity would seem to be a factor in long-term relationships. Based on these arguments, this study anticipates that affective familiarity with mobile services in HEIs has positive influences on their mobile services continuance intention. Meanwhile, familiarity with a mobile service is acquired through students' prior experiences with the services. In general, students find IT easier to use if they have more experience [24].

Furthermore, students having an understanding of how to use the mobile services as well as knowledge of the basic mobile technology usage [25], they will need to expend less cognitive effort to utilize it. Hence, this study expects that familiarity with mobile services will have positive influences on perceived ease of use of the mobile services. Hence:

Hypothesis 7 (H7): Students' level of familiarity with initial mobile services use is positively associated with their mobile services continuance intention to use.

Hypothesis 8 (H8): Students' level of familiarity with initial mobile services use is positively associated with their perceived ease of use with mobile services.

### C. Facilitating Condition

Facilitating conditions are defined as the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system. This definition captures concepts embodied by three different constructs: perceived behavioral control, facilitating conditions, and compatibility [26]. Each of these constructs is operationalized to include aspects of the technological and/or organizational environment that are designed to remove barriers to use. A study [27] explained the theoretical overlap by modeling facilitating conditions as a core component of acceptance models.

The compatibilityconstruct fromInnovation Diffusion Theory (IDT) incorporates items that tap the fit between the individual's work style and the use of the system in the organization. Furthermore, facilitating conditions do have a direct influence on usage beyond that explained by behavioral intentions alone [26]. Hence: Hypothesis 9 (H9): facilitating conditions are positively associated with students' mobile services continuance intention to use.

## IV. METHODOLOGY

A survey method was employed since it is most successfully adapted to obtain personal and social facts, beliefs, and attitude [28]. Items of each factor are adapted from previous researches with some minor modifications. Questionnaire has two main parts. First part consists of demographic data that comprises gender, age, studying level, study background, university, and type of mobile device. Part two consists of the expectation of continuous usage of mobile services as shown in Table 1 below

Table 1: Items of each factor

| Factor | Items | Ref. |
|---|---|---|
| Confirmation | CONF1: My experience with using the university mobile services was better than what I expected.<br>CONF2: The service level provided by the university mobile services was better than what I expected.<br>CONF3. Overall, most of my expectations from using the university mobile services were confirmed.<br>CONF4: My online tasks experience via the university mobile services did not meet my expectations. (R) | Bhattacherjee [29] |
| Satisfaction | SAT1: I am satisfied with my decision the university mobile services use.<br>SAT2: My choice to use the university mobile services was a wise one.<br>SAT3: Overall, this is a good mobile service to do university tasks with. SAT4: My choice to do my tasks via the university mobile services was a wise one.<br>SAT5: In general, I am satisfied with the services provided by the university mobile services. | Bhattacherjee [29] Tsai and Huang, [30] |
| Perceived Usefulness | PU1: Using the university mobile services improves my performance in accomplishing tasks what I need.<br>PU2: Using the university mobile services enhances my effectiveness in accomplishing tasks what I need.<br>PU3: Overall, the university mobile services are useful in accomplishing tasks what I need.<br>PU4: Using the university mobile services enables me to access a lot of useful information about university tasks what I need.<br>PU5: Using the university mobile services gives me more convenience. | Davis [19] Bhattacherjee [29] Lin, Wu, and Tsai [31] |
| Perceived Ease of Use | PEOU1: It is easy to become skillful at using the university mobile services.<br>PEOU2: Learning to use the university mobile services application is easy.<br>PEOU3: My interaction with the university mobile services is clear and understandable.<br>PEOU4: It is easy to get the university mobile services to do what I want.<br>PEOU5: The university mobile services are easy to use. | Davis [19] Gefen et al., [32] |

| | | |
|---|---|---|
| Familiarity | FAM1: I feel familiar with accessing and navigating the university mobile services.<br>FAM2: I feel familiar with accomplishing tasks at the university mobile services.<br>FAM3: I feel familiar with the interface presented on the university mobile services. FAM4: I feel familiar with the terminology presented on the university mobile services.<br>FAM5: I feel familiar with the university mobile services. | Lee and Kwon [7] Gefen, D., Karahanna, E. and Straub [32] |
| Facilitating Condition | FC1: I have the resources necessary to use the university mobile services.<br>FC2: I have the knowledge necessary to use the university mobile services.<br>FC3: The university mobile services are not compatible with other university online services I use.<br>FC4: A specific person (or group) is available for assistance with difficulties of the university mobile services. | Alzaza, 2013 [33] Venkatesh, Morris, Davis, and Davis [26] |
| Continuance intention | CONT1: I intend to continue using university mobile services rather than discontinue its use.<br>CONT2: My intentions are to continue using university mobile services than use any alternative online university services.<br>CONT3: If I could, I would like to discontinue my use of university mobile services. (R)<br>CONT4: I consider myself a loyal user of university mobile services.<br>CONT5: I consider university mobile services as my first choice for online university tasks. | Lee and Kwon [7] Bhattacherjee [29] Tsai and Huang, [30] |

4.5% are between 26-30 years and only 1.4 is aged more than 30 years old.

It is not surprising that majority (97.1%) of participants were in Bachelor level. This is reflecting the current practice of learning facilities in HEIs. However, master degree was 2.9% that is come from focusing of this study on graduate and posts graduate institutions not the diploma level.

Despite Science background (such as Engendering, Information Technology, Medical) and Art Studies background (such as Languages, Law, History, Education, Religious) made up the largest groups of respondents 48.4% and 40.4%, respectively; Business (such as accountancy, Finance, Management) were only 11.2%. Furthermore, 35.5% of respondents were in last year of study while 25.2% were in third year. First level represent 20.9% and second level 18.3%. Respondents' distribution on the five Palestinian HEIs is shown in table 2 below.

Table 2: Participants Universities

| University Name | No. | % |
|---|---|---|
| Al-Aqsa | 57 | 16.33 |
| UP | 87 | 24.93 |
| IUG | 65 | 18.62 |
| QOU | 68 | 19.48 |
| Al-Azhar | 72 | 20.63 |
| Total | 349 | 100.00 |

### *A.* Study Population and Sample

A purposive sampling method was used in selecting the participants (subjects). Students of Palestinian HEIs formed the study participants. Sample size matched the criteria of universities population [34]. According to rule of Roscoe [35], the sample size could be 10 times the number of variables. The present study consisted of eight variables. Therefore, following the rule, the minimum sample size required is 80.

420 questionnaires were distributed to students at five of palestinian higher education institutions in Gaza. The universities were Islamic University of Gaza (IUG), Al- Quds Open University (QOU), Al-Azhar University– Gaza, University of Palestine (UP), Al-Aqsa University. The analysis of the survey results is presented based on a valid response of 349 respondents from the five

mentioned universities with 83% of response rate. The sample size appears to be adequate and response rate obtained from students as respondents in higher education environment [36].

### *B.* Profile of the Respondents

While (45%) of the respondents are males, majority (55%) of the respondents are Females. Most of the respondents are young, where 65.9% are aged between 20 and 25 years, 27.2 are aged less than 20 years. However,

77.1% of the participants declared that they own a smart phone and 22.3% own normal (conventional) mobile, while only 0.6% declared they do not have a mobile phone at all.

To conclude, the above discussions indicate that the sample of this study does not deviate significantly from the general population and the sample is therefore deemed representative of the population of interest.

## V. FINDINGS

### *A.* Mobile Services Usage

Participants were also asked about their usage of the available university mobile services. They asked to reflect their actual usage based on 5 Likert scale that start from (1) low to (5) high usage. Respondents expressed that Exams Results is the highest rank with (72.49%) weight followed by Calendar/Timetable (70.66%). However, Library Services and other Campus Services have the lowest ranks with weights 56.91% and 54.96%, respectively. The result indicates that students more active with mobile services that closely to their classes and study subjects. Table 3 shows the mobile services usage among the students

Table 3: Usage of university mobile services

| Mobile Service | Sum | Mean | % Weight | Rank |
|---|---|---|---|---|
| Exams Results | 1265 | 3.625 | 72.49 | 1 |
| Calendar/Timetable | 1233 | 3.533 | 70.66 | 2 |
| **Mobile Service** | **Sum** | **Mean** | **% Weight** | **Rank** |
| Alert System | 1156 | 3.312 | 66.25 | 3 |
| Admission Status | 1136 | 3.255 | 65.10 | 4 |
| Course Registration | 1101 | 3.155 | 63.09 | 5 |
| Finance (e.g., financial statement and balance) | 1059 | 3.034 | 60.69 | 6 |
| Library services | 993 | 2.845 | 56.91 | 7 |
| Campus Facilities | 959 | 2.748 | 54.96 | 8 |

### *A.* Validity and Reliability Testing

Most of the items used to measure the variables have been adopted from the literature. Even though the adopted measurements have been confirmed of its discriminate and convergent validity, it is felt necessary to re-examine the validity of these measures. This is because this study is undertaken in Arabic and Palestinian context which may be different from other countries. The existing literatures on continues intention usage of mobile services have been done in other countries, particularly in the west-countries where the environment and culture are entirely different from Palestine.

In order to ascertain whether the measurements used in this study have construct validity, that is, measure what they are supposed to measure, exploratory factor analysis was conducted on all items. Factor analysis was based on Principal Component Method (PCA) with Varimax rotation for all components. The results for each factor analysis conducted are summarized in Table 4. From the output, measures of the proposed model's factors, 4 factors with eigenvalues more than 1. These 4 factors captured 60.99% of the total variance of the factors. However, participants consider that both factors Ease of Use and Familiarity represent the same orientation. This could lead to merge both factors with a new factor named Familiarity and Ease of Use [28] [29].

Table 4: Factor Loading of the expectation of continuous usage

| Item | Factor Loadings of the Components | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| The university's mobile services are easy to use. | .757 | | | |
| I feel familiar with the university's mobile services. | .723 | | | |
| My interaction with the university's mobile services is clear and understandable. | .712 | | | |
| I feel familiar with the terminology presented on the university's mobile services. | .698 | | | |
| I feel familiar with accomplishing tasks at the university's mobile services. | .696 | | | |
| I feel familiar with the interface presented on the university's mobile services. | .695 | | | |
| It is easy to get the university's mobile services to do what I want. | .663 | | | |

| Item | Factor Loadings of the Components | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| I feel familiar with accessing and navigating the university's mobile services. | .627 | | | |
| Learning to use the university's mobile services application is easy. | .590 | | | |
| It is easy to become skillful at using the university's mobile services. | .402 | | | |
| Using the university's mobile services improves my performance in accomplishing tasks that I need. | | .786 | | |
| Using the university's mobile services enables me to access a lot of useful information about university tasks that I need. | | .786 | | |
| Overall, the university's mobile services are useful in accomplishing tasks that I need. | | .756 | | |
| Using the university's mobile services enhances my effectiveness in accomplishing tasks that I need. | | .741 | | |
| Using the university's mobile services gives me more convenience. | | .710 | | |
| My choice to do my tasks via the university's mobile services was a wise one. | | | .740 | |
| My choice to use the university's mobile services is a wise one. | | | .704 | |
| I am satisfied with my decision in using mobile services at the university . | | | .693 | |
| In general, I am satisfied with the services provided by the university's mobile services. | | | .657 | |
| Overall, this is a good mobile service to do university tasks with. | | | 651. | |
| The university's mobile services are not compatible with other university online services I use. | | | | .738 |
| A specific person (or group) is available for assistance with difficulties of the university's mobile services. | | | | .622 |
| I have the necessary knowledge to use the university's mobile services. | | | | .552 |
| I have the necessary resources to use the university's mobile services. | | | | .491 |
| % of variance | | | 60.99 | |
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy | | | .936 | |
| Bartlett's Test of Sphericity: Approx. Chi-Square | | | 4623.208 | |
| Df | | | 276 | |
| Sig | | | .000 | |

Measuring the constructs of Table 5 below summarizes the reliability test of all measures after factor analysis has been done. The Cronpach Alphas of the measures were all comfortably above the lower limit of acceptability that is α >= .6 [38]. Hence, all the measures were highly reliable

Table 5: Reliability Coefficients for all the variables

| Variable | # of Items | Reliability |
|---|---|---|
| Confirmation (CONF) | 4 | .604 |
| Satisfaction (SAT) | 5 | .848 |
| Perceived Usefulness (PU) | 5 | .897 |
| Perceived Ease of Use and Familiarity (PEOUandFAM) | 10 | .910 |
| Facilitating Condition (FC) | 4 | .608 |

*A.* Descriptive statistics

Descriptive statistics for the final list of variables of the study are shown in Table 6. Scale measurements used is a five-point Likert scale. The ranges of 5 point Likert- scales were categorized into equal sized categories of low, moderate, and high. Therefore, scores of less than 2.33 [4/3 + lowest value (1)] is considered as low; scores of 3.67 [highest value (5) - 4/3] is considered high; and those in between considered moderate.

Mean values for all variables fall in the range of 2.97 and 3.61. Indeed, respondents are generally moderate in all variables towards the expectation of continuous usage of mobile services. However, with standard deviation of all variables are fall in the range .81 and .96, it indicates that statistically, the variation of Confirmation, Satisfaction, Perceived Usefulness, Perceived Ease of Use & Familiarity, and Facilitating Condition among respondents are high.

Table 6: Descriptive Statistics for All Variables

| Variable | *M* | *SD* |
|---|---|---|
| Confirmation | 2.9785 | .81401 |
| Satisfaction | 3.5026 | .96091 |
| Perceived Usefulness | 3.6149 | .95400 |
| Perceived Ease of Use and Familiarity | 3.4358 | .86967 |
| Facilitating Condition | 3.1862 | .83523 |

In light of the factor analysis results, some amendments have to be made to the statement of hypotheses stated earlier then update the proposed research model (see Figure 3). The hypotheses tested in this study are as follow:

H1: Students' extent of confirmation is positively associated with their satisfaction with mobile services use.

H2: Students' extent of confirmation is positively associated with their perceived usefulness of mobile services use.

H3: Students' perceived usefulness of mobile services use is positively associated with their satisfaction with mobile services use.

H4: Students' level of satisfaction with initial mobile services use is positively associated with their mobile services continuance intention to use.

H5: Students' mobile services continuance intention to use is positively associated with their perceived usefulness of mobile services use.

H6: Students' perceived ease of use and familiarity of mobile services is positively associated with their perceived usefulness with mobile services use.

H7: facilitating conditions are positively associated with students' mobile services continuance intention to use.

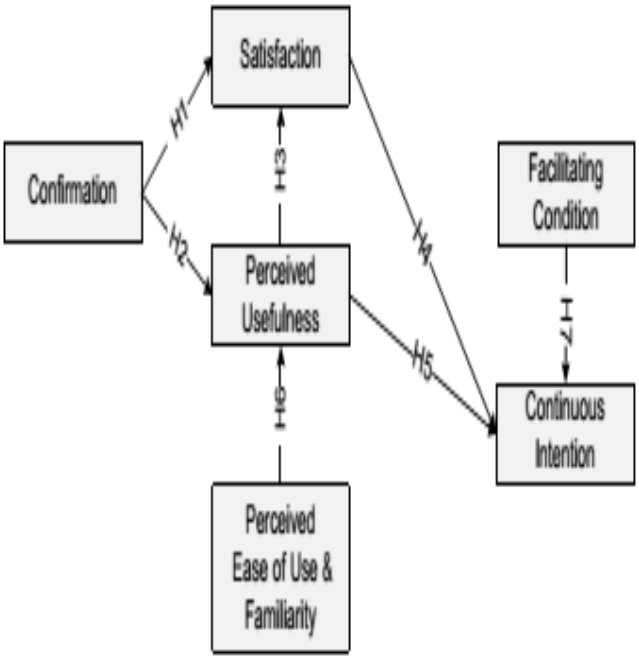


Figure 3: The New proposed research model

One of the important steps in data analysis is to understand the dimension of the variables in the proposed model or the relationships in empirical research [38]. In other words, factor analysis is conducted to identify the structure of interrelationship (correlation) among a large number of items. This is done by defining common underlying dimensions, known as factors [38]. The cut- off point chosen for significant factors loading will be (.30), which is suggested by Hair et al. [38].

T-test was conducted to explore the impact of gender, age, study level, Education Background, and universities groups on levels of all measurements and to find if there a significant differences between groups of students on Confirmation, Satisfaction, Perceived Usefulness, Perceived Ease of Use & Familiarity, and Facilitating Condition. However, results indicate that respondents with different gender, age, study level, Education Background, and universities are found to perform similar level of all adoption variables.

## VI. CONCLUSION

Nowadays, mobile services are interesting and are considered to be very recent addition as a new vital platform for the Palestinian higher education environment. Understanding the expectation-

experience gap and its implications for technology use will be of great value to both research and practice. Nevertheless, Student's perspective is very important to investigate the use behavior of mobile services' in the HEIs. The proposed research model was developed based on ECM- IT. ECM-IT research model was extended to comprise perceived ease of use, familiarity, and facilitating conditions. These new factors could explain why students continuously continue use specific mobile services. Results show that the proposed research model has some modification. Two independent factors (i.e. Ease of Use and Familiarity) have been merged. There are no significant differences between all student groups even based on gender, age, study level, education background, and universities on all research factors. The new proposed research model needs to verify and examine its hypotheses. However, these theoretical and practical implications could encourage Palestinian HEIs management and mobile developer to pay more attention on such factors to keep continuous intention usage of mobile services. Indeed, the initial theoretical contribution of this study is that it provides a new perspective model to understand students' post adoption behavior with the introduction of the Expectation Confirmation Model (ECM-IT) in the Information Technology (IT) context

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# A Study of Different Queuing Techniques in Videoconferencing Service Using OPNET Modeler

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**Abstract** Videoconferencing service has become very popular over the last few years and is now supported by many applications. It can be used by people of different professions and in different work environments like, students and academic staff in universities, doctors in hospitals or by engineers collaborating in projects. Video conferencing requires a precise level of quality to be utilized. Quality of Service (QoS) is determined by factors such as, delay and delay variation (jitter), so both factors are critical for video conferencing service. In this paper, the performance of different queuing techniques was studied. The FIFO, priority Queuing PQ, and the weighted Fair Queuing WFQ scheduling schemes were taken into account. The implementation of the schemes will be carried out using OPNET. Video conference service will be deployed using common data communication networks internet implementing the Resource Reservation Protocol (RSVP). The results of the simulation show that the end-to-end delay and the packet delay variation for the priority queuing scheduling scheme gives the shortest time.

**Keywords**
Example:
OPNET, video conference, delay, packet variation delay, RSVP

## 1.0 INTRODUCTION

Videoconferencing service, has been used for years by many businesses. It has been often considered as a high cost service. Nowadays where internet has reached very high data transfer rates, this service could be deployed using common data communication networks internet implementing the Resource Reservation Protocol (RSVP). Transmitting video needs some compression schemes like, H.261used over RTP protocol which in turn over UDP then over IP. This paper puts emphases on the IP packets and how they are manipulated in the routers.

Using the Internet connection, we should be aware about the quality of the video conference service. Video conference service requires a precise level of quality to be utilized.

Quality of Service (QoS) is determined by impairment parameters like the delay the packet delay variation, and the data loss rate (Park, 2005; Chen, Farley & Ye 2004). All the three mentioned parameters are critical for video conferencing service.

This paper, studies the performance of the most popular scheduling schemes, like, First-In First-Out (FIFO), priority Queuing (PQ), and Weighted Fair Queuing (WFQ) (Li, Hamdi, Iang, Cao & Hou, 2000). OPNET has gained considerable popularity in academia as it is being offered free of charge to
academic institutions. That has given OPNET an edge over DES NS2 in both market place and academia (Salah & Alkhoraidly, 2006; Jannu & Deekonda, 2010). The implementation of the schemes was carried out using OPNET Modeler (OPNET, 2005).

Videoconferencing scenario over wide area network (WAN) was studied. It is suggested that

two enterprises in different countries will use Internet to deploy a video conference session. The two enterprises could be two universities, hospitals, companies or any other entity. The two enterprises use video conferencing server in a third country.

Using OPNET Modeler, we built this WAN model and supplied it with the required settings and configurations. Running the Simulator, we got the results for the quality parameters that we determined.

The rest of the paper is organized as follows. Section 4 presents a typical WAN network topology that uses Best Effort service to be used as a case study for deploying video conferencing service. Section 5 presents the OPNET-based simulation approach for deploying videoconferencing service. The section details and summarizes the OPNET model and results. Section 6 describes the results and analysis of the simulation study. The conclusion is included at the end of section 6.

## 2.0 RELATED WORK

(Salah, Calyam & Buhari, 2008) conducted a research Assessing Readiness of IP Networks to Support Desktop Videoconferencing Using OPNET. Authors demonstrate how OPNET can be leveraged to assess the readiness of existing IP networks to support desktop videoconference. They try to determine the number of videoconference sessions to be supported.

(Rashed & Kabir, 2010) studied different queuing techniques, they found that user traffic stream like voice, video, data can be easily transferred with its efficient level performance by using Weighted Fair Queue algorithm in routers.

(Aamir, Zaidi & Mansoor, 2012) studied the Performance Analysis of DiffServ based Quality of Service in a Multimedia Wired Network and VPN effect using OPNET. They found that queuing delay and jitter have same values in both PQ and WFQ for high priority services (Voice and Video).

(Ali, Ajami & Alotaibi, 2016) found that the effect of constant packet delay on the quality of video streaming is much smaller than that of variable delay.

## 3.0 VIDEO CONFERENCING QUALITY OF SERVICE (QOS)

One of the methods used to achieve the video conferencing quality of service could be the implementation of the RSVP protocol. QoS parameters of video conferencing service include: packet delay variation, end-to-end delay and packet loss.

### 2.1 Resource Reservation Protocol

The Integrated Services(IntServ) architecture model (RFC 1633, June 1994) was motivated by the needs of real-time applications such as remote video, multimedia conferencing. IntServ provide some control over the end-to-end packet delays to meet the VoIP requirements. In RSVP, the source transmits a Path message along the routed path to the destination to collect information about the QoS viability of the routers along that path[1].

### 2.1 Packet Delay Variation

Please Packet delay variation is based on the difference in the One-Way-Delay of selected packets. This difference in delay is called "IP Packet Delay Variation (ipdv)". Packet delay variation (PDV) is the difference in end-to-end one-way delay between selected packets in a flow with any lost packets being ignored. The one-way-ipdv values are limited by virtue of the fact that there are upper and lower bounds on the one-way-delay values. Specifically, one-way-delay is upper bounded by the value chosen as the maximum beyond which a packet is counted as lost[2].

### 2.1 End-To-End Delay

End-To-End delay is the time interval in which a packets travels from one node to another node. VoIP is very sensitive to delay; thus, it must be controlled and managed. As mentioned previously, it is inefficient to wait for all packets arriving in an organized order; therefore, some packets may be dropped if they don't arrive in time and this can cause short periods of silence in the audio stream and causing bad VoIP quality. Ideally, the delay constraint for VoIP packets is not above 80ms (Salah et al., 2008).

## 4.0 NETWORK TOPOLOGY

The network model of the videoconference WAN is shown in Figure 1. Subnet 0 and subnet 3 could

[1] https://www.cisco.com/c/en/us/products/ios-nx-os-software/resource-reservation-protocol-rsvp/index.html [Accessed: 11/10/2017]
[2] https://tools.ietf.org/html/**rfc3393** [Accessed: 10/10/2017]

be two hospitals or universities that use the videoconference servers in subnet 2.

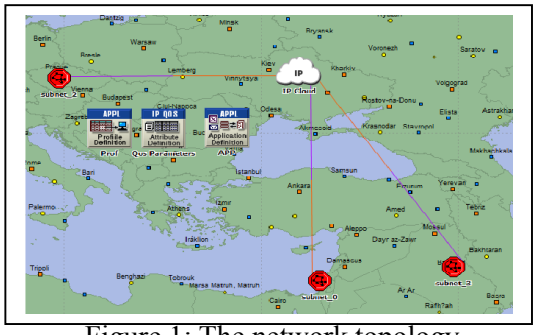

Figure 1: The network topology

The subnet model for subnet 0 and subnet 2 is shown in Figure 2. It consists of a LAN connected to a switch and then to a router.

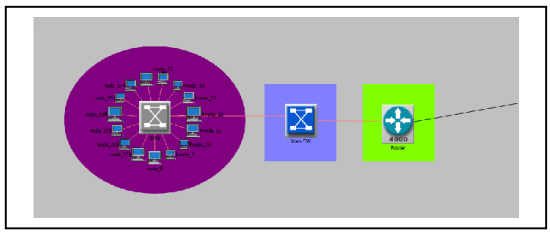

Figure 2: The subnet at each institution

## 5.0 SIMULATION

Video conference service will be deployed using common data communication networks internet implementing the Resource Reservation Protocol (RSVP) which is a transport layer protocol designed to reserve resources across a network for an integrated services Internet (RFC 2205)[3].

Cisco IOS Software supports two fundamental Quality of Service architectures: Differentiated Services (DiffServ) and Integrated Services (IntServ). In the DiffServ model a packet's "class" can be marked directly in the packet, which contrasts with the IntServ model where a signaling protocol is required to tell the routers which flows of packets requires special QoS treatment. DiffServ achieves better QoS scalability, while IntServ provides a tighter QoS mechanism for real-time traffic. These approaches can be complimentary and are not mutually exclusive[4].

We used the attributes shown in Figure 3 for the videoconference service. It uses the Expedited Forwarding (EF) type of service. The simulation lasted for 500 seconds.

[3] https://tools.ietf.org/html/rfc2205 [Accessed: 12/10/2017]

[4] http://www.cisco.com/c/en/us/products/ios-nx-os-software/resource-reservation-protocol-rsvp/index.html [Accessed: 12/10/2017]

We measured parameters such as, packet delay variation, traffic sent, traffic received and end-to-end delay. A curve was derived by the OPNET simulator for each scheme for all parameters. The results are nearly similar for all schemes in the traffic sent, the traffic received and in the lost packets. So, we gave more attention to the packet delay variation and the end-to-end delay.

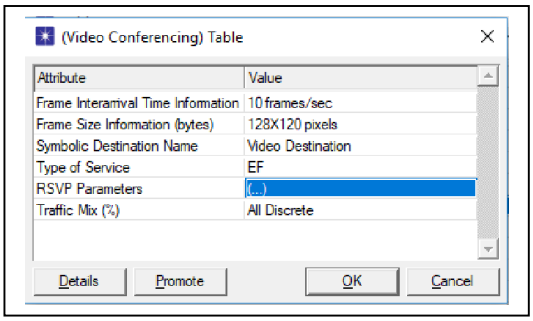


Figure 3: Video conference attributes

## 6.0 RESULTS AND ANALYSIS

The results of the following parameters: traffic sent, traffic received, and lost packets are similar for all schemes. So, we gave more attention to the packet delay variation and to the end-to-end delay parameters.

The maximum acceptable values will be considered. The maximum acceptable value for packet delay variation is 20 ms. The Maximum acceptable amount of delay that a voice call can tolerate one way is 150 Milliseconds[5] (Qinxia, 2007; Karam & Tobagi, 2001).

Figure 4 shows that the steady value of the packet delay variation is 91ms for the default scheme, 84 ms for the FIFO scheme, 65ms for the WFQ scheme and 0.015 ms for PQ scheme.

The reference list should be arranged alphabetically by the author's last name, followed by the date and should be typed in single space with justify alignment. In the case of multiple listings by a single author, the earliest publication appears first. When an author is listed both as a single author and as a senior author with coauthor(s), all of the single-author listings precede the multiple-author listings, with the latter arranged alphabetically by last name of successive authors. Again, chronological order is used for multiple papers by the same set of authors. The lowercase letter used

[5] https://tools.ietf.org/html/rfc5481 [Accessed: 11/10/2017]

in the citation to distinguish multiple papers by the same author(s) in the same year should be displayed in the reference list.

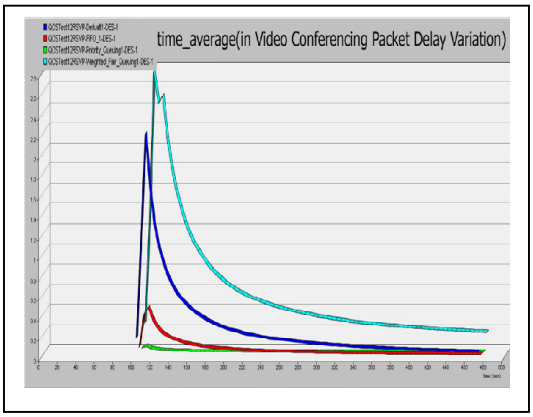


Figure 4: Packet delay variation

The steady value of the end-to-end delay is 25 ms for the default scheme, 26 ms for the FIFO scheme, 26 ms for the WFQ scheme and 17 ms for PQ scheme as shown in figure 5.

From figures 4 and 5, it is determined that the videoconference packet delay variation of the PQ scheme has the shortest time among all studied scheduling schemes. The end-to-end delay of the PQ scheme also has the shortest time. Table 1summarizes the results of figure 4 and figure 5.

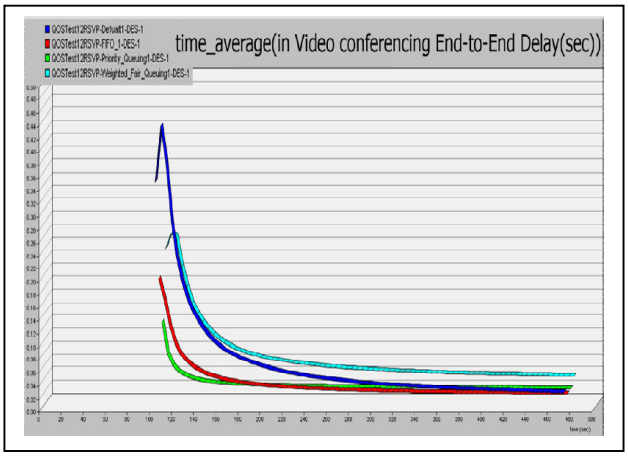


Figure 5: End-to-end delay

From the results in table 1 we can conclude that- Only the PQ scheduling scheme has acceptable packet delay variation.

End-to-end delay values are acceptable for all schemes, but the lowest value belongs to PQ scheduling scheme.

Table 1: Results achieved for the different schemes

| Parameter/scheme | Default scheme | FIFO scheme | PQ scheme | WFQ scheme |
|---|---|---|---|---|
| Packet delay variation | 91 ms | 84 ms | 0.015 ms | 65 ms |
| End-to-end delay | 25 ms | 26 ms | 17 ms | 26 ms |

Priority Queuing PQ scheme has the best results and will be recommended for the video conferencing service.

Priority Queuing PQ is the best scheme for video conferencing service and that can be explained by the priority that is given to the video packets at the expense of other low priority packets usually like the File Transfer Protocol (FTP) packets or Email packets.

**2.1 Conclusion:**

In this paper, the performance of different queuing techniques was studied. The FIFO, the priority Queuing PQ, and the weighted Fair Queuing WFQ scheduling schemes were considered. The implementation of the schemes was carried out using OPNET. Video conference service was deployed using common data communication networks internet implementing the Resource Reservation Protocol (RSVP). The results of the simulation show that the end-to-end delay and the packet delay variation for the priority queuing (PQ) scheduling scheme gives the shortest time. As a future work, more types of traffic like Email, FTP and HTTP will be added to make the simulation more realistic.

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# Dynamic Web Service Composition Method Based on OWL-S for Educational Environment

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**Abstract**—Dynamic web service composition (DWSC) is a challenging issue that many companies and enterprises try to apply it on their services. It expands the ability of web services so that many goals can be achieved by combining little number of services. DWSC have many complex issues that make its implementation so difficult. Many algorithms have been appeared and try to solve these difficulties, but a little of them succeed to solve all difficulties of DWSC. In this paper we propose a new approach that can construct a composition between web services at run time, our approach aim to facilitate the web services work in the educational environment.
The proposed method adds semantic description to the available WSs that found in the local server, and then it clusters them and expands the consumer query words using WORDNET to facilitate the WSs discovery process. Further the suitable composition is chosen depending on the execution time of the whole composition.
We discuss many scenarios that could be occurred in the educational environment and explain how the proposed method will work, further we suggest a way to evaluate our method in the future. Hence the method may provide the scalability, compatibility and reduces the efforts that could be spent in establishing new WSs to achieve the consumer's goals.

**Keywords**—method, web service, clustering, education, dynamic

## 1.0 INTRODUCTION

Web service (WS) is any self-described software that is available over the web, which uses xml structure for description, communication and messaging to produce specific goal for the consumer. This feature for the WS make it more scalable because there are not any Restrictions in dealing with it, neither by operating systems nor programming languages. But sometimes a single service given alone cannot achieve the consumer goal, so a need for combining between many WSs appeared, this combining technique called web service composition WSC.

WSC can reduce the time and effort that could be spent in creating new services for every required goal, so instead of that we can combine between many WSs to provide new service that able to achieve new goal for the consumer.

There are two types for WSC, static and dynamic, the major differentiation between them is the time of composition construction. In the static composition the service provider must construct the composition process manually before they publish the services, but this way has a lot of limitations, the new composition still provide a specific single service that cannot adapt with the continues demand in consumers' needs, and it doesn't take into account the continues changing in the web services. So we cannot depend on this type of composition to achieve consumer needs. DWSC appeared as a solution for all problems that found in the static composition, it can combine between the web services in the run time and Take into account the demand changing in the WS without any human participation in the composition construction.

We take the educational environment such as universities, colleges and institutes as case study for our method. Usually educational enterprises have many WSs that aim to achieve many goals for its consumers, which can be classified to three groups (e.g. Students, academics and employees),

so the WSs can be clustered based on those three groups. So the DWSC is the ideal technique to reduce the time and effort in creating new services to achieve consumers goals, it can satisfy the consumers by combining between the available WSs.

In the next chapter a background about DWSC, OWL-S and educational environment will be discussed, then we will compare between many DWSC algorithms in chapter 3, the proposed method will be discussed in chapter 4, then we discuss many possible scenarios that can be occurred in chapter 5 and suggest a way to evaluate the method in chapter 6, then we conclude our work in the last chapter.

## 2.0BACKGROUND

### 2.1Dynamic web service composition

DWSC can expand the ability of the WSs by combining

Between many of them in the run time based on the required consumer's goal, it can adapt with the continues changing in requirements, goals and WSs. But there are many complexity issues in DWSC implementation, it is difficult for a normal consumer to use a web services without any particular knowledge about it, other issue about DWSC is the difficulty of choosing the suitable services that are combatable with the consumer's preferences and how to analyze his requirements to support the composition plan with the consideration of functional and non-functional attributes of the participating services.

### 2.2Web Ontology Language (OWL-S)

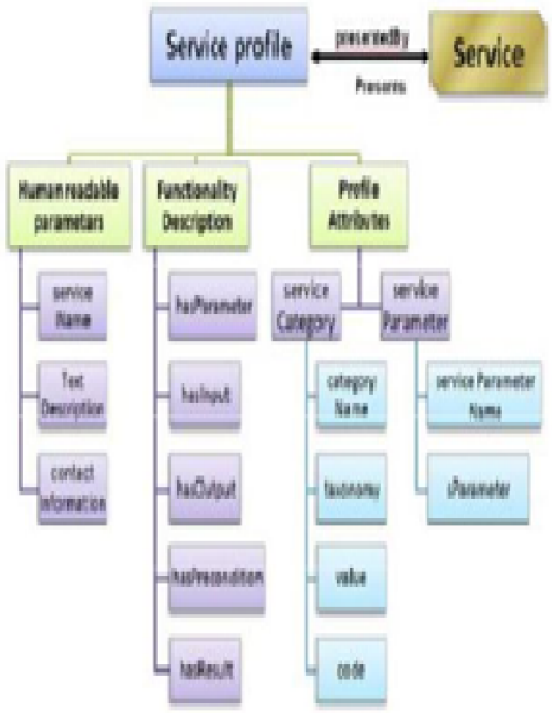
Owl is an ontology that used to describe the WS properties and capabilities, the target of owl is enable the automatic WS discovery and invocation based on the consumer query , most algorithms that rely on WSDL to find the suitable WSs for the composition depend on the keyword matching to discover them, this way have a big limitation that it can only find the services that have the same query keywords, but when we add semantic to the WSs using OWL, WSs can be discovered by matching the query keywords with its definition or meanings . OWL has three main components:

-Service profile that describe WS functionality and provide the necessary details for the WS discovery

-Service model that describe how to compose the WS and the conditions that must found to execute it.

-Service grounding that help to map WS that described by owl with WSDL.

In our paper we will use the OWL to facilities the discovery process so we care about service profile more than other components. Fig. 1shows the OWL's service profile's information [6].




### 2.3Educational environment

Educational enterprises like schools, universities, and institutes are one of the most important environments that need the WSs to execute the tasks and achieve their consumers goals, WSs can provide the scalability and availability for the educational environment's public due to its ability to handle with different platforms and operating systems. There are many types of consumers that can interact with the educational WSs, we can classify this users based on their goals to three groups, students, employees and academics. Every type of users

has his own WSs that can achieve his goals, so combining between available services can expand its abilities to achieve maximum number of goals with the least number of WSs.

We can benefit from applying our DWSC algorithm in the educational environments through several points:

The main problem that researchers suffer in QOS calculation is how they will determine the trusted providers that describe the correct QOS for his WSs, but in our work we will not search about trusted providers, because we will apply our work on an educational enterprise's WSs that have been implemented by a known provider.

We know the WSs provider so this facilitates the mapping process between WSDL and OWL as we will explain in the methodology section.

All WSs will be in the same repository so we don't have to determine the UDDI for the WS, this facilitate the discovery process.

## 3.0 RELATED WORKS

There are many algorithms that try to facilitate DWSC implementation, in this chapter we will discuss many of these algorithms and try to solve their limitations in our suggested algorithm.

EFlow is one of the most popular algorithms that depends on graph to determine the WSs flow during the run time [7], every WS is defined by its input and output, which are not enough to determine the suitable WS to participate in the composition, another limitation is that the developer must determine the processes flow at design time and every process will call the suitable service at run time, so it is semi-dynamic algorithms and it can't provide the scalability that DWSC can provide.

Another algorithm that support DWSC has been developed [8], it save the WS description into two documents, WSDL that we have mentioned before and WSCI that describes the behavior of the WS in the context of a collaborative work-flow, it perform the composition by determine the WSs that can communicate with each other to perform the process that have the input that the consumer enter and the output that consumer need, they haven't explained how their algorithm will choose the suitable composition if the algorithm return more than one composition, their algorithm has not supported QOS, it's just rely on keywords matching to discover the WSs that are suitable for the composition, the algorithm rely on WSDL to determine the input and output of each service in the workflow without determining the max number of the services that they can be combined to have a suitable composition .

A new algorithm that address the web service composition as a dependency graph is suggested in[9], the developers apply their algorithm that based on A* algorithm to find the shortest path for the composition with the minimal services, they solve a complex problem that no one as they mentioned have solved before, this problem is the redundant WSs that are invoked into the composition to achieve specific goal, it makes the graph very huge with unused services, which make the composition process more complex and increase the time for it, this problem has been noticed as a limitation in many researches[10, 11], so they describe an algorithm to eliminate the redundancy in the graph to remove all unused service, this step will reduce the time for choosing the ideal composition, their work have not taken in the consideration the QOS of the WSs, their algorithm is based on

A* that return the shortest path that link the input to the output, but sometimes the shortest path would not be the ideal solution for the composition, their algorithm depend on keyword matching to determine the WS's input/output with the request parameters.

There are many algorithms that rely on QOS to build the composition like what developed in [12], they have suggested to cluster the WSs based on its QOS to facilitate the discovery and composition process, they define the composition process as a workflow, every node in the workflow represent a specific job, then at the run time the algorithm get the suitable WS that can achieve the node job and have the best QOS, this algorithm rely on the shortest path to reach the composition output, they used manual preplanned composition workflow with nodes to invoke the

WSs automatically in the run time, so we think that this algorithm could be classified as semi dynamic web services composition .

Another algorithm that rely on QOS is mentioned in [13], they tried to solve the composition problem using WSs clustering to get the best QOS composition, they defined the WS based on its functionality and QOS, then they clustered the WSs based on the task that they can achieve. Their algorithm tries to mix between the clusters to produce the best composition that have the best QOS and can achieve the consumer goal. Further, the algorithm requires manual participate by the human to determine the WSs clusters and determine the tasks that can be performed by the cluster and the WSs order.

Another DWSC algorithm what Have been suggested in [15], its able to find the best composition based on the best response time that it take to provide the require output, it save the WSs as dependency graph that link every WS's output by the input of another WS until it link the consumer input parameter by the output that he need, it use the technique that mentioned in [9] to remove the redundancy services and reduce the time of implementation, but it still rely on keywords matching to get the WS's input/output and they have not taken other QOS parameters in the account .

Hashemian and Mavaddat have developed Another algorithm that based on Graph to construct Web Services Composition [16], they assume that a local repository that save information about existing web services is exists, this information is the service's input, output and dependency between the input and the output, they save the dependency as A graph that display the relation between the services input and output, the algorithm steps is as follow : first they convert the input to condition statement x to y, then they run BFS (Breadth First Search) algorithm on the left side of the statement to get the reachable nodes from the left side, the returned node become the left side for the next step y to z so they perform the BFS again and repeat it until they have the full composition, this algorithm solve the limitation that we talked about in the previous algorithm but it has many weakness points, it depends on WSDL for WSs description, so the participated web services will be chosen depend on keyword matching between consumer query and WS description, and if the algorithm get more than one Composition, they choose the composition randomly, so the chosen composition may not be the ideal one.

Another algorithms called QOS-WSC[17], it receives the consumer request and translate it, then it select the suitable services based on keyword matching with the translated request, it passes the request to the evaluation block that evaluate those services and pass it to the composition phase that compose it, if it doesn't found the suitable services in the local repository it will search about the service in the web then store it in the local repository with age factor to keep this service updated, this is a good algorithm but it still depend on keywords matching and this is a limitation in searching about suitable WS, and it search about the web services in the web depends on the QOS that the developer describe in his WS's WSDL, but the developer may add wrong QOS as we mentioned before, so this is another problem they didn't discuss .

FUSION is DWSC algorithm [18]; it contains 6 Subsystems as the follow: User Specification Subsystem that takes the user input and converts it to structural statement that will be the input for the next phase that called Web Services Dynamic Plan Generator. that generate a suitable plan for the composition according to the output of the previous phase, this plan will be passed to the Plan Execution Subsystem and invoke the methods instances and web service according to the generated map from the previous phase and pass it to Verification Subsystem that evaluate the result with the consumer specification to be sure that the selected services will satisfy the consumer, if the result wasn't as the consumer need then it will be passed to the next phase that called Recovery Subsystem that will roll back all process and try to search for new services to satisfy the consumer and the last phase is the User Response Generation Subsystem (URGS).

**4.0EDUDC approach**

In this section we propose a new dynamic web service composition's algorithm which capable to achieve educational enterprises consumer's goals by combining between WSs that saved in the local repository of the enterprise and can produce the output that required, this algorithm is based on semantic web, Figure 2 show the algorithm model that we will be discussed in this section.

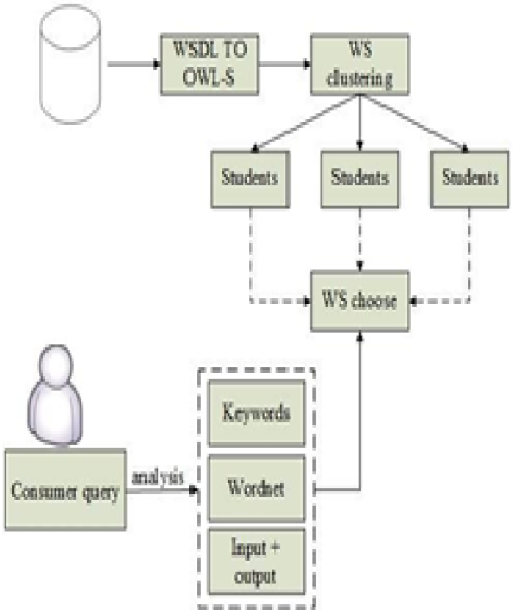



Fig. 2: EDUDC algorithm model

We can split our algorithm to five phases as the follows:

1.Mapping between WSDL and OWL-S
2.Reduce the WSs
3.Analyze the consumer requirements
4.Web services composition
5.QOS evaluation

### 4.1 MAPPING BETWEEN WSDL AND OWL-S

In the normal situation WSs is rely on WSDL to describe its functionality, it contain an important information such as input, output, data type, port type and other information, the WS that rely on WSDL to describe its functionality is difficult to discover because WSDL structure provide only the essential details for the WS, so we have suggested to add semantic description to the WSs in the local repository to support automatic discover and facilitate the search process.

We will use the same algorithm that [6]used to map between WSDL and OLW-S , that support the sematic description, they parse the WSDL document to extract the WS details, then their algorithm ask the WS provider that represent the educational enterprise in our paper to add the semantic details that WSDL cannot provide ,then we will cluster the semantic WSs into prepared three clusters based on consumer type, this clusters are students, academic employees, and administrative employees, clustering WSs will make the discovery more easy and faster, and adding semantic description to the WSs will facilitate the discovery process because WSs won't be rely on keyword matching that we mentioned as a weakness point in the other algorithms.

Figure 3 show the mapping process between WSDL and OWL-S according to [6], now we add the semantic description to all WSs in the repository.

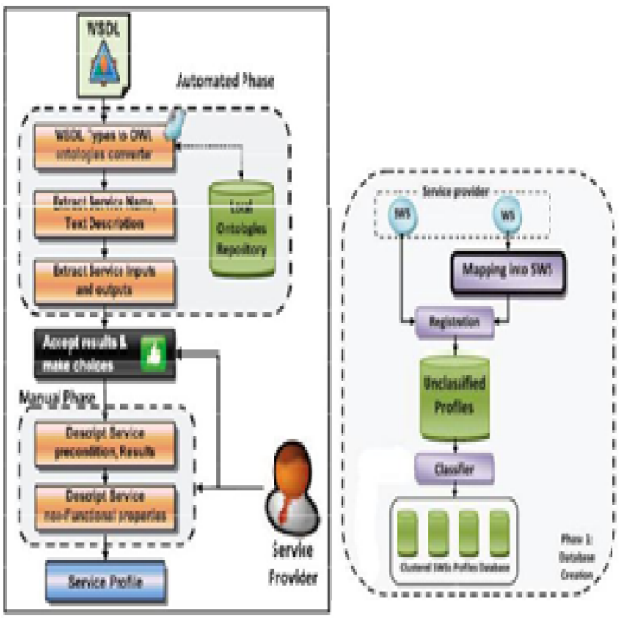



Figure3: the mapping process between WSDL and OWL-S and cluster WSs [6]

### 4.2 REDUCE THE WSS

There are three types of consumers in the educational environment as we mentioned before, students, academic employees, and administrative employees. Each type of this three consumers have his own goals, so to facilitate the discovery process about the suitable WSs that can be involved in the composition we will filter the WSs based on the consumer type, so if the

consumer log in as a student, only the WSs that are exist in the student cluster will be available for the discovery process, for example "marks enter" WS will not be available if the consumer login as student , the filter process will reduce the number of WSs to make the search about services more easy .

### 4.3ANALYZE THE CONSUMER REQUIREMENTS

we will split this phase to many sub phases, the first one is to split the consumer's query to tokens, so the complete sentence that consumer entered will be splitted to many words, so the result will be nouns, verbs, numbers and other language Structures, then we will remove any modification in the words, such as (is, was, were, are) will convert to ( be ), the next phase is to reduce the number of words by removing the common words such as (a, am, be, will ... etc.), and remove all words that used to write the ontology in OWL such as (WSDL,XSD ... etc.), A group of words will be produced, we will calculate the weight for each word by divide the number of times that this word found in the query to the number of all query words, and sort the words Descending order, for example if we enter a query like:" I am a Muslim, what is the month that Muslims cannot eat in it", the result will be Muslim (2/16), month (1/16), eat (1/16).

Now we will get the related words based on WorldNet, WorldNet is a database that provide short definition for a lot of English words, we can benefit from WorldNet to get the semantic meaning for the consumer query.

Now the results for consumer query analysis is a group of words and its definition so we can get all WSs from the enterprise's repository by matching the results with the WS description that the provider add in the mapping phase.

### WEB SERVICES COMPOSITION

Now we have all WSs that can be involved in the composition and know the output for the composition and the input for it, the algorithm will search on the available WSs that have the same composition input, and WSs that have the same desire output for the composition, if it found any WS that have the desired output as its output and the composition input as its input, then there are no need for composition and the goal can be achieved by single WS, if the algorithm return more than one single WS that can achieve the goal, then the algorithm will select the best QOS WS, we will discuss how to calculate the QOS for the WSs later .

Else the algorithm will search for the WSs that have the desire output for the composition and put all of them in the last layer of the composition, then it search for another WSs that have the output as the same input for the previous WSs that we put.

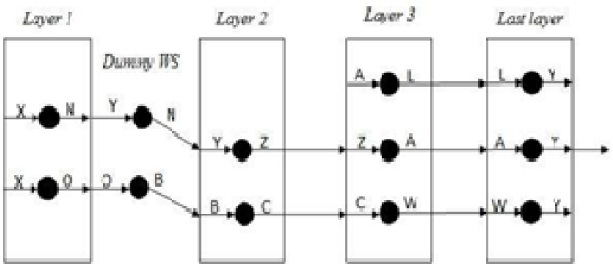



Figure4: composition establishment that have X as an input and Y as an output

### 4.5QOS EVALUATION

It is possible to produce more than one composition that can achieve consumer's goals, in this case we suggest choosing the fitness composition based in its QOS.

QOS is the non-functionality attributes of the WS like the cost, execution time, security, availability and other attributes, the main problem that researchers suffer in QOS calculation is how will they determine the trusted providers that describe the correct QOS for his WSs, most of providers provide an incorrect QOS values to motivate the consumer to use their service, but in our work we will not search about trusted providers , because we will apply our work on specific enterprise WSs that have been implemented by known provider, we can get each WS QOS from the SLA document that the provider can publish many details about the WS in it, and it can be as a contact between the consumer and the provider .

The local consumers in the educational environment will not be interested with price attribute because all of the WSs that exist in the repository are usually free, and the availability

will be the same for all WSs because they are found in the same repository, we assume that the most factor that important for the consumers is the execution time of the composition.

There are many techniques to combine WSs to achieve specific goal, WSs can be combined in parallel or in sequence Figure 5 show the difference between them.

Figure5: sequence composition and parallel composition

In the parallel we can calculate the total execution time for the combined WSs by get the min value from the services, while the sequence composition could be calculated by summation of all combined services in this composition.

So after the calculation the best composition will be the one with the less time to execute.

### 4.6SCENARIOS

First of all we have to add the semantic description to all WSs in the educational enterprise's repository based on the steps that we mentioned in Section 6.1. Figure 6 shows an example for WSs that could be available in the educational environment repository; we will not discuss the semantic description for every WS in details here

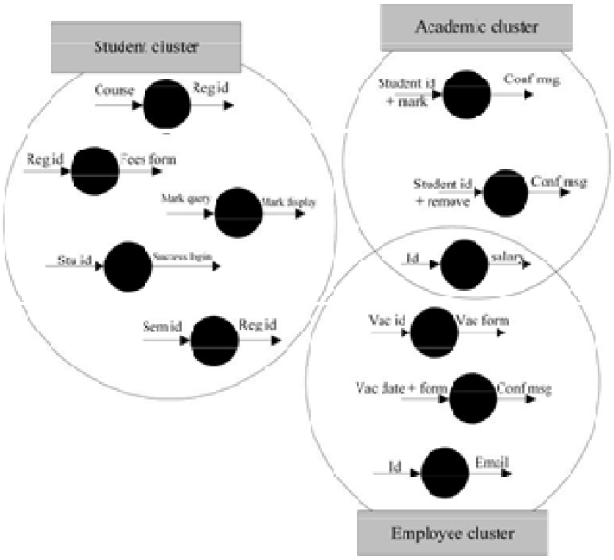



Figure 6: clustered web services

Suppose that a student want to register new course called "algorithms", the input query of the process is "I want to register algorithms course" and the output is a successes registration message with course fees details, there are many WSs in the student cluster as shown in Figure 6, but there are no WS can achieve the process goal alone, so we must combine between two services to achieve student goal, the composition algorithm will be applied as the following steps:

1- Student query will be analyzed based on the steps that mentioned in section 6.3, so the result will be: "register, algorithms, course ", then the algorithm will get the definitions for this words from WorldNet to expand the search process and facilitate the discovery process.

2- The algorithm will search in the student cluster about any WS that have register, algorithms, course or their

Definitions that have been returned from WorldNet in its semantic description and get all matching results.

3- The algorithm will combine between services based on the technique that explained in section 6.4, Figure 7 show the possible composition that can achieve the student goal, if more than one composition can be as a solution for the student problem then the algorithm will choose the composition with the minimum execution time

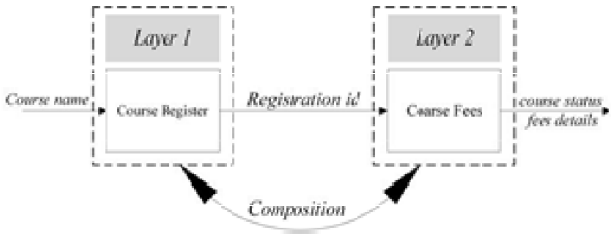



Figure 7: Course registration composition

Another scenario for our algorithm when an administrative employee want to ask for vacation, he enter "I want to ask for normal vacation in 25-12-2016". The input of the process is the vacation id and date and the output is a success confirmation message, to achieve this goal we have to combine between two WSs as shown in Figure 7 .the composition algorithm will be applied as the following steps: 1- The employee query will be analyzed based on the steps

That mentioned in section 6.3, so the result will be: "vacation, request, 25-12-2016 ", then the algorithm will get the definitions for this words from WorldNet to expand the search process and facilitate the discovery process.

2- The algorithm will search in the employee cluster about any WS that contains vacation request or date in its semantic description and get all matching results.

3- The algorithm will combine between services based on the technique that explained in section 6.4, Figure 8 show the possible composition that can achieve the student goal, if more than one composition can be as a solution for the student problem then the algorithm will choose the composition with the minimum execution time

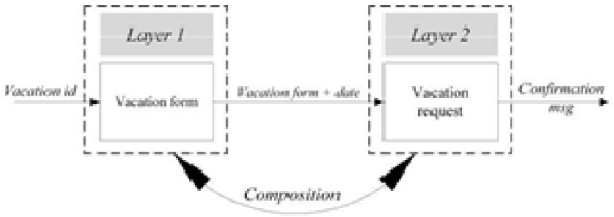



Figure 8: vacation request composition

Another scenario for our algorithm when an academic employee want to enter mark for specific student, he enter "put 95 mark for 20150197". The input of the process is the mark and the student id and the output is a success confirmation message, to achieve this goal there are no need for composition because we have a WS in the repository that can achieve this goal alone as shown in Figure 9.


Figure 9: enter mark web service

## 5.0FUTURE WORK

In our work we calculate the total QOS for the whole composition according to the execution time off all participated WSs in the composition, we think that this is enough to choose the suitable composition, but we have not enough time to evaluate this assumption, and let the evaluation for the future.

We will evaluate our approach by implementing a group of WSs that could be available in the educational environment and try to ask for specific task that no one of the existing services can achieved a lone, we will compare between normal system and our system based on many factors such as:

The ability of achieve the consumer goal, the execution time.

How many solution of the problem that can be got from every system.

## 6.0 CONCLUSION

In this paper we suggested a new algorithm that can handle with the complexity issues of the dynamic composition , our algorithm take the educational environment as a case study to apply our algorithm on it, it rely on OWL-S to add semantic description to the web services and cluster them based on the consumer type that can use this service, we add some additional features to our algorithm such as its ability to analyze the consumer query and QOS calculation, then we mention one scenario for every consumer type and explain how we can evaluate this algorithm

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# Prediction of Student's Performance Using Modified KNN Classifiers

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**Abstract** The Educational field research using Data Mining techniques increased rapidly. The aim of Data Mining on Educational data is to discover the hidden patterns and knowledge about student's performance. This study focus on predicting the student's performance according to their marks through classification using modified KNN classifiers such as Cosine KNN, Cubic KNN, and Weighted KNN. The Dataset of the students of the 11th Grade of scientific branch at Gaza Strip secondary schools contains 13 parameters, 11 parameters of the subject's marks, average parameter and Grade parameter. The classifiers should predict the performance (Grade) the student will gain depending on the marks of two subjects. The early prediction of the student's grade can help the principals to take decisions in order to help schools to initially identify students with low academic achievement and find ways to support them.

**Keywords**
NN techniques, KNN classification, Weighted KNN, Cosine KNN, Cubic KNN, Student's performance, Data Mining, Educational research

## 1.0 INTRODUCTION

The using of information technology in various fields has led the large volumes of data storage in various formats like records, files, documents, images, scientific data and many new data formats. The data collected from different applications require a proper method of extracting knowledge from large repositories for better decision making [1]. Knowledge discovery in databases (KDD) is used for discovery of useful information from large collections of data. The data mining applies various methods and algorithms in order to discover and extract patterns of stored data. Data mining techniques have been introduced into new fields of Statistics, Machine Learning, Pattern Reorganization, Artificial Intelligence and computation capabilities. Educational Data Mining (EDM) uses many techniques such as Decision Trees, Neural Networks, Naïve Bayes, K- Nearest neighbor, and many others. These techniques are used to discover knowledge, such as classifications, association rules and clustering. The discovered knowledge can be used for prediction regarding enrollment of students in a particular course, prediction about students' performance and so on. Nearest Neighbor classification was proposed by P. E. Hart and T. M. Cover in 1966 – 67, and now it is very popular in application and research field (Papadopoulos 2006). The reason of its popularity is the simplicity and efficiency in programming. The searching result needs high memory and computation requirements, but after implementing NN technique, it enhanced and reduced the usage of memory and computation time. The NN classifier idea is to classify X find its closer neighbor among the training points (call it X') and assign to X the label of X'. The K Nearest Neighbors rules are a well-known classifiers in Data Mining and Machine learning tasks(Kononenko and Kukar 2007). It is one of the most effective and useful algorithms in DM(Papadopoulos 2006), Pattern recognition(Shakhnarovich, Indyk et al. 2006), and considered as one of top 10 methods in DM(Wu, Kumar et al. 2008). As shown in Fig.1, the KNN classifier finds the K training samples $x_r$, r= 1… k which are closest in distance to x, and then classify them using majority vote among the k neighbors. The amount of computation can be intense when the training data is large. This is because the distance between a new data point and every training point has to be computed and sorted.

To adjust the complexity of KNN, we use the number of neighbors k, which is the only parameter used to determine the complexity. The larger k is, the smoother the classif classification boundary becomes. In other word, the complexity of KNN becomes lower when k increases.

**Input:** $D$, the set of $k$ training objects, and test object $z = (\mathbf{x}', y')$

**Process:**

Compute $d(\mathbf{x}', \mathbf{x})$, the distance between $z$ and every object, $(\mathbf{x}, y) \in D$.

Select $D_z \subseteq D$, the set of $k$ closest training objects to $z$.

**Output:** $y' = \underset{v}{\operatorname{argmax}} \sum_{(\mathbf{x}_i, y_i) \in D_z} I(v = y_i)$

**Fig.6: KNN classifier**

KNN classification performance can be improved through supervised learning. The Nearest prototype classifier is a classification model that assigns to observations the class labels of training samples whose mean is closest to the observation. In this study, we compare different types of NN classifiers that derived from the basic KNN classifier. These classifiers differ in the distance metric used and the amount of neighbors, which is the K value. Dealing with raw data is very complex to extract any useful information or knowledge. That is the reason why the data science has established for, and therefore using customized algorithms to work on the data are helpful.

According to these reasons, we want to classify the dataset of the 11th grade of the scientific branch of secondary schools in Gaza Strip to find out the classification structure, and show the relations between the item sets of the data. This can help in predicting the student's grade early and help schools to initially identify students with low academic achievement and find ways to support them.

**2.0 Background and Related work**

Classification techniques as KNN use different types of distance metrics which are used by applying the classification model. The following metrics are considered in this study.

The Euclidean distance uses Minkowski metric as a special case.

$$d2st = (xs - yt)(xs - yt)' \quad \textbf{(1)}$$

For the special case of p = 1, the Minkowski metric gives the city block metric, for the special case of p = 2, the Minkowski metric gives the Euclidean distance, and for the special case of p = ∞, the Minkowski metric gives the Chebychev distance.

$$\mathbf{dst} = \sqrt[p]{\sum_{j=1}^{n} |xsj - ytj|^p} \quad \textbf{(2)}$$

Cosine distance is a measure of similarity between two none zero vectors of an inner product space that measures the cosine of the angle between them.

$$dst = \left(1 - \frac{(xsx't)}{\sqrt{(xsx's)(yty't)}}\right) \quad \textbf{(3)}$$

A list of KNN Classifiers and its specification, which are used in this study, are explained as follows:

- Fine KNN Classifier: A classifier that makes finely detailed distinctions between classes with the number of neighbors set to 1.
- Medium KNN Classifier: A classifier that makes fewer distinctions than a Fine KNN, with the number of neighbors set to 10.
- Coarse KNN Classifier: A classifier that makes coarse distinctions between classes, with the number of neighbors set to 100.
- Cosine KNN Classifier: A classifier that uses the cosine distance metric.
- Cubic KNN Classifier: A classifier that uses the cubic distance metric.
- Weighted KNN Classifier: A classifier that uses distance weighting.

The rest of this section review previous studies which are related to our study in predicting student's performance, and review other studies which deals with KNN classification.

Fadhilah Ahmad et al. (Ahmad, Ismail et al. 2015) used classification methods in data mining to predict the student's academic performance in the first year of study at university in Computer science course. After applying the classification methods on the dataset, the result shows that Rule Based is the better model among the other techniques by receiving the highest accuracy value of 71.3%.

Other researchers, E. Osmanbegović and M. Suljić (Osmanbegović and Suljić 2012), used the surveys conducted during the summer semester at the university of Tazla, faculty of economics, among the first year students and data taken during the enrollment. After applying a three supervised data mining algorithms, they indicate

that the Naive Bayes classifier outperforms decision tree and neural network methods in term of prediction accuracy.

S. K. Yadav et al. (Yadav, Bharadwaj et al. 2012) gives a study based on the decision tree supervised algorithm to predict the student performance based on the past performance data, and it helps identifying the dropouts and the students who need special attention.

Recently, A. Deshpande et al. (Deshpande, Pimpare et al. 2016) used data mining techniques to analyze, visualize and predict the performance of the students in tests, extra-curricular activities, sports to grade students for campus placement activity. They used ID3 decision tree algorithm to predict the performance of the students in end semester exam where previous and current year performance have been used in prediction. They also reported that the evaluation helps to know strong & weak areas of students and give more guidance on weak areas.

B. K. Baradwaj and S. Pal (Baradwaj and Pal 2012) use data mining to analyze student's performance. They use classification tasks to evaluate student's performance where the decision tree is used as a classification method. Knowledge that describes student's performance in the end semester examination has been extracted.

Dealing with varying types of algorithms needs to be considered by reviewing the previous studies and take a part of these algorithms and make an evaluation of their benefits, efficiency and effectiveness of the data classification.

To compare between NN searches algorithms, some researchers define metric and non metric spaces. The metric spaces used in NN search problems. Diverse distance formulas which are used in this problem to find the nearest data point are described. Then, different structures are introduced. These structures are used for indexing points and making the searching operation faster. The NN searching algorithms was used to find the nearest data point, and then different structures of NN searching are introduced (Mahapatra and Chakraborty 2015). These structures are used for indexing points and making the searching operation faster. Some of these structures as Ball-Tree, LSH, and KD-Tree are considered as a technique for NNS problem (Mahapatra and Chakraborty 2015).

The fast KNN classification algorithm has been used by the authors to explore the mean of the vector and the propose of this algorithm that alters the search order of the technique in the wavelet domain(Jeng-Shyang, Yu-Long et al. 2004).

Multi-label classification algorithm was implemented, which derived from the traditional KNN algorithm. According to the label sets of these neighboring instances, maximum a posteriori principle is utilized to determine the label set for the new instance(Zhang and Zhou 2005).

On the other point of view, varieties of NN techniques have to be considered. Comparing between the techniques of NN gives as two methods of comparison; structure less and structure base. These techniques have improvements over the basic KNN techniques. The KNN lies in the first category, where the data are classified into training data and sample data point. The distance evaluated from training to sample points, and the point with the lowest distance called nearest neighbor. The Second category of NN techniques is based on structures of data, for example principal axis Tree (PAT), Ball Tree, k-d Tree, orthogonal structure Tree (OST), Nearest feature line (NFL), Center Line (CL) etc. A ball tree for example is a binary tree and constructed using top down approach. This technique is an improvement over KNN in terms of speed. The improvements proposed to gain speed and space efficiency(Bhatia 2010).

The Fuzzy KNN basis algorithm is to assign membership as a function of the object's distance from its KNN and the membership in the possible classes. A sample of this kind of algorithms is JFKNN which is an improved version of the standard KNN. It is based on a learning scheme of class memberships, which provide each training instance with membership array which defines its fuzzy membership to each class. After the learning process, the final classification is performed similar to KNN (Jóźwik 1983).

For pattern classification, Cover, T. and Hart, P. (Cover and Hart 1967) used the decision rules to implement a method to classify a set of unclassified data from a previously classified

points. For high dimensional data used in computer vision and machine learning, several types of algorithms were compared to get the best algorithm to deal with searching in high dimensional spaces (Muja and Lowe 2014).

Asif, R. et al (Asif, Merceron et al. 2014) did a study to help both of the teachers and the students to find out innovative ways using data mining techniques. They present a case study to predict the student's performance at an early stage of a university degree program, in order to help universities to initially identify students with low academic achievement and find ways to support them. Their results show that it is possible to predict the graduation performance in 4th year at university using only pre-university marks and marks of 1st and 2nd year courses.

Due to the previous researches, we find out that the researchers used several types of classification methods, but little studies use the modified KNN classifiers. In this study, we use the modified KNN classifiers for the prediction of the student's performance. The modified classifiers consist of 6 different types of KNN classifiers that differ from the original KNN classifier from the perspective of the Distance metrics and the amount of neighbors.

## 3.0 Methodology

As mentioned in the introduction, the aim of this study is to classify the dataset of the 11th grade of the scientific branch of secondary schools in Gaza Strip to find out the classification structure, and to show the relations between the item sets of the data. The study tries to utilize the classification models to predict the performance of the students according to their marks in two subjects. The classification model of KNN and its modified versions can predict the performance by comparing the input marks with the training dataset and find the nearest value of these marks which called the nearest neighbor.

MATLAB 2016 environment has been used to conduct all experiments. The students' marks dataset have been used to evaluate KNN classification algorithms. The dataset contains 13 attributes; 11 attributes contain the marks of subjects, Average and Grade. The dataset was collected from the database of ministry of education in Gaza strip. Classification learner of Matlab 2016 is used to apply the different KNN classification algorithms on the dataset. Fig.2 shows sample examples of students' marks for 14 students.

Depending on two subject's marks, the proposed classification model uses the dataset in order to predict the student's performance

| religon | Arabic | English | Math | Physics | Chemistry | Biology | IT | Management | Sport | Art | Average | Grade |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 96 | 129 | 97 | 87 | 61 | 68 | 38 | 84 | 75 | 90 | 90 | 70.38 | Good |
| 90 | 111 | 85 | 115 | 81 | 79 | 66 | 84 | 81 | 90 | 91 | 74.85 | Good |
| 84 | 108 | 89 | 108 | 64 | 68 | 53 | 86 | 66 | 92 | 90 | 69.85 | Good |
| 93 | 115 | 132 | 160 | 80 | 89 | 61 | 89 | 86 | 92 | 91 | 83.69 | Very Good |
| 100 | 137 | 120 | 157 | 84 | 93 | 80 | 89 | 92 | 92 | 92 | 87.38 | Very Good |
| 69 | 75 | 55 | 90 | 57 | 51 | 31 | 61 | 51 | 92 | 91 | 55.62 | Fair |
| 94 | 108 | 76 | 131 | 60 | 66 | 61 | 78 | 79 | 92 | 92 | 72.08 | Good |
| 94 | 136 | 109 | 155 | 85 | 84 | 82 | 88 | 91 | 94 | 89 | 85.15 | Very Good |
| 100 | 146 | 147 | 193 | 100 | 100 | 98 | 98 | 98 | 94 | 90 | 97.23 | Excelent |
| 94 | 141 | 147 | 174 | 85 | 85 | 78 | 94 | 92 | 94 | 89 | 90.23 | Excelent |
| 87 | 131 | 115 | 158 | 78 | 80 | 80 | 93 | 86 | 94 | 88 | 83.85 | Very Good |
| 89 | 139 | 109 | 152 | 74 | 81 | 70 | 69 | 64 | 60 | 85 | 76.31 | Good |
| 84 | 133 | 111 | 153 | 79 | 83 | 69 | 82 | 72 | 60 | 84 | 77.69 | Good |
| 99 | 139 | 136 | 181 | 93 | 92 | 96 | 96 | 93 | 82 | 86 | 91.77 | Excelent |

**Fig.7: Dataset**

## 4.0 Results and discussion

In this section, the experimental evaluation aspects of classification methods using modified KNN classifiers such as Cosine KNN, Cubic KNN, and Weighted KNN are reported.

All experiments were implemented with MATLAB 2016 on a workstation with Core I7 CPU and 6 GB RAM. The dataset were randomly divided into two sets; 70% of the records have been used for training and the remaining 30% for testing the classifiers.

The experimental results of classification algorithms are shown in confusion matrices of the algorithm and prediction graphs. The model classify the data based on the grade of the students which are 6 categories; Excellent, Very Good, Good, Fair, Pass, and Fail.

Every classification algorithm used in this comparison has its own distance metric and value. Fine KNN uses Euclidian distance metric, Equal distance weight and default number of neighbors 1. The Accuracy of this algorithm based on the default values is 90.7%.

Regarding Medium KNN, it uses Euclidian distance metric, Equal distance weight and default number of neighbors 10. The accuracy of this algorithm based on the default values is 93.8%. Coarse KNN uses Euclidian distance metric, Equal distance weight and default number of neighbors 100. The Accuracy of this algorithm based on the default values is 92.3%. Cosine KNN uses cosine distance metric, Equal distance weight and default number of neighbors 10. The accuracy of this algorithm based on the default values is 81.3%. Cubic KNN uses Minkowski distance metric, Equal distance weight and default number of neighbors 10. The accuracy of this algorithm based on the default values is 93.5%. Weighted KNN uses Euclidian distance metric, Squared inverse distance weight and default number of neighbors 10. The Accuracy of this algorithm based on the default values is 94.1%.

The classification results according to the confusion matrix graph will show form Fig.3 to Fig.8, and in Fig.9 we show a sample of the prediction graph for all types of classifiers used in this study.

**Table 1: Comparing Results**

| Classifier | Distance | neighbor | Accuracy | Time |
|---|---|---|---|---|
| **Fine** | Euclidian | 1 | 90.7% | 1.8972 Sec |
| **Medium** | Euclidian | 10 | 93.8% | 1.0067 Sec |
| **Coarse** | Euclidian | 100 | 92.3% | 1.3072 Sec |
| **Cosine** | Cosine | 10 | 81.3% | 1.0665 Sec |
| **Cubic** | Minkowski | 10 | 93.5% | 30.441 Sec |
| **Weighted** | Euclidian | 10 | 94.1% | 0.97885 Sec |

Applying the KNN modified algorithms on the dataset as in Table 1 shows a variety of results in accuracy and the time it takes. It depends on the distance matrix applied by the model and the number of neighbors.

Fine KNN confusion matrix as in Fig.3 represents the prediction of classes according to the marks provided in by the dataset. It shows that the best prediction value is in excellent class and the worst prediction value in Fair class. The high amount of false prediction is in Fair class due to the confusion matrix.

The confusion matrix of Medium KNN shown in Fig.4 gives a better prediction values rather than the Fine KNN. It represents a best prediction of Fail class with 100% and the worse prediction of Pass class with 88%.

The best prediction of Coarse KNN model shown in Fig.5 of the confusion matrix is 95% of the Excellent class and the worse prediction is in Fail class with false prediction of 39%.

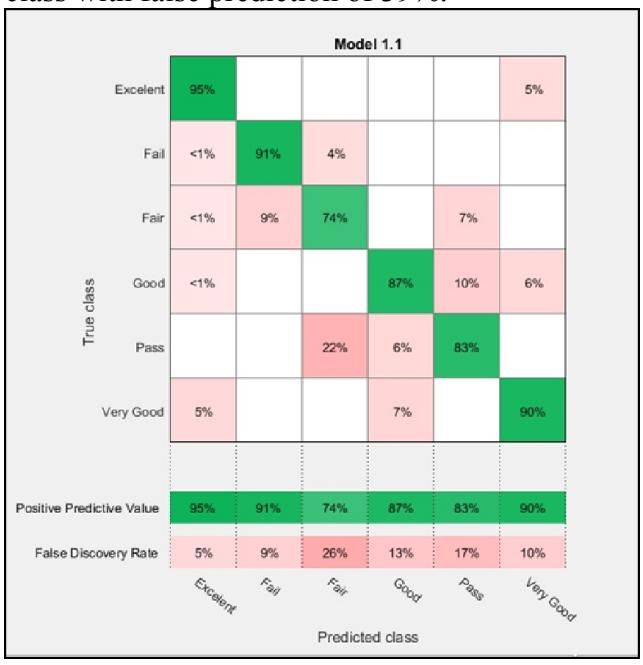


**Fig.3: Fine KNN Confusion Matrix**

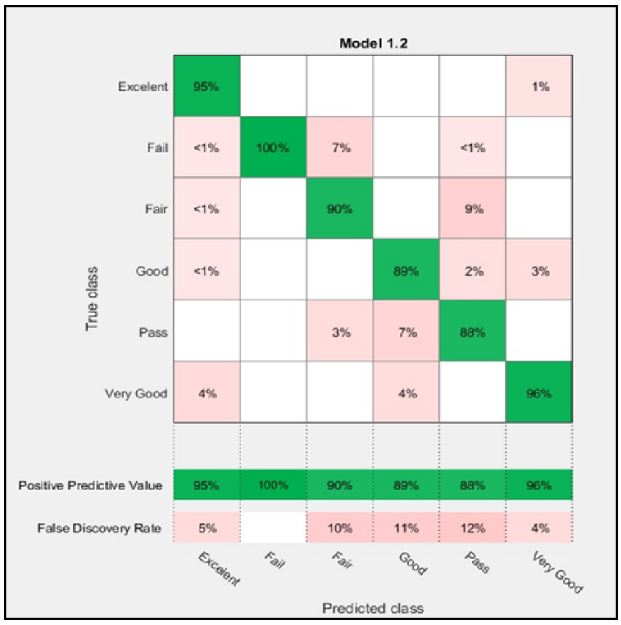


**Fig.4: Medium KNN Confusion Matrix**

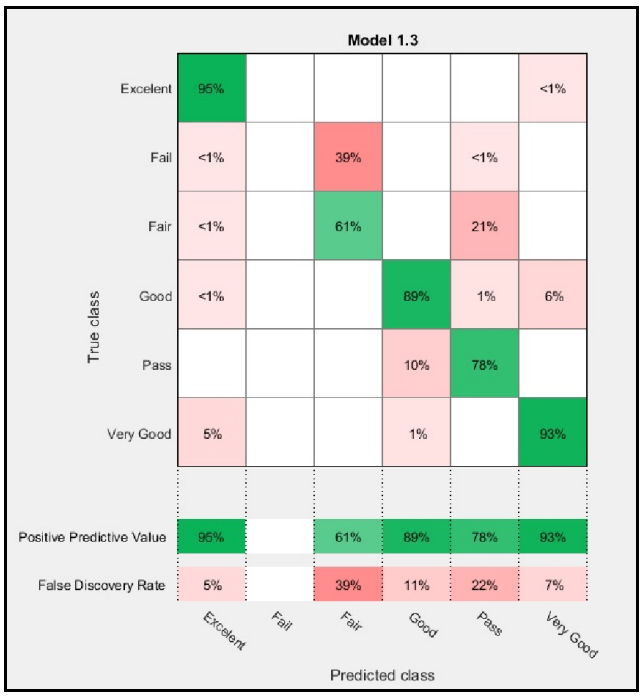


**Fig.5: Coarse KNN Confusion Matrix**

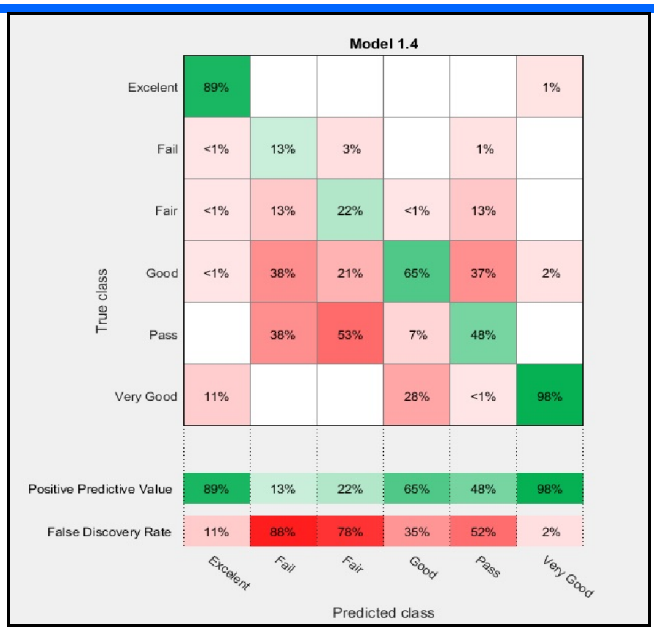


**Fig.6: Cosine KNN Confusion Matrix**

The Cosine KNN model has a large amount of false prediction shown in Fig.6. It gives 88% false prediction of Fail class and 98% positive prediction of Very Good class.

The Cubic confusion matrix in Fig.7 represents the positive and false prediction of classes according to the dataset. The best prediction value gives by the model is in Fail class with 100% positive prediction 13% of Pass class as false prediction

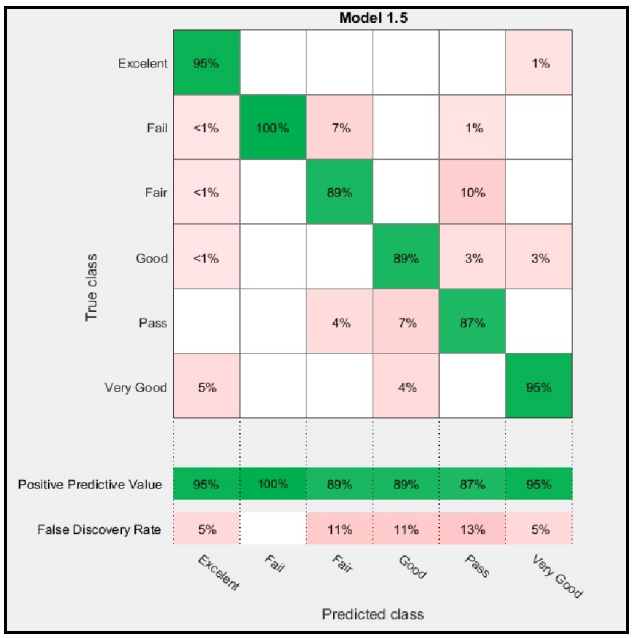


**Fig.7: Cubic Confusion Matrix**

he Weighted KNN model uses Euclidian distance metric to predict the nearest values according to the dataset. As in Fig.8 the confusion matrix of the positive and false prediction values shows that the best positive prediction is in Excellent class with 96% and the worst false prediction is in Pass class with 12%.

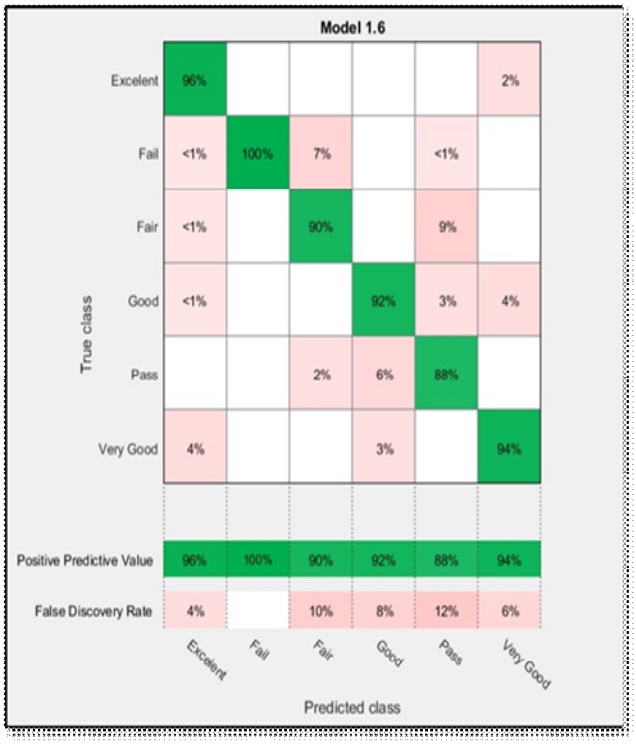


**Fig.8: Weighted KNN Confusion Matrix**

The prediction Graph shown in Fig.9 represents the classification of the classes according to the model applied on the dataset.

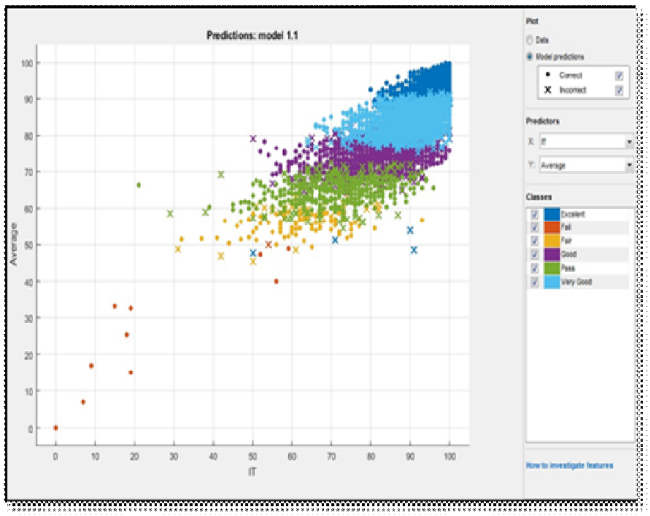


**Fig.9: Prediction Graph**

According to the results obtained from the conducted experiments, we found out that the most accurate algorithm used in classification is the Weighted KNN algorithm. It gives the best prediction accuracy according to the confusion matrix and the prediction graph. The Weighted KNN algorithm scored 94.1% accuracy and takes less time than other algorithms with 0.97885 Sec. On the other hand, Cosine KNN had the worst classification performance in which it scored 81.3% accuracy. However, the worst classifier in term of training time was the Cubic KNN with 30.441 Sec. The prediction model shows the predicted grade according to selecting of two attributes and creates the coordinator graph putting the selected attributes in X and Y axis, then show the predicted grade with correct and incorrect predictions .

## 5.0 Conclusion and future work

This study introduced a classification model for predicting the student's performance according to the marks of two subjects. We employed modified KNN classifiers such as Cosine KNN, Cubic KNN, and Weighted KNN for the classification. The dataset has been collected from Gaza Strip secondary schools, which has grade records for the students of the 11th scientific branch. Due to the classification experiment, we have shown that every algorithm gives a different value of accuracy and predictions due to the distance metrics used. The distance metrics, distance weight and number of neighbors are changeable variables that lead to enhance the efficiency of the algorithm results by increasing the accuracy of classification. On the other hand, the early prediction of the student's grade can help the principals to take decisions in order to help schools to initially identify students with low academic achievement and find ways to support them.

In the future, we will try to compare between the KNN classification algorithm and a different type of classification algorithm such as Naive Bayes algorithm to show the best in classification.

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# Net Benefits Quality Factors of Using Mobile Services from the Perspective of Students at Al-Quds Open University

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**Abstract**

Mobile applications are the main platform for most mobile services of different fields as well as education. Palestinian higher education environment, as well as Al- Quds Open University (QOU) has the required infrastructure to utilize mobile services. This study aims to determine the factors of quality net benefits of using mobile services from the perspective of students. Understanding such factors is very important to fully penetrate such services in higher education environment. Net Benefits Model was proposed based on DeLone and McLean IS Success Model. Structure of model has three independent variables and one dependent variable as follow: Information Quality, System Quality, and Service Quality are treated as the independent variables, whereas Net Benefits as the dependent variable. Model was evaluated on 400 of QOU students. The results show that the examined Model explains 62.9 percent of the variance in Net Benefits. The most factor that influences Net Benefits is Service Quality (SERVQ) with 46.4 percent. Results indicate that respondents with different Gender, Age, and Faculty are found to perform similar level of all quality variables. However, respondents of different Mobile Experience usage have significant difference regarding System Quality only.

**Keywords:** Mobile Services, Service Quality, Mobile Learning, Net Benefits Model

## I. INTRODUCTION

Nowadays, Mobile services considered as a daily life activity for all peoples. Mobile applications are the main platform for most mobile services of different fields as well as education. Palestinian higher education environment, as well as Al-Quds Open University (QOU)[1] has the required infrastructure to utilize m- learning services.

The study shows that the students are quite aware about mobile technology issues and they had adequate knowledge to use mobile applications [2].

QOU founded in 1991 as an open university which utilizes the open learning and blended learning. it has achieved many goals and success to promote academic standard in the Palestinian community. The number of enrolled students began with hundreds, and annually increased to reach 56,000 students by the end of the first semester of the Academic Year 2016/2017. The first graduates of the University received their certificates in 1997 [3].

QOU provides a mobile application which enables students to follow-up their academic affairs such as their personal data, classes schedules, exams schedule, current semester data such as incomplete courses, passed hours, number of registered hours and cumulative average, registered courses for the current semester and the University news [4].

## II. HYPOTHESES OF NET BENEFITS' MODEL

In the traditional information system (IS) success measure, Delone and Mclean [5] used information quality as one of the technological factors necessary for system success. Net benefits refer to the level of which IS contributes to successful individuals, groups, organizations, industries and countries [6]. Delone and McLean [5] also decide that rather than complicating their model with more success measures, they refer to move in the opposite direction and group all the impact measures into a single impact or benefit category called "Net Benefits".

Indeed, quality factors of IS can utilized to measure the quality of mobile application for open education [1]. Several information system success models were developed based on the Delone and McLean Success Model [6–10].

Net benefit is considered as the main dimension of the Information Success Model [11]. Based on Delone and McLean [5] success model, the measurement of information system success or effectiveness is critical to our understanding of the value and efficacy of information system actions [7]. Delone and McLean added that net benefit measure the effectiveness success. Information system benefits are the valuation of the benefits of the information system by users [9]. For instance, enhanced decision making, enhanced productivity, heightened sales level, reduction of costs, enhanced profitability, efficiency of markets, consumer welfare, jobs creation, and development of the economy are all net benefits [12]. However, the dependent variable of IS success model is net benefit as well as mobile application. Moreover, it is directly and positively affected by the following factors; system quality, information quality and service quality [9], [11], [12]. Lin, Wang, and Li [13] argued that when measuring the
net benefits of an IS, researchers need to define clearly and carefully the stakeholders and context in which the net benefits are to be measured.

### *A.* Information Quality

Information quality refers to measures of information system production, namely the quality of the information that the system principally produces as reports [6–8], [14]. Study [15] referred to information quality as the user's perceived high value property of information, and the characteristics of information that is consistent with the specifications, expectations and requirements of the user. Mukred and Yusof [6] added it as the level to which information is composed of the format and time characteristics that encourages value to the users that endures with time. The key measurements for Information quality are, accuracy, timeliness, completeness, relevance and consistency are key measurements for Information quality.

Information is an asset, and losing it means losing competitive advantage. In addition, information quality refers to the desirable characteristics of the information system outputs. Moreover, Jennex and Olfman [7] defined information quality as ensures that the right information with sufficient context is captured and available for the right users at the right time.

However, several studies [5], [8], [9], [16], [17] suggested that Information quality is an important aspect in Information system success. In a study on the determinants of information system success, Delone and Mclean [5] and other studies [8], [9], [16], [17] highlighted the importance of accuracy, completeness, currency, consistency, relevance, format, availability relevant, and security of information. Indeed, Information quality could play an important role to success the mobile application. Hence: Hypothesis 1 (H1): Students' perspective towards Information Quality of mobile services is positively associated with their educational net benefits.

### *B.* System Quality

Delone and Mclean [5] IS success model, Jennex and Olfman [7] and Wu and Wang [9] argued that system quality is an important part of IS success. System quality It has been explained by DeLone and McLean as the desired characteristics of the information system.. System quality is described as a measure of information system that is needed in the production output of the information processing system. Petter et al. [12] mentioned some of the success measures of system quality,

which are: "ease of use, system flexibility, system reliability, and ease of learning and response times".

Quality of IS systems includes accessibility, ease of use for retrieval as well as input, output flexibility to meet the user needs, search capability, and documentation [10]. System quality is recognized as an important technical factor in successful Information system implementation [14]. According to Kulkarni et al. [10] system quality measures the technical success of IS.

Study [9] found that system quality depends on the intended operational characteristics. It is concerned with whether there are errors in the system; its ease of use; response time; flexibility, or stability. System quality measures the reliability and predicts ability of the system independent of the Information it contains. In essence, the system quality is critical to success the mobile application. Hence: Hypothesis 2 (H2): Students' perspective towards System Quality of mobile services is positively associated with their educational net benefits.

### *C.* Service Quality

Service quality of IS is an important component of IS performance [15]. Service quality measures as a new dimension of the updated IS success model [18]. Service quality is defined as the discrepancy between what students expect and what they get. Wu and Wang

[9] state that system quality depends on the intended operational characteristics. It is concerned with whether there are errors in the system; its ease of use; response time; flexibility, or stability.

Mukred and Yusof [6] mention that it refers to the difference between the normative service expectations and the actual performance gauged from the recipient's viewpoint and it focuses on the provided types of service. System quality measures the reliability and predicts ability of the system independent of the Information it contains. The measurement of IS success or effectiveness is critical for understanding the measure of IS service quality. There are five dimensions to evaluate service quality which are tangibles, reliability, responsiveness, assurance, and empathy [19]. However, service quality one of the important measurement to evaluate the mobile application. Hypothesis 3 (H3): Students' perspective towards Service Quality of mobile services is positively associated with their educational net benefits.

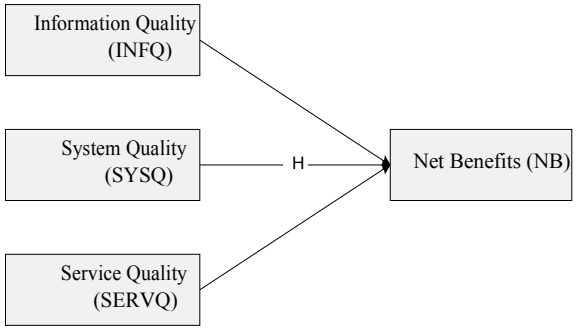


Figure 1: The proposed net benefits model

A survey (questionnaire) method was employed to evaluate the proposed net benefits model because it is most successfully adapted to obtain personal and social facts, beliefs, and attitude [20]. Questionnaire has three parts; first part collects personal and demographic data about participants. Second part the mobile services that

are available in QOU. Third part consists of quality net benefits' factors based on proposed model.

The community of the study consisted of all students at the QOU in deferent levels of study. A purposive sampling method was used in selecting the participants. Clear sample is (400) students which matched the criteria of study population [21]. According to rule of Roscoe [22], the sample size could be 10 times the number of variables. The present study consisted of eight variables. Therefore, following the rule, the minimum sample size required is 40.

## III. METHODOLOGY AND FINDINGS

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### A. Demographic Data of Respondants

The majority of respondents (400) were female (53%). 77.8% aged between 18-23 years which reflects the undergraduate students' level. Despite Faculty of Administrative & Economic Sciences and Faculty of Education made up the largest groups of respondents 38.3% and 35.5%, respectively, Faculty of Media was only 0.8%. In terms of mobile experience on QOU services, (82.8%) of respondents declared that they have experience less that two study years (4 semesters).

Table 1: Demographic data of respondents

| Profile | Classification | N | % |
|---|---|---|---|
| Gender | Male | 188 | 47.0 |
| | Female | 212 | 53.0 |
| Age | 18-23 years | 311 | 77.8 |
| | 24-30 years | 55 | 13.8 |
| | 31-39 years | 29 | 7.3 |
| | More than 40 years | 5 | 1.3 |
| Faculty | Faculty of Technology and Applied Sciences | 68 | 17.0 |
| | Faculty of Social and Family Development | 34 | 8.5 |
| | Faculty of Education | 142 | 35.5 |
| | Faculty of Administrative and Economic Sciences | 153 | 38.3 |
| | Faculty of Media | 3 | 0.8 |
| Mobile Experience | Less than 4 months | 180 | 45.0 |
| | 1-2 years | 151 | 37.8 |
| | More than 2 years | 69 | 17.3 |

### B. Mobile Services Usage

Students were also asked about their usage of the available university mobile services. They asked to reflect their actual usage in two modes, first the Actual usage currently or previously. Second, respondents intend to use such services in the next semesters. Respondents expressed that Exams' Timetable is the highest rank actually used (87.3%) followed by CGPA (84.8%) and Student Profile (83.5%). However, Passed Credit Hours (36.3%) was highly intended to use in the future followed by News & Announcements (34.3%). The result indicates that students are very active with the mobile application of QOU, see Table.

Table 2: Usage of QOU mobile services

| Mobile Service | Actual usage (%) | Intend to use (%) |
|---|---|---|
| Classes' Timetable | 87.3 | 12.8 |
| Registered Credit Hours | 86.3 | 13.8 |
| CGPA | 84.8 | 15.3 |
| Student Profile | 83.5 | 16.5 |
| Exams' Timetable | 81.5 | 18.5 |
| Incomplete Courses | 79.8 | 20.3 |
| Email & Transactions | 78.5 | 21.5 |
| GPA (current semester) | 68.3 | 31.8 |
| News & Announcements | 65.8 | 34.3 |
| Passed Credit Hours | 63.8 | 36.3 |

### C. Validity and Reliability Testing

Most of the items used to measure the variables have been adopted from the literature. Even though the adopted measurements have been confirmed of its discriminate and convergent validity, it is felt necessary to re-examine the validity of these measures. The existing literatures on net benefits of service quality have been done in other countries, particularly in the west-countries where the environment and culture are entirely different from Palestine. The test is reliable when it gives the same results if it is reapplied in the same conditions. The reliability of the test was measured by Alpha Cronbach (α). As shown in Table 3 below, Cronpach Alphas of the measures were all comfortably above the lower limit of acceptability that is α >= .7, thus, these measures satisfy the internal reliability criterion [23], [24].

Table 3: Reliability Coefficients for all the variables

| Variable | # of Items | Reliability |
|---|---|---|
| Information Quality (INFQ) | 8 | .858 |
| System Quality (SYSQ) | 5 | .805 |
| Service Quality (SERVQ) | 5 | .774 |
| Net Benefits (NB) | 5 | .833 |

### D. Descriptive statistics

Scale measurements used is five-point Likert scale. The ranges of 5 point Likert-scales were categorized into equal sized categories of low, moderate, and high. Therefore, scores of less than 2.33 [4/3 + lowest value (1)] is considered as low; scores of 3.67 [highest value (5)

- 4/3] is considered high; and those in between considered moderate.

Mean values for all variables fall in the range of 3.52 and 3.57. Indeed, respondents are generally moderate in all variables towards the expectation of continuous usage of mobile services. As shown in Table 4, standard deviation (SD) of all variables are fall in the range .78 and .86, it indicates that statistically, the variation of Information Quality, System Quality, Service Quality, and Net Benefits among respondents are high.

Table 4: Descriptive Statistics for All Variables

| Variable | M | SD |
|---|---|---|
| Information Quality (INFQ) | 3.53 | .80 |
| System Quality (SYSQ) | 3.57 | .84 |
| Service Quality (SERVQ) | 3.52 | .78 |
| Net Benefits (NB) | 3.58 | .86 |

### *E.* Correlation Analysis

The values of the correlation coefficients (r) indicate the strength of the relationship between variables. The computation of the Pearson product-moment correlation coefficients was performed to obtain an understanding of the relationship between all the variables in the study. Preliminary analyses were performed to ensure no violation of assumptions of normality, linearity, and homoscedasticity [23], [24].

As shown in Table 5, overall correlation values of the variables showed significant correlations coefficients. Furthermore, correlations amongst all measures of Information Quality, System Quality, Service Quality, and Net Benefits are between .65 and .76 which fall in (r
.50 – 1.0) that are large correlated significantly [24].

Table 5: Correlations Strength between All Variables

| Variable | NB | INFQ | SYSQ | SERVQ |
|---|---|---|---|---|
| Net Benefits (NB) | | .680 | .687 | .745 |
| Information Quality (INFQ) | .680 | | .760 | .650 |
| System Quality (SYSQ) | .687 | .760 | | .724 |
| Service Quality (SERVQ) | .745 | .650 | .724 | |

### *F.* Hypothesis Testing

In order to determine the factors those effect on quality net benefits of using mobile services from the, regression analyses were conducted. However, before conducting the analysis, the data were first examined to detect whether there is any serious violations from the basic assumptions underlying the regression analysis, namely linearity, normality and homoscedasticity [23], [24]. Furthermore, normality assumption is examined by normal Probability-plot (P-P) of the residuals (see figure 3). From the normal p-p plot, the values fall along the diagonal with no substantial or systematic departures, seating that the residuals are about normal distributed.

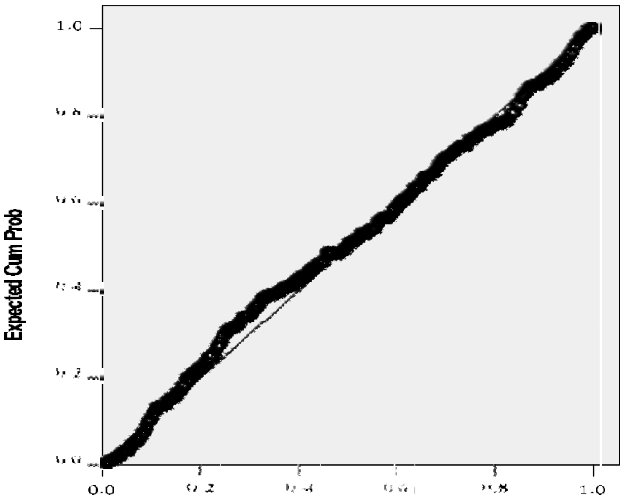


Figure 3: Probability-plot for dependent variable (NB)

Furthermore, inspection on data revealed that there was no serious violation of the basic assumptions. Therefore, the use of regression for subsequent analysis is appropriate. The interpretation of the regression analysis is based on the standardized coefficient beta (β) and $R^2$ which provides evidence whether to support the hypotheses or not.

In this analysis, Information Quality, System Quality, and Service Quality are treated as the independent variables, whereas Net Benefits as the dependent variable. Through regression analysis procedure, the examined model explain 62.9 percent ($R^2$ = .629) of the

variance in Net Benefits. Moreover, the model reaches statistical significance (Sig. = .000, this really means p<.0005). Table 6 shows that Information Quality positively influences Net Benefits (β= .265). Consequently, System Quality positively influences Net Benefits (β= .150). Furthermore, Service Quality is the highest positively influences Net Benefits (β= .464). Therefore, all hypotheses H1, H2 and H3 are supported.

Table 6: The influence of Behavior Intention to Use; and Facilitating Condition on Use Behavior

| Variable | β | Sig. |
|---|---|---|
| Information Quality (INFQ) | .265 | .000 |
| System Quality (SYSQ) | .150 | .005 |
| Service Quality (SERVQ) | .464 | .000 |

Sig. F= .000; N= 400; Dependent Variable: Net Benefits (NB)

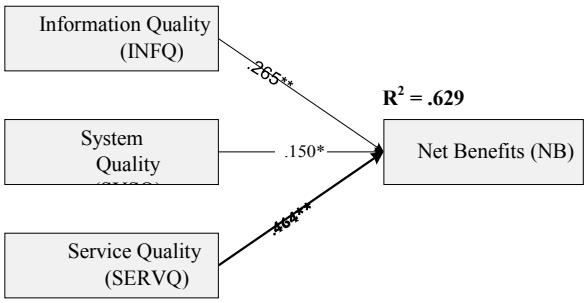


Figure 3: Net Benefits Model with Correlation Coefficients and Squared Multiple Regressions

T-test was conducted to explore the impact of Gender, Age, Faculty, or Mobile Experience. Results indicate that respondents with different Gender, Age, and Faculty are found to perform similar level of all quality variables. However, respondents of different Mobile Experience usage have significant difference regarding System Quality only.

## *G.* CONCLUSION

Mobile applications are the main platform for most mobile services of different fields as well as education.

Palestinian higher education environment, as well as QOU has the required infrastructure to utilize mobile services. Determining factors of quality net benefits of using mobile services from the perspective of students are very important to fully penetrate such services in higher education environment. Net Benefits Model was proposed based on DeLone and McLean IS Success Model. Structure of model has three independent variables and one dependent variable as follow: Information Quality, System Quality, and Service Quality are treated as the independent variables, whereas Net Benefits as the dependent variable. Model was evaluated on 400 of QOU students. The results show that the examined Model explains 62.9 percent of the variance in Net Benefits. The most factor that influences Net Benefits is Service Quality with 46.4 percent. However, these theoretical and practical implications could encourage Palestinian HEIs management and mobile developer to pay more attention on such factors to keep continuous intention usage of mobile services .

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# University Orientation Enhancement for High School Students in Gaza Strip: A Data Mining Experimental Study

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**Abstract**—Education is one of the most essential trends for people in the world. In Gaza strip, Education is considered as a the first choice for high school graduates that's because of the limited resources and the lake of real industry or agriculture sectors and further the high percentage of unemployment. University Education is considered as the dominant light of families for theirs children. Important notes of national statistics draw the attention to a crucial problem in university orientation for high school students in Gaza Strip. Data mining offers techniques that help to study the data delivered from the graduate students of high school and first years at the universities. In this research paper we report a Data mining experimental study on a big dataset of student at the Islamic University of Gaza IUG. Student collected grades from both the high school and the first two years at the IUG. Using data mining techniques(Decision Tree, Naïve Bayes, K-Nearest Nightboor) we were able predict a set of enhancement rules for orientation of students based on their performance in high school (Tawjihi) and later at the university. An evaluation and Validation process was performed to checkup the efficiency of the experimental study results.

**Keywords—Datamining, High Education, Decision Tree, NaiveBayes, K-nearstnightboor**.

## I. INTRODUCTION

Due to the advent of new technologies, devices, and communication in several domains, like Education, Health Care, Medicine, Transportations, Food Production, etc., the amount of data produced by mankind is growing rapidly every second. One if the main challenges of Data Mining domain experts is to get benefit from the huge amount of Data produced from the daily activities in the educational systems.[1].

The Big Data amounts delivered from high schools graduate students grades and from their results at the first years in the universities could be a basis for data mining process that target the amelioration off orientation of students to the universities in Gaza Strip[2, 3].

As mentioned, Palestinian Higher Education Institutions face the challenge of providing enhancement of orientation and learning experiences to their students. In addition, there is a large amount of educational data about students, alumni,

courses, academic staff. This data can be demonstrated as a strategic resource for enterprises to enhance the quality of their educational processes. This can be achieved through the use of various data mining techniques to extract data that derived from the educational activities, i.e. by extracting useful knowledge that supports the management of each organization in making the appropriate decision to improve the quality of educational processes.

In this paper, we have selected three techniques of data mining (Decision Tree, Naïve Bayes, and K-Nearest Nightboor) which are suitable with our dataset structure that used for these research[4, 5]. Also, have a good accuracy measure, to make an experimental study on a collected dataset of 12000 record of students result in high school and in the first two years at the university.

We aimed to extract knowledge about the main factors(rules) that affect the orientation of students at the university.

## II. BACKGROUND AND STATE OF THE ART

Data Mining Concepts and Techniques can be applied in Education field to discover knowledge from data come from students' performance. Data Mining uses many techniques such as Decision Trees, Naïve Bayes, K-Nearest neighbor, Neural Networks and many others, to offer useful knowledge about the learning process for students, where following some of the methods of data mining[6, 7].

### A. Decision Tree

Is the learning of decision trees from class labeled training tuples. A decision tree is a flow chart diagram like as tree branches structure, where each internal node (not a leaf node) denotes test on an attribute, each branch represents an outcome of the test, and each leaf node (or terminal node) holds a class label. The topmost node in a tree is the root node which is defined as class label[6].

### B. Naïve Bayes

Bayes Classification or Naïve Bayes is statistical classifiers based on applying Bayes' theorem with strong (naive)

independence assumptions, which is technique for estimating probabilities of individual variable values, given a class, from training data and to then allow the use of these probabilities to classify new entities. It has also exhibited high accuracy and speed when it is applied to large databases. In addition, easy to implement and good results obtained in most of the cases, which is consistent with this study[6].

### C. K-Neareast Nighboor

K-nearest neighbor is one of the most fundamental a supervised learning algorithm where the result of new instance query is classified based on majority of K-nearest neighbor category. So the purpose of this algorithm is used to classify students prediction based on attributes and training samples[6].

## III. RELATED WORK

Todays, Data becomes one of the most trends in the world; especially in Education Systems. The data come from these systems need to mining prospect to understand the composition of this information to gain educational knowledge. However, Mining Techniques start begins between 2000 – 2007 as a series of Educational Data Mining(EDM) workshops as a part of several international research conferences[8].

After 2011, researchers began more investigation studies in EDM, researchers have been starting to use mining techniques on educational systems to explore information within the educational systems[9].

From Data perspective, X. Wu, X. Zhu, G. Q. Wu and W. Ding faced autonomous Sources with Distributed and Decentralized Control, Complex and Evolving Relationships data. So presents a HACE theorem that characterizes the features of the Data revolution, and proposes a Data processing model, from the data mining perspective, but faced mining algorithm as a big challenger to generate global models by combining locally discovered patterns to form a unifying view. However, Wu. focused on algorithm designs in tackling the difficulties raised by the Data volumes, distributed data distributions, complex and dynamically of data characteristics[10].

Richard A. Huebner using artificial intelligence for specific applications of educational Data Mining, which include student retention and attrition in addition to personal recommender systems, and other data mining studies within course management systems[11].

Wassan, Jyotsna TalrejaIsman, Aytekin. focus on trial of educational modelling based on Big Data platforms techniques which translate to V's definitions; volume, variety, velocity, veracity and value. Depending on data storage like Hadoop, MongoDB, and Cassandra etc. that is schema-less and highly scalable and on data analytics like MapReduce techniques depend on JASON Object that deals with management, processing and distribution of data with NoSQL databases are inherently schema-less and highly scalable. Wassan. Expectance usage of various Big Data platforms like Hadoop, MongoDB, Cassandra etc. and parallel programming models like Hadoop MapReduce, PACT etc., for various data analytics

techniques could be explored to accelerate the analysis of educational data. This will help in building scalable models in the field of education and may provide a better scope of impraxovement in the field of educational analytics[12].

Jyoti Parashar. using Regressing Technique depends on criteria such like teaching skills, students skills, social and family pressure and area of interest to provide a comparison research to make a recommend for student to help him choose between Technical or Non-Technical College by develop a questionnaire consisting of various questions/parameters that interact students and teachers in acquiring their views based on questionnaire which produced technical education is favored rather than non-technical which indicates it may be good for students[13].

Suchita Borkar. provide an attributes selection for predicting students' academic performance using education data mining and artificial neural network which classified as association rule mining algorithm and artificial neural network to predicting students' performance, depend on attributes (such like Education, Previous knowledge of computer, Father/Mother is educated, Graduation percentage, Attendance%, Assignment, Unit Test, University result) using Neural Network(NN) Technique Borkar. looking to apply same method using fuzzy logic in categorized values[14].

Manolis Chalaris. Used Data mining techniques on educational data to present a useful strategic tool for administration of Higher Education Institutions to mapping the complex and critical challenge of improving the quality of educational processes using decision-making process that includes association rules, correlation analysis , and clustering analysis, by applied these models on Educational Technology Institutions in Athens(TEIA)[15], at same idea with a little deference Al-Twijri, Mohammed I. and Noaman, Amin Y. propose a DM model for filtering out students satisfying all eligibility criteria that satisfy the admission methods, they suggested model could predict the best admission methodology to which a student can be applied to the King Abdul-Aziz University in Saudi Arabia[16].

On the same context, Mohammed M. Abu Tair and Alaa M. El-Halees used educational data mining to improve graduate students' performance, and overcome the problem of low grades of graduate students, by applied data mining techniques to discover association, classification, clustering and outlier detection rules also evaluated association ruleson data extracted using two classification methods which are Rule Induction and Naïve Bayesian classifier to predict the Grade of the graduate student then clustered the students into groups using K-Means clustering algorithm. Finally, using outlier methods which are Distance-Based Approach and Density- Based Approach to improve the performance of graduate student result[3].

Monteiro Gomes, Colcher, Wolcott, Herrera-Viedma, Shi, Ramos, Machado and Cordeiro. applied some analysis of some specific indicators were performed through by clustering mechanism to understand the assessment of basic education in the perspective of the State Reviewer as a mechanism that generates information regarding the positivity and weaknesses of a school or an educational system to provide the improvements[17].

The previous related work helped us to refine our vision of research problem and the expected solutions. Especially research paper of Chalaris[15], Abu Tair[3], Al-Twijri [16] and Ramos[17] gave us a complete and comprehensive understanding of applying DMT for education. Purpose our research will mainly focus on Palestinian educational system and using the most recent Data Mining Techniques to enhancement orientation of Palestinian student to give them a best university success and improve of Palestinian educational quality process.

## IV. METHODOLOGY OF WORK

The primary goal of the proposed approach is to enhance the orientation of Palestinians high school students for the best choices in university domain. Our methodology in this research consists of a number of steps, each step leading into next one. Next Figure.1 present each step.

Figure .1: Part of Description of Decision Tree predictor Graph

The research methodology divided into three main phases: Phase .1; Collecting and preprocessing data: in this step we have worked to find a suitable dataset that contains information about students and their evaluations and qualifications. Then we have been applied data mining preprocessing techniques such as cleaning, discretization, sampling, feature selection and normalization. Which lead to increase data quality and perform data preprocessing to increase the accuracy of the mining. To do serious, effective, real- world data mining. Phase .2; Apply and evaluate data mining models: after we had processed the data set, we will apply the data mining classification techniques such as Decision Tree, Naïve Baysan, KNN. Which lead to using the most usefulness and most techniques task to be considered the main used techniques. Phase .3; Select and evaluate performance of the best model through testing on actual present cases. Which lead to evaluating the performance of the selected model. In figure.1, we presents three general steps of our methodology: collecting and preprocessing data, apply and evaluate data mining models, and select and evaluate performance of the best models.

## V.RESULTS AND DISSCUSION

In this section, we present results of data mining models that's applying on our dataset, after the experiment of predicting the student majors(Specialty) based on student performance, presented to three parts:

A Decision Tree

After applying the decision tree depending on GPA and university college we get a recommended college to every GPA in high school.

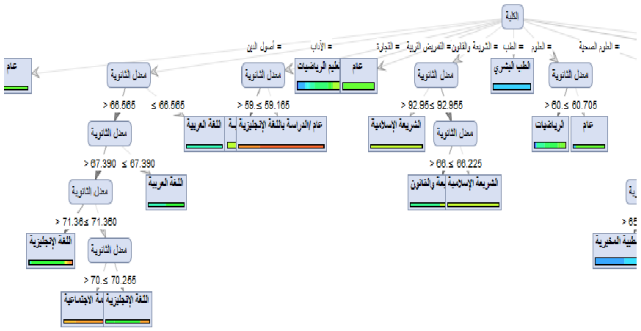
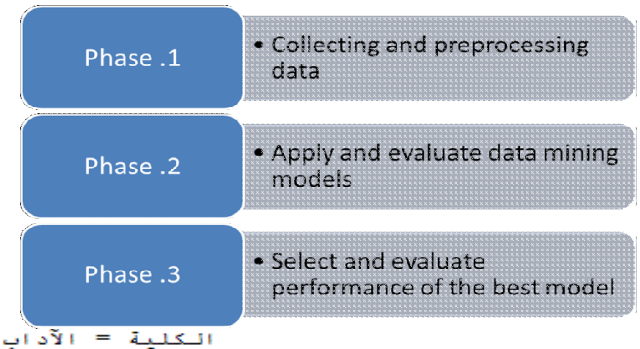


Figure .2: Part of Graph of Decision Tree predictor




```
الكلية = الآداب
|   66.565< معدل الثانوية
|   |   67.390< معدل الثانوية
|   |   |   الحاسوب وأساليب تدريسه=0 ,1=ر
|   |   |   71.360≥ معدل الثانوية
|   |   |   |   الحاسوب وأساليب تدريسه=0
|   |   |   |   الحاسوب وأساليب تدريسه=0
|   |   الآثار=0, الحاسوب وأساليب تدريسه=0
|   الآثار=0, الحاسوب وأساليب تدريسه=0 ...خ
الكلية = التجارة
|   الآثار=0, الحاسوب وأساليب تدريسه=0 ...خ
|   الآثار=0, الحاسوب وأساليب تدريسه=0 ...خ
تاريخ والآثار=0, الحاسوب وأساليب تدريسه=1 ...
تاريخ والآثار=0, الحاسوب وأساليب تدريسه=0 ...
الكلية = الشريعة والقانون
|   الآثار=0, الحاسوب وأساليب تدريسه=0 ...خ
|   92.955≥ معدل الثانوية
|   |   الآثار=0, الحاسوب وأساليب تدريسه=0
|   |   الآثار=0, الحاسوب وأساليب تدريسه=0
تاريخ والآثار=0, الحاسوب وأساليب تدريسه=0 ...
الكلية = العلوم
|   الآثار=0, الحاسوب وأساليب تدريسه=0 ...خ
|   الآثار=0, الحاسوب وأساليب تدريسه=0 ...خ
الكلية = العلوم الصحية
|   61.550< معدل الثانوية
|   |   64.530< معدل الثانوية
|   |   |   الحاسوب وأساليب تدريسه=0 ,0=ر
|   |   |   الحاسوب وأساليب تدريسه=0 ,0=ر
|   |   الآثار=0, الحاسوب وأساليب تدريسه=0
|   الآثار=0, الحاسوب وأساليب تدريسه=0 ...خ
```

Figure .3: Part of Description of Decision Tree predictor Graph

One of the Rule says that **IF** student high_School_GPA between 66-67 and Arabic (65-84) then best choice is Faculty of Arts (Arabic), that mean students graduated from high school, have total GPA 66-67 and 65-84 in Arabic then should be study in Art College with preferred Arabic specialty(major).

Table .1: DT Predicted Grades Range

| # | College Name | Arabic | Predicted GPA | avg of Predicted GPA |
|---|---|---|---|---|
| 1. | Medicine | الطب | 87 - 97 | 92 |
| 2. | Engineering | الهندسة | 78 – 88 | 83 |
| 3. | IT | تكنولوجيا المعلومات | 75 – 85<br>85 – 95 | 85 |
| 4. | Nursing | التمريض | 76 – 86<br>87 – 97 | 86 |
| 5. | Science | العلوم | 80-90 | 85 |
| 6. | Health Science | العلوم الصحية | 75 – 85<br>85 - 95 | 85 |
| 7. | Education | التربية | 80 - 90 | 85 |
| 8. | Arts | الآداب | 80 - 90 | 85 |
| 9. | Sharia & Law | شريعة وقانون | 80 – 90<br>90 - 99 | 90 |
| 10. | Osoul Eddin | أصول الدين | 65 – 75<br>75 – 85<br>85 - 95 | 80 |
| 11. | Commerce | التجارة | 75 – 85<br>85 - 95 | 85 |

**In Table**.1 we show predicted grades rang for student graduated from high school, and some of predicted range for a college are similar with other college, so to more sufficient prediction we need to explore more deep in student situation and depending on courses in high school to enhancing students orientation in university choices, and after we applied these mechanism DT model achieved 89.0% of accuracy.

### B .NAÏVE BAYES

table .2: NB Predicted Grades

| # | College Name | Arabic | avg of Predicted GPA |
|---|---|---|---|
| 1. | Medicine | الطب | 97 |
| 2. | Engineering | الهندسة | 87 |
| 3. | IT | تكنولوجيا المعلومات | 75 |
| 4. | Nursing | التمريض | 78 |
| 5. | Science | العلوم | 85 |
| 6. | Health Science | العلوم الصحية | 84 |
| 7. | Education | التربية | 84 |
| 8. | Arts | الآداب | 83 |
| 9. | Sharia & Law | شريعة وقانون | 79 |
| 10. | Osoul Eddin | أصول الدين | 75 |
| 11. | Commerce | التجارة | 79 |

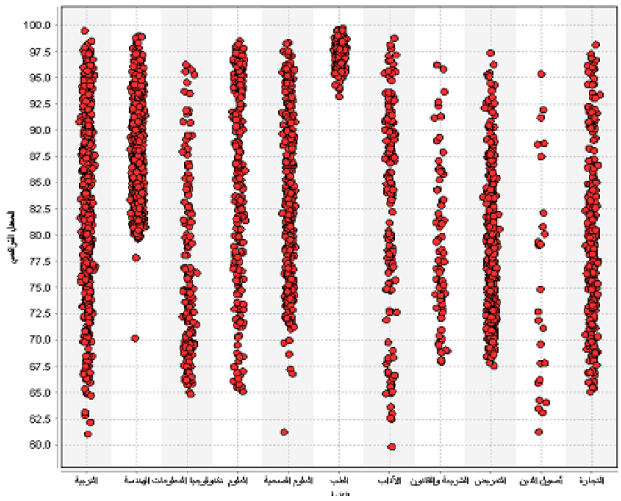


Figure .4: NB Predictor Graph

In Table.2 and Figure.4 we show rang of predicted GPA for students orientate to colleges choices, and after we applied these mechanism NB model achieved 80.4% of accuracy.

### C. K- Nearest Neighbor

In this mechanism we tested this model four times with different K values and the results were all similar even different K values

Table .3: KNN Predicted Grades

| # | College Name | Arabic | avg of Predicted GPA |
|---|---|---|---|
| 1. | Medicine | الطب | 97 |
| 2. | Engineering | الهندسة | 87 |
| 3. | IT | تكنولوجيا المعلومات | 76 |
| 4. | Nursing | التمريض | 79 |
| 5. | Science | العلوم | 86 |
| 6. | Health Science | العلوم الصحية | 84 |
| 7. | Education | التربية | 84 |
| 8. | Arts | الآداب | 83 |
| 9. | Sharia & Law | شريعة وقانون | 79 |
| 10. | Osoul Eddin | أصول الدين | 76 |
| 11. | Commerce | التجارة | 80 |

In Table.3 and Figure.5 we show rang of predicted GPA for students orientate to colleges choices, and after we applied these mechanism KNN model achieved 86.7% of accuracy.

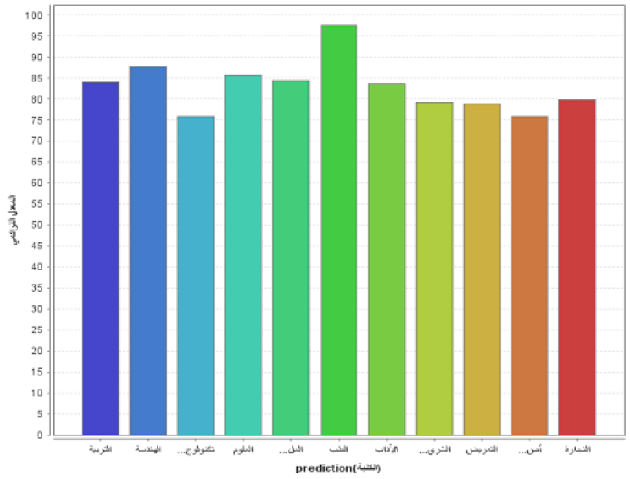



Figure .5: KNN Predictor Graph

The three techniques gives different accuracy values based on data nature, many attempts had done on the data set to give accuracies better than accuracies that were illustrated in previous sections, the final accuracies are listed in Table .2 based on considering the predicted values is true.

As mentioned in the introduction and the state of the art of the paper, the main objective of the research is to use data mining technique's to distinguish between faculties and specializations based on students results. As shown in Tables .1, .2, and .3, and as an example of the medicine faculty, results illustrate different GPAs depending on the data mining techniques used (92% with DT, 97% with NB, and 97% with KNN). These results give recommendations for researcher and university's responsible to perform a more investigations and experimental data mining work depending on some specific orientation criteria. Such investigations and research can be accomplished in the near future in collaboration with interested audience (universities, ministry of educations, related community institutions, …etc.).

## VI.PERFORMANCE VALIDATION

In validation process we depends on accuracy measure to evaluate used models;

Table.4 shows results of accuracy measurements of three models that used in our experiments In evaluation we focused on Tawjihi GPA(Grade Point Average) and University Colleges GPA as features selection to predict best case for study

Table .4: Accuracy measurements

| No. | Model | Accuracy |
|---|---|---|
| 1. | Decision Tree | 89.0 % |
| 2. | Naïve Bayes | 80.4 % |
| 3. | K-Nearest Nighboor | 86.7 % |

The results of the experimental study presented in the previous section were validated by a performance process that select the accuracy unit. As shown in Table .4 the accuracy of results for three methods was as follow, Decision tree 89.0%, Naïve Bayesian 80.4%, and K-Nearest Neighbors 86.7%.

## VII.CONCLUSION

As a research of investigating data mining techniques for predicting student's performance based on students grades and results, we collect the related data from two place; First: is The Ministry of Education and Higher Education in Gaza[18], Second is Islamic University of Gaza[5], the data belonging to the students that was graduated from (Tawjihi) High school in 2013 – 2015 and students that was joined at the university in 2013- 2015. The data set contains the performance of the students in the courses that was succeeded. we preprocessed the data and format it to be in predictable format, then we apply three famous classification techniques, Decision tree, Naïve Bayes, K-Nearest Neighbors. The three techniques give closed results as follow, Decision tree 89.0%, Naïve Bayesian 80.4%, and K-Nearest Neighbors 86.7%.

As presented in the research results we were able to distinguish the key factors that enhanced the orientation of high school graduate students to the universities in Gaza Strip.

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# Community Behavior in Space among Conflict Palestinian Community and Gaza War 2014

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**Abstract:** Wars are regarded as among the most important challenges facing the world today, due to their impacts on communities and built environments. It is important to study community behavior and reaction towards violence in order to address the rift resulting from wars among communities, peoples, and spaces. The war in Gaza is worth highlighting due to the new cultural and urban realities and reactions that were produced and formed through the act of occupation and Palestinians' will to struggle and endure on the land.

This research highlights the Palestinian community's behavior towards the violent degradation of built forms in the space of conflict in Gaza during and after the last war in July 2014. It seeks to determine how these practices overcame the negative aspects of violent degradation of architecture. The research will combine two approaches to investigate social phenomena in space: a phenomenological approach together with an ethnographic approach. The findings will help guide a new way of thinking within architecture to refine spaces distorted by violent conflict and convert them into fertile spaces for social behavior.

**Keywords: urban studies; conflict; community; architecture; Gaza; space**

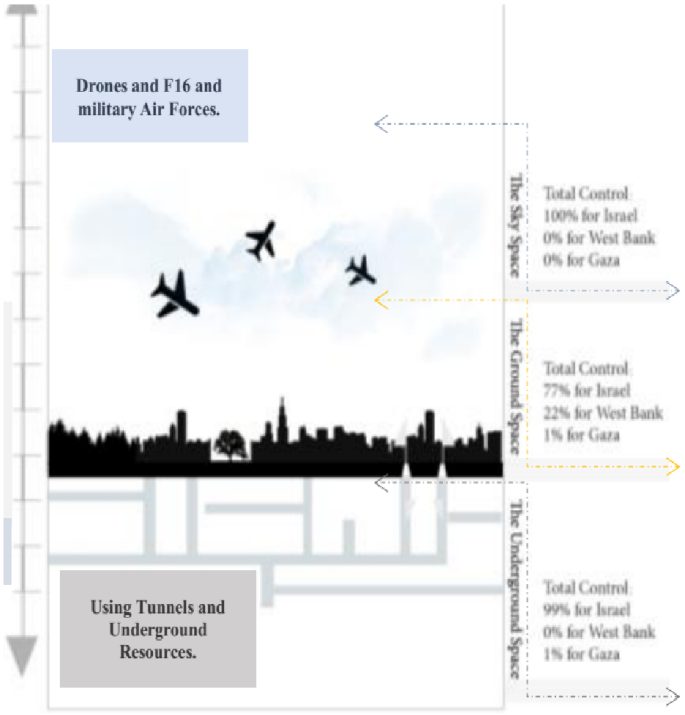
## I. INTRODUCTION

This study will take Gaza Strip as the key testing ground, investigating the community ordinary practices during and after the last war in July 2014. Gaza Strip as a testing ground is one of three main parts that get involved in the main politic conflict. The three parts; Gaza, West Bank, and Israel share a space with dimensions need to be considered in the investigation; the sky, the ground, and the underground space are all spaces that architecture goes through. For example, tunnels occupy the underground space, whilst buildings inhabit the ground space expand vertically into sky space. In the research, the investigation will focus in the ground spaces. "Fig. 1" and "Fig. 2" illustrate the scope of testing regarding to space and time.

According to the vertical axis of Architecture; the basics of focus on are:

1. The sky space.
2. The underground space.
3. The ground space.

**Fig. 1: Scope of Testing – Space. By the author.**



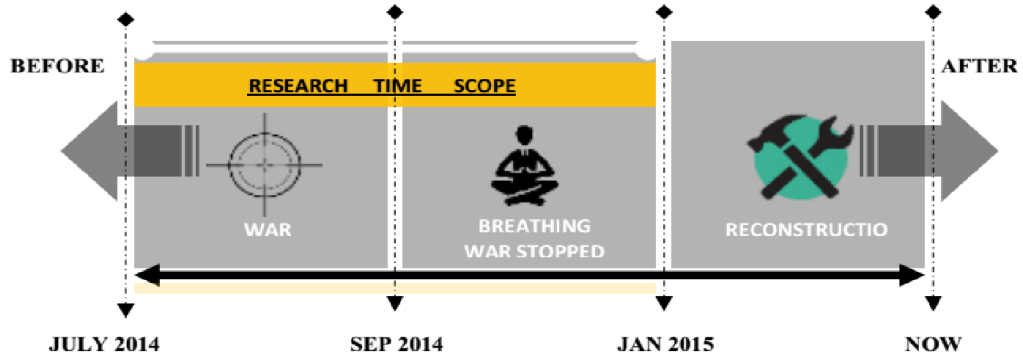



Fig. 2: Scope of Testing – Time. By the author.

To some extent; the existing knowledge shows different case studies similar to the Palestinian community experience in Gaza, and according to the individual analysis; the Palestinian experience in Gaza Strip was the worse and the most difficult one when compared to the other cases in the world or even in West Bank. However, the ordinary practices and the scenes show more complexity within architecture, especially after the three sequences wars in the last ten years. Depending on previous theoretical debates that discuss issues related to conflicts, architecture, and community practices, different academic resources and references have been used to help in building the research and find answers to the following upraised questions:

**Firstly:** As a result to the phenomenon of violent degradation towards architecture during the last crisis in Gaza Strip, what were the public community practices within architecture during and after war 2014?

**Secondly:** How did these practices overcome the negative aspects of the phenomenon of violent degradation towards architecture? The research will use the qualitative research methodology and apply a combination of two approaches; the phenomenology approach together with the ethnography approach. In the ethnographic method the investigation will focus on visual ethnography which depends on using photographs as a methodological tool. On the other hand, the phenomenological approach will help in investigating the external appearance and inner consciousness of phenomena based on memory, imagery, and meaning. However, to achieve the research objectives and find answers to the proposed questions; a wide variety of tactics have been used, including photos, maps and figures, document studies, observation, and case studies.

## II. OVERVIEW OF GAZA STRIP, URBAN LIFE, AND ARCHITECTUR.

Today Gaza Strip is a narrow land area in the Southeastern Mediterranean Sea, with a length of about 41 km and a width ranging from 6 to 12 km “Fig. 3”. Regarding to the Palestinian Central Bureau of Statistics 2015 (PCBS) there are approximately 1.8 million inhabitants living in the Strip, in area comprising 360 km2, which makes it one of the most densely populated areas in the world. The Gaza Strip is linked to the outside world through five border crossings; four with Israel and one with Egypt. All materials and goods required for the people in the Gaza Strip are official to enter through the Israeli border crossings, whereas the Egyptian crossing is only for person's movement. Access to the Mediterranean Sea is limited to three nautical miles along the Strip coastline. [1]


Fig. 3: Ga za Strip map [2]

The urban life in the Gaza Strip had been shaped by the periods of growth as well as by crises. During the 1990s, Gaza city grew taller; and many high-rise apartment buildings increased in the city center and neighborhoods "Fig. 4". The Strip has passed through many political and economic periods in the last years; started from the Israeli siege that has continued for eight years and the 2008-2009,2012, and 2014 attack. All of the mentioned problems provide fertile ground for a prolonged humanitarian crisis, caused a large deterioration in the economic, social and political infrastructures of Palestinian society in the Gaza Strip, and affected the style of architecture, construction and building process. However, the cultural urban transformation in the Gaza ,

changes in social structure and urban landscape from open to closed spaces due to the occupation policies, all these factors lead to form a special style of construction for residential buildings which are gray boxes[3].

## III. Gaza Strip Conflicts And Crisis- War 2014

Between (2009-2014) there were three sequential wars that had a destructive effect on all aspects of life, where large areas of the Strip had been demolished, and thousands become homeless and contributed considerably to worsen already deteriorated economic and social conditions. The extensive devastation to houses, and infrastructure during the aggressive has further expanded poverty and hindered the probabilities of economic retrieval, if and when conditions allow. Provided for the infrastructure which was significantly damaged [3]. Gaza was already in the grip of a humanitarian and environmental crisis after the first two wars in 2009 and 2012 and before the last crisis began.

The last crisis happened on 7 July 2014, when a humanitarian emergency was professed in the Gaza Strip, following of an increase in aggression, involving heavy Israeli aerial and naval shelling and Palestinian rocket fire. In this war, 2,205 Palestinians were killed, including at least 1,483 civilians, of whom at least 521 were children and 283 were women. Over 500,000 Palestinians were displaced at the height of the hostilities; thousands remain displaced. Seventy-one Israelis were killed, including 66 soldiers [1]. The scale of obliteration, devastation and dislocation during the 50 days of fighting was extraordinary in Gaza, since the Israeli occupation in 1967 *"Fig. 5,6"*.

**Fig. 4: Gaza Strip style of buildings** [3].

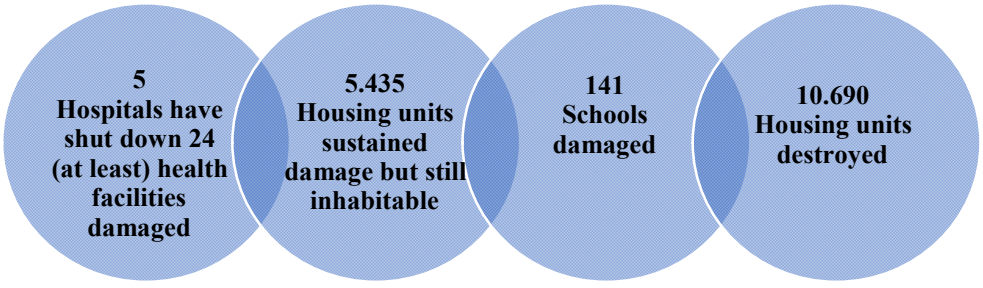



**Fig. 5: Destruction statics according to OCHA report** [4].

**Fig. 6: Destruction in North Gaza during war 2014. (Photos taken by the author)**

## IV. THE COMMUNITY PRACTICES WITHIN ARCHITECTURE DURING AND AFTER WAR 2014

It is hard to imagine the forms of human behaviors and reactions to survive in dangerous environments where conflict, wars, destruction, and death exist. The Palestinian community behavior in Gaza among the last war (July 2014) was a unique human experience that can be highlighted. Architecture was one of the most outstanding and clarity scene in the recent ten years of conflict in Gaza. Odile Decq once said; "Architecture: It's a discipline which helps people to live." [5].

In conflict, the political controversies between the parties are considered intangible, thus there is an opportunity for architecture to create an influence. Looking at the dialogue of daily spatial resistance shows that within the Israeli policies of occupation, destruction, and killing there were different forms of Palestinian spatial practices, that recast the political equation of conflict on the ground by displaying creative tools within architecture.

Since the first day of the war, the Palestinian families have started their journey of suffering and pain, especially those who have their houses near the borders. However, most of them have left their houses looking for a safe place for them and their children. Unfortunately, the Gazans had not much choice, some people looked for relatives who live in a safe area away from the bombing and shooting, have a free space, and able to welcome them to spend few nights in their house till the ceasefire is declared or war ends. Thus; the families who could not find any relevant to live with had to move directly to the nearest UNRWA school, and find a class if there are still any free classes. The last choice is to gather some cloth and build your tent anywhere in Al-Shifa hospital garden. Among this journey the Gazans have practiced their life in a different way. The practices included in this short period of time show several phenomena that reflect their social culture, and express their way of thinking. In the next page a scenario displays the war daily event in Gaza Strip "Fig. 7", it illustrates the Gazans journey and its consequences; which included a set of practices that comes as a reaction towards violence they suffered.


**Fig. 7: The Scenario of Investigation Within Space and time. By the author.**

### A. *Al-Shifa Hospital- Hospital Or Hospitality?*

Al Shifa is the largest medical complex and central hospital in Gaza City [6]. During the war Al-Shifa has opened its doors for thousands of Gazans who have been evacuated from their houses after the Israeli occupation destroyed their houses in east Gaza [7]. *"Fig. 8"*
Despite the emergency situation that have been declared in the hospital to manage the crisis and be able to receive martyrs and wounded people, the hospital facilities have become shelters. However, the hospital garden has been occupied by dozens of tents reminding everyone with the exile catastrophe in 1948 *"Fig. 9,10,11"*, the corridors have been used as spaces for treating wounded people, the streets have been used as a media base for news agencies and journalists who document and write stories and reports about what happening in the hospital, and some streets have been used as a space for praying and sleeping.

**Fig. 8: Displaced Palestinians seek refuge at al-Shifa hospital in Gaza City on 27 July. Photo by: Ezz Zanoun.**

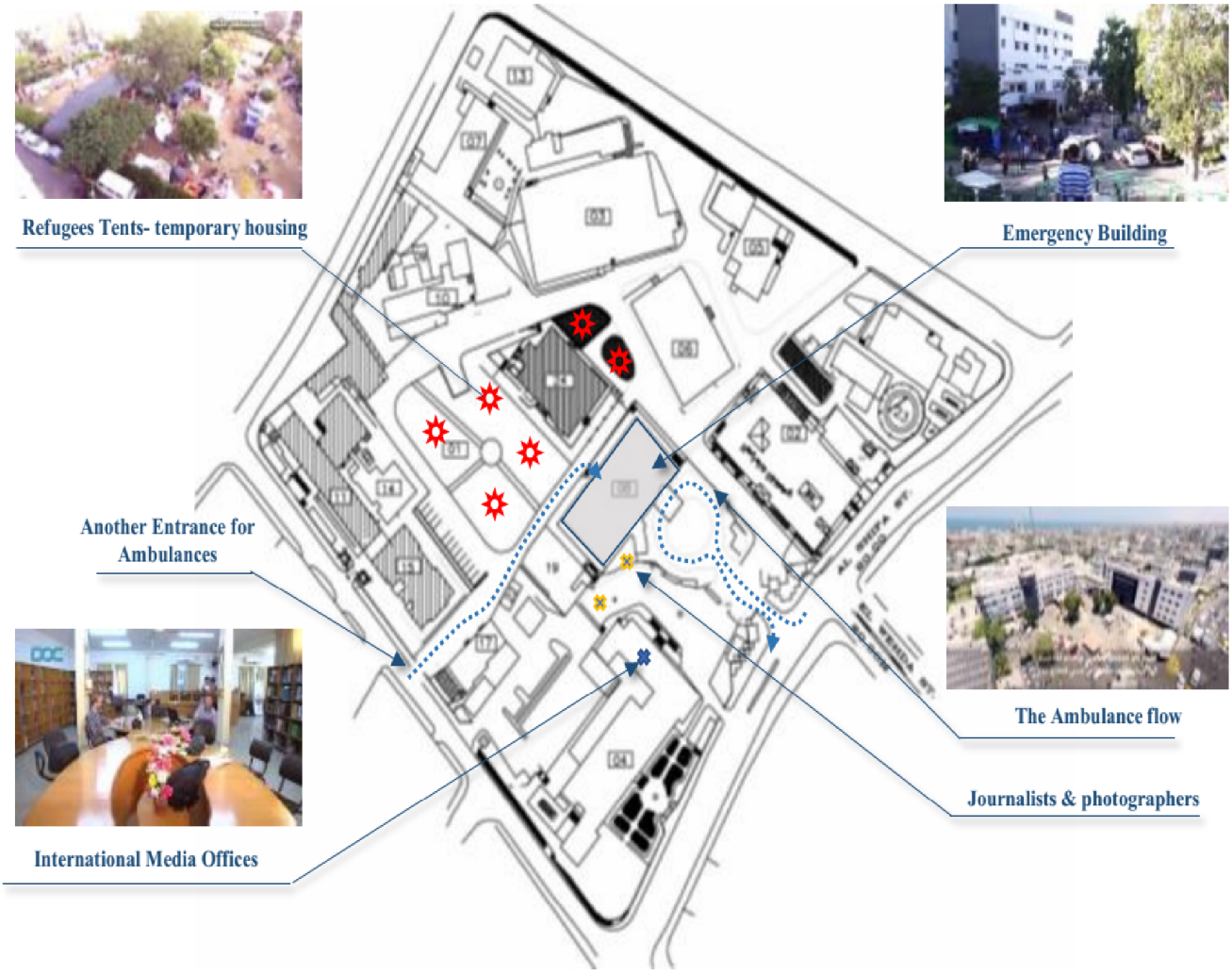



**Fig. 9: The site of Al-Shifa hospital in Gaza and the signed of active spaces during the war. By the author**

It seems that the hospital buildings have assumed other function amidst the conflict; here is how doctors describe Al-Shifa, " a de-facto refugee camp, shelter, local hangout, and target.".

Dr. Sobhi Skaik, chief surgeon at al-Shifa, said that the situation in the hospital became worse especially with the amounts of accumulated rubbish. He added that the situation has been complicated by the fact that several members of the same family can often be found in different units of the hospital, while other relatives have camped near the hospital after their homes have been destroyed [10]. The relatives were thronging into the hospital, especially after the bombardment of Shujaiya, which is a city of around 60,000 people. The refugees came to Shifa, shocked and confused as they had lost their homes and many had lost their family members. They sought refuge in the garden of Shifa. Thus, Al-Shifa had not only the patients and their families, but it had a large group of refugees in the middle of its garden [11].

Despite that the garden was planned in a spontaneous and random way by the refugees, it was divided in a marshaled technique trying to preserve as much as possible of their beliefs and social values which were ruptured by war together with their houses. For example; the refugees who have the same family name will be found in contiguous tents in reference to the unity and thread they have, and they tried to save it despite the critic situation they live. On the other hand, you will find that most of the men have left their tents and lay down on the sidewalks in order to sleep, giving their wives a space of privacy and freedom.

The tents the refugees used were not ready-made tents. However, they were forced to build their own tents using any available materials. As shown in the figures below; the refugees used the hospital bed sheets as well as their own fabrics and blankets which have been rescued before their houses were bombed. They used a structural element made of wood or metal to support the tent provided to cords to fix the tent “Fig. 12” . However, some

**Fig. 10: The corridors in the hospital have been used as spaces for treating wounded people** [8].

**Fig. 11 : Awaiting ambulances carrying casualties, Palestinians sit at the entrance to the emergency room of Al-Shifa hospital in Gaza City** [9].

**Fig. 12: Refugees tents, style 1**
**1.** [12]. **2.** [11]. **3. Photo by Ezz Zanoun.**

**Fig. 13: Refugees tents, style 2**
**1.** [11]. **2.** [13]. **3.** [7].

### *B.* UNRWA Shelters- Living In A Classroom!

During the conflict, UNRWA provided humanitarian support (including food, water, Sanitation, Health, psycho-social assistance provided to non-food-items such as hygiene supplies, mattresses and blankets) to internally displaced persons (IDPs) in 90 of 156 UNRWA schools, with the remaining school buildings either unsafe or destroyed.

Regarding to UNRWA assessment; "On 23 August, a record-high of 292,959 internally displaced persons (IDPs) were counted in 85 UNRWA school buildings. After the ceasefire on 26 August as the majority of IDPs left to occupy their original damaged and undamaged properties, the Agency consolidated the remaining 74 shelters into 18 for the 60,000 IDPs who remained." [14]. The environment of living in the shelters was difficult. However, thousands of displaced people lived in overcrowded spaces; sharing toilets and classrooms together. They were trying to have a sense of privacy and dignity for their women and children by dividing classrooms with hanging blankets or insulation elements. Regarding to a testimony from the UN school in North Gaza who described the situation there said that there was no freedom and no privacy, they were living in a very overcrowded place which makes them especially the women feel afraid and anxious. They were unable to sleep as they were feeling ashamed to sleep and lie down or use the bathroom because there were no keys and locks on the doors and windows. “Fig. 14”

**Fig. 14: Palestinians sleep in a classroom as they take shelter at the UNRWA New Gaza Boys Prep school in the Refugee Beach Camp on July 14** [15].

Unfortunately, the UNRWA schools also were targeted by Israeli forces. However, the emergency shelter in Jabalia camp in north Gaza had been targeted by the Israeli artillery. *"Fig. 15"*

The shelter was hosting approximately 3,300 refugees. Fifteen civilians were killed in the attack, provided to four children were sleeping next to their parents on the floor of the classrooms [16]. Due to the enormous numbers of refugees and limited space capacities in other shelters, the surviving civilians continued seeking refuge in Jabalia shelter and staying in the non-affected classrooms as there was no place to go.

**Fig. 15: Two photos for Jabalia school after the Israeli shelling. The classes where dozens of displaced people were sleeping there** [16].

### C. Life By Architecture- Spaces As It Should Be!

The cruelty of the scenes and events the Palestinians passed through have had great impact on their behavior. The war has left an imbalance in the built environment performance in all its forms. For example; the school as a learning environment with classrooms, activity spaces, and playground has become a shelter that is full of hard humanitarian scenes which did not respect the Gazans freedom, privacy and dignity. This imbalance led many to reject these distorted spaces and think of changing this painful reality. So they used drawing and imagination to redesign these spaces and draw it as it should be. In the figures, designs for a group of designers called Cortoba team. The drawings show the gap between the reality of the distorted spaces the Gazans live in, and the functional task the space should offer in the normal state. "Fig. 16,17"


Fig. 16: Two designs by Cortoba team entitled *In Gaza: The school is a dream*. The designs embody the impact of the war on school spaces [17].


Fig. 17: Another two designs by Cortoba team for a public space, where a child plays with remains of a missile fired by the Israeli forces. The design embodies the impact of the war on public spaces [17]

### *D.* Sense Of Space- Visualization And Drawings

The impact of conflict and crisis on the physical nature in any space can be observed obviously. On the other hand, the moral impact needs a deep observation as it can be considered as a long- term impact. However, the space of violence that has been created during the war in Gaza has become a part of children's memory. The distorted environment that was directly targeted by the Israeli forces has become the black side of children's memory.

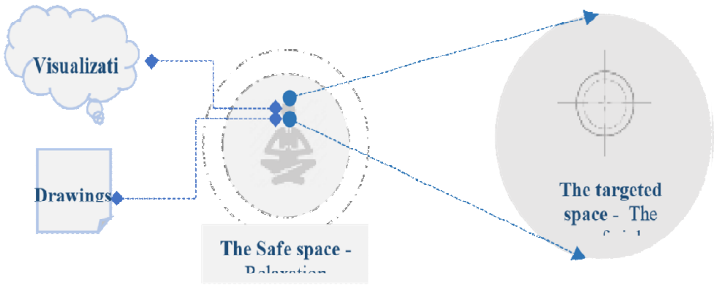



**Fig. 18: Illustration process, spaces and tools of investigation. By the author.**

In the investigation a safe space was used to help in observing the children's reactions and hidden feelings towards violence“Fig. 18”. The children who were tested in the investigation found the shelter a safe place compared to their neighborhood which targeted by the Israeli artillery. However, to investigate the impact of conflict on children regarding to their sense of spatial environment two

techniques have been used and applied to children; Visualization and drawings. The figure below illustrates the investigation process.

Despite that the children's awareness and deep understanding of the surroundings is not mature enough; but they have an awareness towards spatial relations, depth and distance in space.

During the war I have worked as a volunteer, and as a part of my voluntary work in UNWRA schools – North Gaza, we were running activities with children and families who were evacuated from their houses after the Israeli occupation destroyed their homes and they were taking shelter there. The families in the shelters are traumatized and the children need care and attention, as well as food, water and clothes. "Fig. 19,20"

Visualization was one of the activities that were running there as a part of relaxation sessions. "Visualization is a visual guided imagery. This technique uses the imagination to slow down the chatter of the mind and help release negative thoughts and worries." [18]. During one of these sessions; my colleague started asking the children one by one about what they were thinking about when they were closing their eyes and breathing with deep thinking; "Tell me about something you love and you were thinking about, and something you hate and get it out from your mind.". Marah, 8 years ol d, was sitting beside commented, saying; "I want to get back to my room and to play with my toys". "OK, tell me about something you hate and you were thinking about", he said. Marah stopped for a while. Then said "I'm afraid to say it… you were standing on the school's roof, and you got shot by Israeli soldier, I heard the sound of the ambulance. But you were died".

Regarding to OCHA assessment report at least 373,000 children requires direct and specialized psychosocial support [19]. However, children are showing symptoms of increasing distress, including bed wetting, clinging to parents and nightmares.

In UNRWA schools when you are working with children you can read the whole story with details that elder people do not note. During the drawing session done by the kids, the children showed ability to draw the details of their house and how it has been destroyed! "Fig. 21".

The domain the child exists in, the experiences,

**Fig. 19: The safe space of activities _ A class in UNRWA schools in North Gaza - where sessions were conducted. Photo by Fred Ekblad**

**Fig. 20: Visualization session with children in UNRWA schools in North Gaza during the last war in July 2014. Photo by the author.**

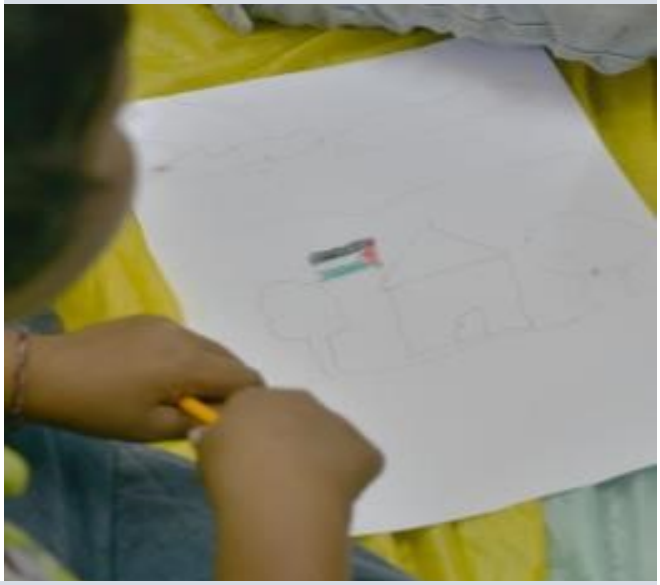


**Fig. 21: Drawing session with children in UNRWA schools _ North Gaza _ war 2014. Photo by the author.**

and the memories he has all find their way onto paper in an attempt to make sense and find meaning to what has happened, what is happening at the moment, or even what he would like in the future [20]. However, drawing is a good tool to find a way to communicate with them, realize, and understand what they are thinking of [21]. As " children only draw what they are aware of" [20].

Here is the collection of children's drawings during one of the sessions. As shown in the images; they are a schematic drawings [21]; In this type of drawing you will find many details, and the child might use words and symbols to express what he is thinking of. They draw as realistically as their skills allow, they show the world from their perspective. They can tell a story with their pencils and colors "Fig. 22". Interpreting children's drawings is attempt to realize a deeper layer to what they are thinking about and feeling towards. In the images attached you will find that:

- The drawings tell the story of what that child has lived through, his feelings, and emotional struggles during the days of the war.
- The images show that the children are aware of the object's orientation to the horizontal and vertical coordinates of space. For example; image No 1 and the artillery in front of the house, image No. 2 the people sitting under the umbrella, image No. 3 the house beside the trees.
- The kids used their perceptual skills and experiences to represent a space on a two dimensional plan.
- The children's environment or neighborhood has not always drawn as a place of cruelty; some images show the green view of their space by showing landscape elements such as trees with mature fruits. As if the children still emotionally involved in the 'before', and the past image of his house hoping to go back in time. However, they are aware that there is no house any more.


**Fig. 22: Drawing session with children in UNRWA schools _ children drawings. Photo by the author**

E. Temporary Housing- Find Alternatives

The social solidarity is one of the main features in the Palestinian community where they live and support each other. During the war, many Palestinians have been forced to leave their houses looking for a safe place. The family unity makes the Gazans live together in one house Thus the Palestinian culture saved the person's life, instead of sleeping in streets their relatives offered a place to live in their houses until they found a new place to live in [22].

The hosting by relatives rescued those families from homelessness, but it was a temporary solution; as the Gazans after a while found themselves unable to continue in these circumstances with limited spaces, limited privacy and comfortability, and feeling of being a burden for their hosting relatives. However, provided to the shelters available in schools and Al-Shifa hospital that suffered from the same problems the Palestinian families started thinking of building their temporary house directly after the war to live in until the reconstruction program start and reconstruct their destroyed houses.

After the war; Israel put restrictions on the flow of concrete, cement, iron bars and other construction materials into Gaza, because of

"dual use" items that could have a military purpose if they were obtained by Hamas and used to rebuild tunnels [23]. Consequently; the displaced families started to construct their huts by themselves or even try to close the holes in their damaged houses with whatever they can find: plastic, wood, or metal. The temporary houses that were built were small rectangular homes, with wood frame and wood slats fixed together to build walls. Then everything was covered by layers of plastic, leather and any protective fabric [24]. "Fig. 23". One of the persons who built his house in this way said that to build a house of two rooms costs approximately 1,500$ [25].

**Fig. 23: Some Gazans are building tiny new h omes of wood and plastic because of the difficulty obtaining cement. Photo by: Emily Harris/NPR** [25].

Unfortunately, some of Gazans could not afford the expenses of building a temporary house or rent a house somewhere, so they built their tent on the ruins of their destroyed house "Fig. 24". The Palestinians could not leave their destroyed house where they had spent years, where they had built their memories and life events. " The importance of the place results from the relation between the person and the place. Hence, the place can survive and withstand, though hardly, as long as the interaction between it and its inhabitant lasts, even if some of the physical elements of the place vanished." [26].

On the other hand, some displaced families were lucky to have caravan that offered by donors and sited in a temporary displacement site. These caravans are prefabricated unit made of metal, which are cold in winter and hot in summer. Even so the families there were living in sordid conditions, particularly in winter where the caravans suffer from leakage in the rain and have no electricity or sanitation[27]. *"Fig. 25".*

**Fig. 24: A Palestinian family taking shelter in their destructed house** [28].

**Fig. 25: Caravans in the temporary displacement sites in the village of Khuza'a in Gaza Strip Photo: Mazen Naim** [29].

## F. Parkour Players- The Cosmetology Architecture

One of the community practices towards architecture in Gaza after the war was for a group of youth players called Parkour team. Parkour is "A training discipline using movement that developed from military obstacle course training. " [30].

Recently an essay published on Domus website for the authors; Joseph Grima, and Antonio Ottmanelli; has talked briefly about Parkour in Gaza through an interview they had organized with the team members [31].

Looking at "Fig. 26", you will find photos for the team members while they were practicing. And you will notice

**Fig. 26: Parkour Players in Palestine between destruction** [32].

that the background of these photos shows deconstructed buildings, and deserted spaces. This character of activities can be seen as a physique of what can be called "The Cosmetology Architecture". The deconstructed buildings in Gaza are an architecture that has been naked of all its positive and constructive values. It becomes a form of dismal architecture with totally negative and deconstructive meanings and values. The buildings that have been bombed in Gaza by the Israeli forces and become rubble today are considered instances of killing memory – with all the past context and the future dreams. The nature of humanity could not accept this havoc, demolition, and desolation. So you will find that the people in Gaza have begun the journey of change and community intervention, looking for meanings of beauty, comfort, happiness, and freedom.

As a part of this affected community; Parkour team has started to create their own spaces within the destructed and deserted buildings using their physical abilities. Joseph Grima, and Antonio Ottmanelli in that essay that have been mentioned previously said " Inspired by the nascent sport of Parkour, the Gaza Parkour Team began to observe the urban fabric of Gaza as a playground through which they could move fluidly, using their bodies—instead of weapons and explosives—to overcome boundaries and barriers." [31]. To some extent this can be true. But their behavior can be considered and analyzed as a natural and human reaction against the affected and damaged environment itself. So it is Cosmetology Architecture; that is created by society as a community intervention among architecture, and against effected environment that has been subjugated by political conflicts (Palestinian – Israeli conflict) in Gaza.

**G. Architecture Inspiration And Sculpting- The Memorial Architecture**

Despite that the architecture has distorted and destroyed, it is nonetheless an effective tool to influence. However, the memorial architecture was one of the prominent manifestations that were introduced after the last war on Gaza. " Memorials are extraordinary places in the public realm that are very important as places that embody the identity of those who build them." (Norden, 2003)

From Shujaiya neighborhood of Gaza, which was severely damaged during the war, and where people have had to run away from their homes during the shelling; looking for a safe place. The Palestinian sculptor Iyad Sabbah from Gaza has set a group of seven clay statues built out of fiberglass (came from waste materials found in bomb sites), and covered with mud [33]"Fig. 27"; symbolized the suffering of Shujaiya residents and displacement. The figures which placed on a beach portrayed bloodstained men and women carrying their children and walking towards the sea to embody the refugees fleeing to other countries illegally through the sea in an attempt to run away from death. However, in the background appear the ruins of the destroyed buildings. Sabbah, who considered his work an open space installation art, said " The project I started directly after the war, lasted for around a month and a half. I called the project "Worn Out" because it's linked to the prevailing psychological state of the people and the destroyed buildings and infrastructure." [34].

**Fig. 27: The memorial statues in front of the destructed buildings** [33].

**V. CONCLUSION**

Among this investigation the analysis and findings raised one important question; How can this informal style of power change the equation of conflict between Palestine and Israel through a set of public, spontaneity, and unplanned practices which were outcomes of cultural, social, and political background.?

In the last war in Gaza, there was a widespread argument about who is the victor in this war in which both sides suffered losses. However, the Palestinians found that their struggle and immovability is their victory. On the other hand, Israel found that the Palestinian losses- which was much more than losses on the Israeli side- is their sign of victory. Despite that peace is the main and mutual demand for both sides, it is important to find out what is behind the reactions from both communities. Consequently, how can the human practices and reactions of resistance face the military force in the space of conflict?

The violent act was done by the military forces has provoked the Palestinians. Thus, the investigated phenomena were the outcomes. These reactions were completely humanitarian due to their weak and undefended position compared to full armed forces.

As a Palestinian who has experienced the crisis in Gaza, and because of being a part of the targeted environment, my experiment has enriched the core of the research, and assisted in analyzing and linking events in sequence. As well as providing me with the ability to design a fully integrated scenario of display that demonstrate the journey of community suffering in the war, included by several phenomena that the Gazans involved in .

Among this investigation, I have realized that the analysis of these phenomena shows the power and elements of human struggle and resistance which is not less important than other means of power. It is a legal, inherent, and human power in any political conflict. However, the political conditions and attitudes cannot be read in isolation from the environment of conflict. Simply because the built environment is considered as the theatre of crisis. As shown in the analyzed phenomena, the built environment has become a part of the struggling power. Thus, the architecture and space together with the community behavior forms a one unit that affect the conflict course.

To conclude, the community and human behavior towards architecture and built environment is very important, hoping this phenomena of investigations raised architect's awareness and interest of the important and community behavior impact of architecture in communities during crises.

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# Aspect of Modelling to Enhance Thermal Comfort, Using Computational Fluid Dynamic (CFD) for Indoor Thermal Comfort in a Tropical Climate

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**Abstract** This paper is a study on the indoor thermal comfort level of hostel occupants in USM Penang, Malaysia. In order to predict the thermal comfort of building occupants, it was necessary to simulate thermal performances of the building(s) and to recognize other options for achieving improved indoor thermal environments. The Computational Fluid Dynamic (CFD) FloVent building performance numerical simulation software was applied to analyse and predict thermal comfort in non-air conditioned rooms in USM Penang. The application of this software also determined air velocities and the temperature performance index. Indoor air flow via distribution devices and thermal sources inside the building was induced by CFD and the same is illustrated by the capability of this technique. It was discovered that systems using wind catchers on roof tops offer the best indoor thermal performance. Measured values of temperature and air velocity for typical days were checked to validate simulation results and both showed reasonable agreement with each other. Adjustments to real buildings from the findings of the CFD analysis will definitely improve the indoor thermal comfort performance of hostel buildings. Indoor thermal comfort in Penang is strongly affected by the outdoor climate as the island is located in a hot and humid region. Quality indoor thermal comfort is of the utmost importance to building occupants as health and productivity of the latter will be affected otherwise. To achieve thermal comfort, building occupants should comply with this study's recommendations and building architects should note issues of concern regarding thermal comfort in their design(s).

**Keywords:** Temperature . Airflow. Numerical simulation. Thermal comfort.

## 1.0 Introduction

The importance of thermal environments related to building occupants has gained such world-wide recognition that it has initiated many comfort studies in various parts of the world with different climatic zones and geographical locations. ASHRAE research projects (ASHRAE,55-1992 and 55-2004) have shown that thermal dissatisfaction is expected due to the varying personalities and behaviour of building occupants and the difficulty in maintaining comfort conditions at all times. In Malaysia, thermal comfort studies have been carried out by (ISO 1994) (Daghigh .et al 2009). (Dahlan, et al 2008, 2009)

Penang, the "Pearl of the Orient" in Malaysia, experiences a warm and sunny climate in a country that is hot and humid. It is situated between 1° and 7° N and 100° and 120° E. The island is affected by the wet and dry monsoons. The primary weather forecast facility for northern Peninsular Malaysia is the Bayan Lepas Regional Meteorological Office which records daily temperatures of between 29 °C - 34 °C and nightly temperatures of between 22 °C – 24 °C with a relative humidity of between 70% - 90% throughout the year (MMS, 2017).

Comfortable and healthy microclimate conditions are necessary for any type of environment but hostel buildings in particular must have a high level of environmental quality which will contribute to building occupants' wellbeing, concentration and performance (Clements-Croom, , et al 2000).

Lately, studies using high performance computer aided systems are more pronounced (Alamdari,. 1994), and in the last two decades, micro climate models using Computational Fluid Dyanmics (CFD) software were used as an efficient tool for air movement and thermal

comfort, especially in the study of air flow. (Alamdari, 2017). Currently, comfort zones recommended in ASHRAE Standard 55 and ISO 7730, are widely applied as a criterion for the measurement of thermal comfort. Field examination is essential for the construction of thermal comfort standards in local areas since thermal comfort requirements vary with geographical and ethical differences. Assessment of air exchange rates and effectiveness in the air distribution system is crucial in determining how well the air is circulated indoors. CFD simulations can contribute to a successful building design, along with validation of thermal comfort reached using Fanger's indices (PPD and PMV). (R. Cocci Grifoni,et al. 2017). control air fluxes triggered by the building, generally being careful to avoid significant turbulence that could worsen living comfort. (R. Cocci Grifoni, et al 2013). evaluation should also investigate the sensible and latent heat fluxes. (Matthias Roth, et al 2017).

## 2.0 Methodology

### 2.1 Object of the study

The aim of this study was to investigate the thermal environmental quality in USM hostel accommodations.

### 2.2Computational Fluid Dynamic (CFD) Simulation

**Overview of the Simulation Software.**

To ensure the credibility of the principal data gathered for this study, instruments and equipment used in the research were meticulously and carefully placed in all parts of the field work to collect or read environmental data at the appropriate sites as required. Then in the next phase, data collected previously from the field study were used in a chosen building model for the preparation of a real case study using the FloVent 9.1 simulation program. The resulting information was subsequently calibrated using different models at different times together with the assaying and testing of resources, directions, louver and ventilation. The basic case model was essential to acquire a superior quality of correct strategies to be applied in the later stage of the study which would successfully achieve thermal comfort for the occupants if said correct strategies were adopted by building designers.

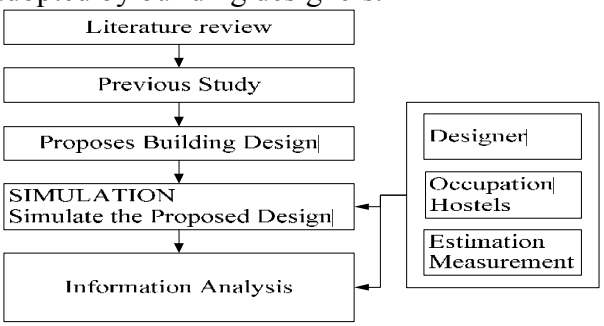


Fig 1. Analysis of design tools

Fig 1. Illustrates an analysis of substitute design tools involved in overcoming the problem of thermal comfort distress via simulation and information analysis.

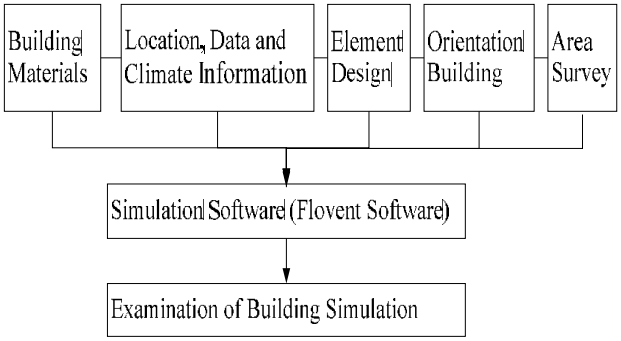


Fig 2. Alternative design tools

Fig 2. Illustration shows alternative design tools encompassing substitute ventilation control strategies used in the estimation model as per recommended general design guidance regarding thermal mass and insulation, temperature, solar radiation, relative humidity and natural ventilation which had been proposed to achieve maximum thermal comfort.

### 2.3 Simulation Using FloVent V 9.1 Software

The test building geometry was drawn by the FloVent V 9.1 software using the primary building information taken from earlier field studies and measurements which included climatic data, material properties, building orientation, location criteria, mechanical system and thermal comfort calibration.

The FloVent V 9.1 software was selected for its capability to simulate external heat transfers and airflow movements inside the building. All climatic factors and thermal comfort criteria have been meticulously considered in this study. Actual findings from collective field measurements in the earlier phase were subsequently compared to the simulation results obtained from the FloVent V 9.1 software.

Indoor simulation of the test model was tested for compatibility with actual indoor temperature of the real buildings in the area surveyed. Simulated test results were assessed against existing real conditions.

## 3.0Results and Discussions

In this section, we see the most crucial findings of the simulation study which shows the impact of climatic factors on indoor thermal performance and how this affects the occupants' thermal comfort. The transient building thermal unit forecast room air and surface temperature including internal air flow movements.

### 3.1 Case Study - DESASISWA RESTU

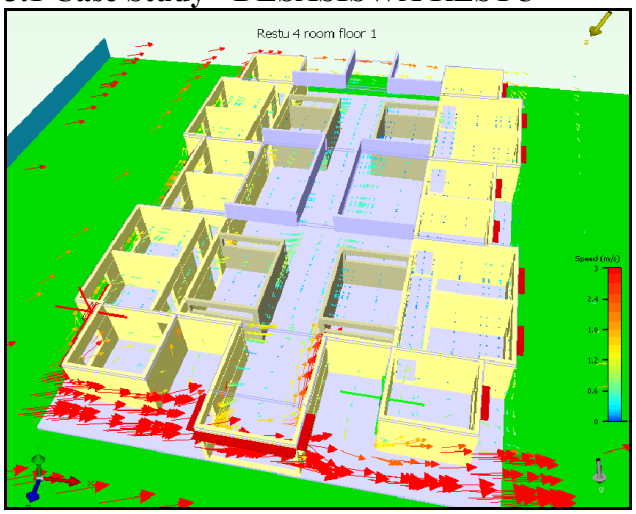


Fig 3. Case study - indoor and outdoor wind direction and speed, RESTU wing.

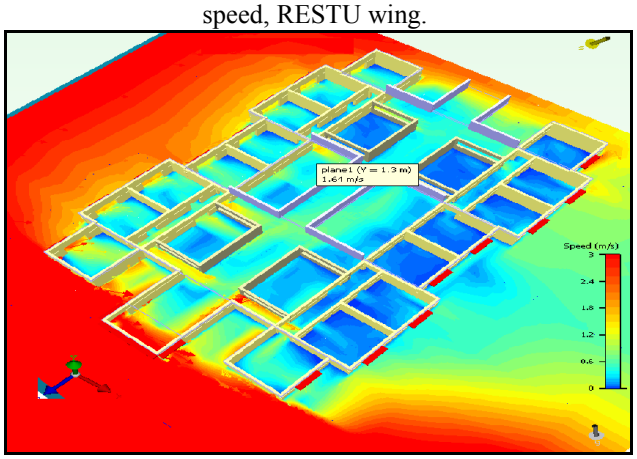


Fig 4. Case study - indoor and outdoor airflow speed, RESTU wing.

In Figures 3 and 4, the airflow movement for Restu Wing was good in the rooms facing the wind direction with speed ranging from 0.6 to1.1 m/s but weak in the room on the opposite side at 0.1 to 0.3 m/s with 0.7 to 1.5 m/s in the internal open area. While the outdoor airflow movement it was 3m/s.

The secondary corridors inside the building allowed good ventilation with airflow speed ranging from 0.8 to 1.6 m/s. However the distribution of airflow to the rooms on the other side of the wing was blocked by the common washrooms. The rooms cannot benefit from the airflow coming from the internal open areas as they are blocked by walls which do not have any vents leading to the internal open areas. The main and secondary corridors have excellent ventilation because they have access to airflow from the internal open areas but the airflow from here cannot enter the rooms on the other side as there are no existing openings or vents. The windows, internal open areas and corridors help to improve the airflow circulation inside the building but obviously, good airflow needs open areas to circulate freely. It is recommended that better airflow currents should be created inside the building as this will improve airflow circulation and enhance the thermal comfort of the occupants.

### 3.2 RESTU Room - Test for Thermal Comfort

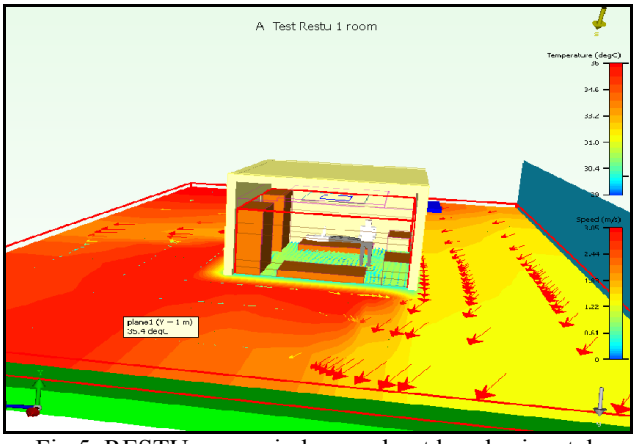


Fig 5. RESTU room - indoor and outdoor horizontal airflow speed and air temperature.

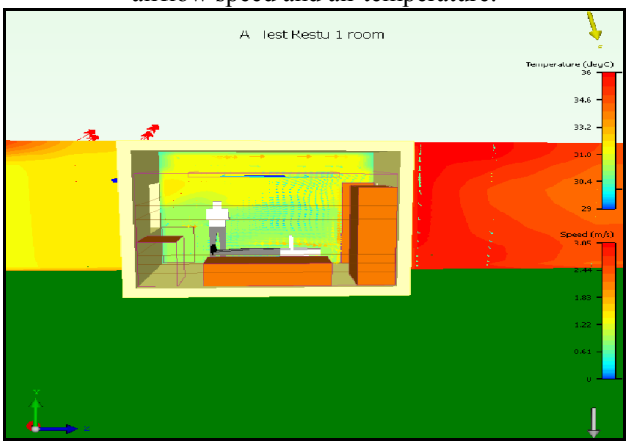


Fig 6. RESTU room - indoor and outdoor vertical airflow speed and air temperature.

In Figures 5 and 6, the vertical external and internal air temperatures for Restu rooms were 34°C and 29.9°C respectively. Air temperature at ceiling level was higher than that at floor level which was 31.2°C and 29.9°C respectively with a difference of 1.3°C. External airflow speed was 3m/s and 0.5 to0.9 m/s inside the building.

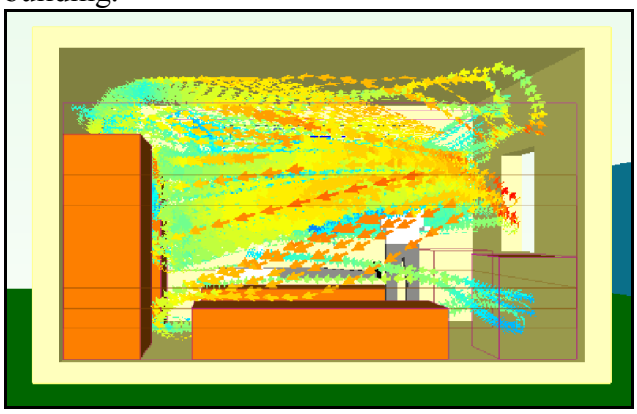

Fig 7. RESTU room - airflow speed by the usage of fan inside the room.

Airflow movement assisted by the fan turned on in the room and how this improves the airflow circulation and the thermal comfort of the occupant by increasing airflow speed is shown in Figure 7.

### 3.3 RESTU Room – Additional Tests for Improve Air Flow Movement.

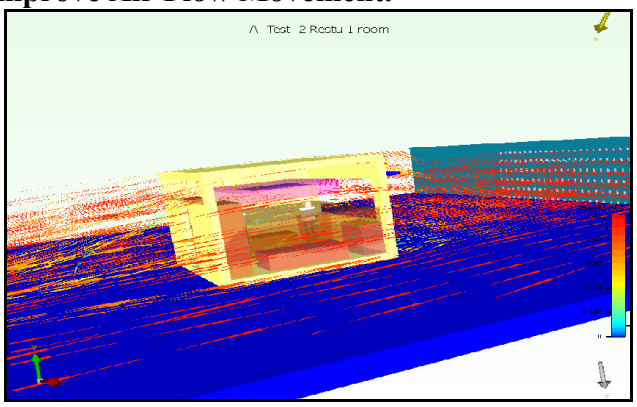


Fig 8. RESTU room - airflow moving towards and through room.

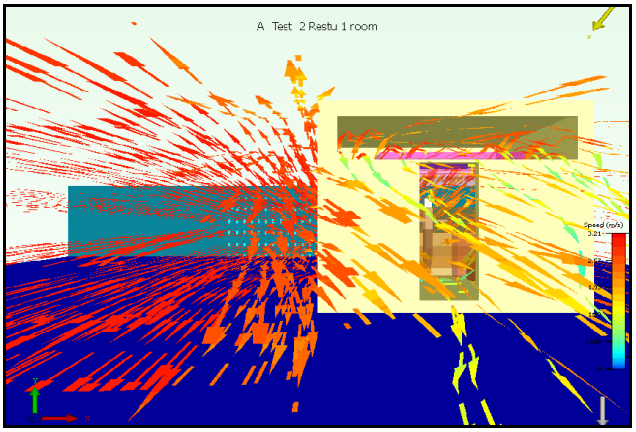


Fig 9. RESTU room - airflow leaving room via additional window.

Figure 8 and 9 present the sample room with experimental changes made to the actual room. The window facing the wind orientation was made wider and a new window was added near to the door. With these experimental changes, the simulation gave better results than previously. The wider window easily allowed more airflow into the room and it was found that airflow circulation was vastly improved inside the room. Hot airflow was easily dispelled allowing for continuous fresh airflow in the room. External airflow speed was 3m/s when indoor airflow was between 1.2 m/s to 1.9 m/s which meant that airflow movement improved by 0.6 m/s compared to actual readings.

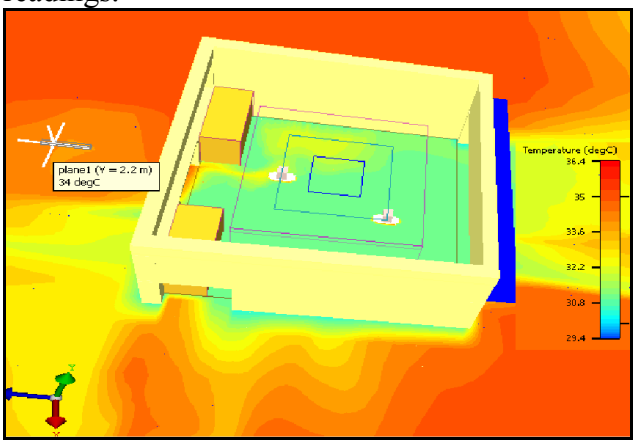


Fig 10. RESTU room - air temperature inside and outside of the room

Figure 10 illustrates air temperature inside and outside of the room after experimental changes to the actual room were made. The external air temperature was 34°C while the internal room air temperature at ceiling level was 31.3°C and that at ground level was 30 °C. This was a difference of 0.1°C compared to actual readings with improved airflow speed of 0.6 m/s.

### 3.4 Creating New Elements for the Building (Wind Catchers).

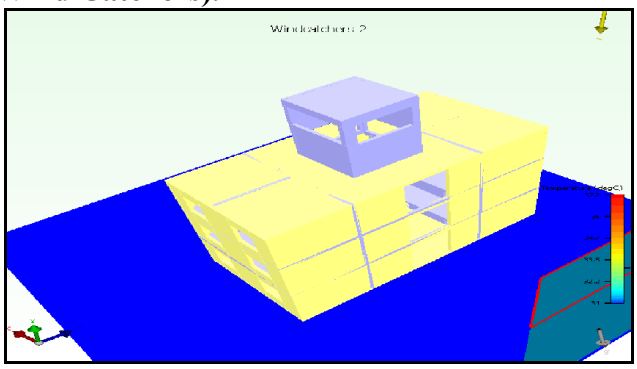

Fig 11. Wind catcher fixed on the building

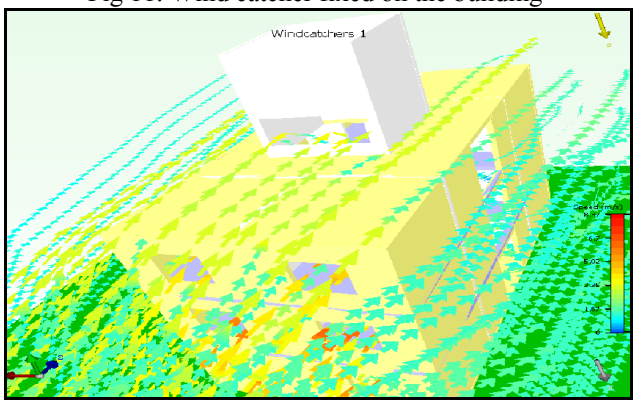


Fig 12. Airflow passes through wind catcher

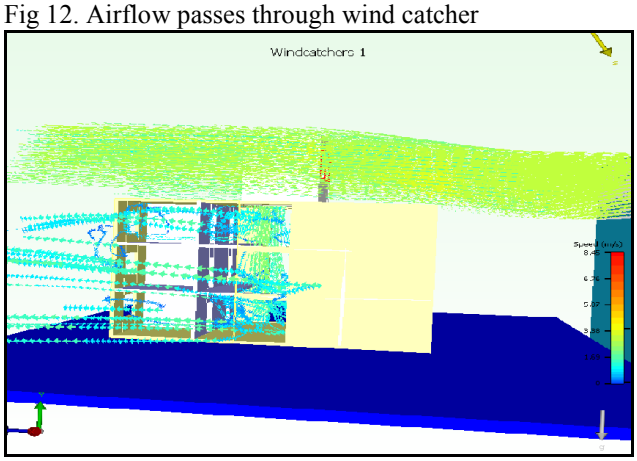


Fig 13. Airflow passes through wind catcher to internal open areas and rooms

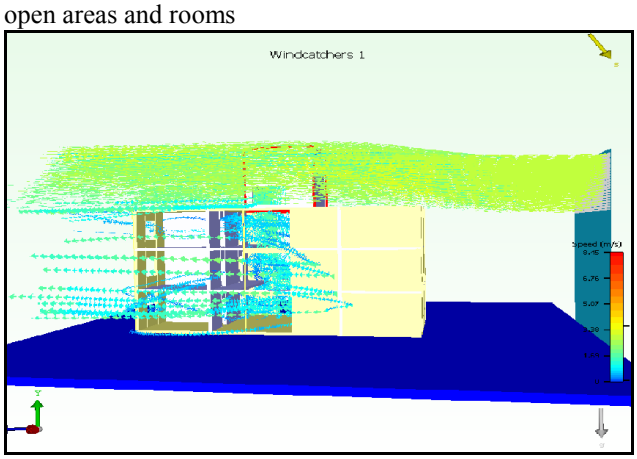


Fig 14. Airflow passes through wind catcher from four sides

In this test, a new element called the Wind Catcher was added to the building. The average wind speed in Penang is 3 m/s from 202.5° SSW and 22.5° NNE. The wind orientation during the daytime is always changing. The Wind Catcher which is fixed on the roof of the building has the advantage of catching wind from all its four sides and then sending the airflow into the building which can then circulate inside the building. The Wind Catcher is not affected by any obstacles around the building as its high location on top of the building is free of any obstructions.

Figure 12 shows the Wind Catcher fixed on top of the building with vents on all four sides to catch airflow from any direction and a reflecting wall shaft to force the airflow to go into the building

Figure 13 shows airflow passing through the Wind Catcher. Figure 14 illustrates airflow passing through the Wind Catcher into the building.

The test using the Wind Catcher showed enhanced airflow movement into the building. Here the outdoor airflow speed was noted at 3 m/s and internal airflow speed was between 1.9 and 2.1 m/s while that in the room was between 1.3 to 1.9 m/s. This indicated that there was 1 m/s improvement of airflow inside the open area, 0.9 m/s in the corridor and 0.7 m/s inside the room.

To improve the function of the Wind Catcher, plants can be hung on the inside walls of the ventilation shaft and a sensor operated electric fan fixed under the roof of the Wind Catcher. The sensor will start the fan when there is no outdoor airflow movement. Vapour moisture from the fan and the plants will contribute to reduce air temperature while the fan will increase air movement when the external airflow movement is weak.

## 4.0 Conclusion

The purpose of this work was to learn how climatic factors such as air temperature, solar radiation and airflow movements including the varying sizes of windows, vents or other openings affect indoor thermal comfort performance, whether directly or indirectly.

Findings from the results of the application of a new strategy in installing a wind catcher on the rooftops showed an improved indoor air flow

circulation as the wind catcher has the advantage of catching wind from all directions the entire time and passing the wind down into the building and rooms.

Actual field measurements of all test hostels were compared to simulated ones using the Computational Fluid Dynamic (CFD) Software FloVent V 9. In the simulated tests , when additional changes such as widening of window openings, additional window openings next to room doors and wind catchers were fixed on top of the base model unit, the findings showed vast improvement to the indoor thermal comfort of hostel occupants.

The purpose of the simulation tests was to attempt to propose the best orientation for new buildings in USM. Hence each test hostels were tested separately and it was noted that the additional changes made in the simulation tests had excellent positive results compared to actual field measurements. The simulation tests were conducted at 2.00 pm when the outdoor air temperature was 34°C.

The test results derived from the simulation tests using FloVent 9.1 are as follows:

- Heat and air temperature inside the room increases when external heat is absorbed through the walls facing the solar radiation.
- The rooms not facing the airflow has poor ventilation compared to the rooms facing the airflow.
- Main and secondary corridors inside the building contribute to improved airflow.
- Open areas indoors help to increase airflow.
- The internal open areas of the building acts as an escape for hot air.
- The upper floor rooms tends to be hotter as heat is absorbed through the building roof.
- One way of protecting the room from direct solar rays is by the installation of window overhangs which help to reflect heat away from the room.
- Of the different building designs, linear buildings offers the best ventilation and airflow circulation.
- The installation of a Wind Catcher on the roofs of buildings will draw airflow from the outside and enhance thermal comfort satisfaction inside the building and rooms.

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# Changing in Land Use and Land Cover in Non-Urbanized Areas"Dir-Al Balah as a Case Study"

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**Abstract:** Like all natural ecosystems, Non-urbanized areas NUAs today are endangered by urban sprawl. The protection of these areas is a fundamental issue for land-use planning and requires appropriate strategies for their management.
The study proposed a land-use suitability strategy based on a comparative analysis. The study addressed the changing in land use and land cover in non-urbanized areas in Gaza strip between 2008 and 2014 planning schemes. The results from these analyses are integrated in a land-use suitability matrix, which produced output of a new scenario of prospective land-uses for NUAs. The method is tested on Dir-AlBalah municipality within the middle Governorate area (Gaza Strip), characterized by a considerable urban sprawl. The study region (Dir Al Balah) was selected because it is located in one of the most agriculture regions at Gaza strip.
The study proposed recommendations for future strategy to change the use of some green areas compatible with the regional plan 2005-2015. The resulting scenario allowed to enhance the production of ecosystem services and define new appropriate land-uses for NUAs within the agricultural and green infrastructure.

**Keywords**
Non-urbanized areas (NUA), Land Use & Land Cover change (LULCC), Land-use suitability strategy, The regional plan, Gaza strip

**1.INTRODUCTION** Non-urbanized areas (NUAs) are a part of the agriculture and green infrastructure that produce ecosystem services. They are outdoor places with significant amounts of vegetation (Rosa, Privitera, 2013). Land-use and land-cover change (LULCC), also known as land change, is a general term for the human modification of earth's terrestrial surface (Ellis , 2013). As population increases and searches for more productive land, keeps changing the land use and hence the land cover (Evrendilek, 2004). Which means that there is a strong relationship between the increased built area and the population increase which is affected by land nature and its soil type.
LULCC are important indicators of how humans interact with their environment and how they can affect it. They drive of humans to exploit the land use, for survival, socioeconomic or political purposes affects the physical structure and surface features of land (Abudagga, 2015). These changes encompass the greatest environmental concerns of human populations today, including climate change, biodiversity loss and the pollution of water, soils and air (Ellis ,2013).
Local planning agencies make use of detailed information generated during ground surveys involving enumeration and observation. Interpretation of large-scale aerial photographs (Anderson, Hardy, Roach and Witmer, 2001). Plans designed for the management of development responding to the changes of the urban development process, and absorbed within the proposals strategic and regulatory. From this perspective it has to be to provide a flexible and clear strategy for implementing the scheme proposals land use in harmony with the Strategic Framework and elements of the main requirements which includes the general structural plan, and local master plans, and urban policy (PCBS, 2014).
The Gaza Strip is one of the most areas in the world that needs to apply the concepts of sustainability and sustainable design, because of the suffering of the growing and highly populated areas with limited space and lack of natural resources and wealth. Also it's clear that the traditional planning failed to solve the environmental and economical issues in Gaza Strip.
Urban sprawl has become a phenomenon on agricultural lands, especially in the Gaza Strip, due to the steady increase in population and the consequent pressure on natural resources. Account of this phenomenon lead to the development of the neighboring large cities and rural areas gradually

increasing population density (AlFarra, 2012). The extension of new urban communities in the Gaza Strip created in areas contrary to the orientations of regional plan, which based on several scenarios for the process of urban development and the principle of the two central cities. The hierarchy is eastward of the Strip that led to the emergence of informal settlements and encroaching on green areas and nature reserves (Al Farra, 2012)

Muhaisen, 2013, at his study impact of Liberated Areas in the Gaza Strip on Land Use Arrangement, addressed recommendations for planning specialists in governmental and civil organizations, to stop current use and adopt concepts of regional planning through finding a mechanism for urban expansion of the city toward the east, and to avoid problems and hindrances existed in the city within a sound development frame. Plus, the necessity that such expansions should have a solid economic feature creates real job opportunities (Muhaisen, 2013).

At Gaza strip, the LULC changes over the last 10 years has been decreased the area of agricultural lands and increase the built area. The current interim and temporary stage that the Palestinian society passes through, particularly after signing the 2009 and 2014 Israeli war on Gaza, which resulted destruction of houses and infrastructure that have imposed a new situation and put various challenges in front of the Palestinian planning institutions (specially on the local level) and prevented the possibility of providing and implementing the attained physical planning. (Gaza Urban Profile, 2014)

The demand for standardized or strategies land use and land cover data can only increase as we seek to assess and manage areas for environmental control.

## 2.THE RESEARCH PROBLEM AND ITS LIMITATIONS:

Urban growth process At Gaza strip is irregular. It is observed variation in the urbanized land area during the period 2004 -2007 comparing to 1998 where it was 1504.6 km2. The urbanized area in 2006 fell by 23.1 km2, while it increased during the year 2008 to 8.3 km2 compared to 1998 (Arij,2014). The agriculture land area 2011 decreased 30 km2 through 10 years (IUG paper, 2014).

There are many different sources of information on existing land use and land cover. Unfortunately, there are some difficulties about collecting information for Gaza strip. They need up-to-date change information to effectively manage the land such as:

1. For many years, agencies at the various governmental levels have been collecting data about land, but for the most part they have worked independently and without coordination.
2. It has been found that data collected for a specific purpose were of little or no value for a similar purpose only a short time later (Anderson, Hardy, Roach and Witmer, 2001), sometimes are different values.
3. The researcher meets lack of access to satellite images of accurate of the Gaza Strip because of Israeli restrictions.
4. There is limited quantification and identification studies of ( LULC) changes of the study region.

## 3.THE OBJECTIVE

The study proposed a scenario for (LULC) suitability that aims to remain the ratio of green areas with a proposed scenario that is consistent within the regional plan 2005-2016 for Gaza strip.

The following specific objectives will be pursued in order to achieve the aim above mentioned:

a. The study use the satellite map and some other studies & references on sign the changing area, to produce the Land Use/Land Cover (LULC) maps of Gaza Strip at the year of 2008 and 2014.
b. A descriptive analysis approach discuss the effective points and reasons of (LULC) changing like population increase density and urban sprawl.

the possibility of changing the use of some green areas for the purposes of service-population such as playing areas, urban gardens, or the nature reserves might even be applied on the case study the Deir Al-Balah city in order to agricultural nature reserve.

## 4.THE METHODOLOGY:DATA ROCESSING

This study is a comparative analysis of the current situation plans of the land-use and land- cover (LULCC) changes of the Gaza Strip at year 2008 and 2014 with a view to the urban development. The following set the methodology steps:

**1. Land use and cover:**

a. A descriptive analysis of a regional plan 2005-2015 which has been developed by government and non-governmental organizations (NGOs) planning specialist in Palestine. This plan considered as a scale to make the comparison between the rates of urban extension on green spaces.
b. The existing maps will interpret the changes of urban areas and settlements on agricultural land and green areas during this period

**2. Comparative analysis between the status quo of the land use of the Gaza Strip in 2008 and 2014 plan:**

- Identify the urbanized and non-urbanized area.

- Identify green land and land cover areas at 2008 by the Ministry of Local Government and aerial photo plot to the Gaza Strip in 2014 approved by the authority of the land in Gaza

**3. Land use suitability matrix :**

Set the suitable of land for specific use appropriate with land use. **Case Study of Dir al-Balah** is a descriptive analysis of land use for the city and determine the green areas and aerial photo in 2014 and then test the proposed scenario to determine the useful usage of green spaces as playgrounds or public gardens and others in order to achieve sustainability.

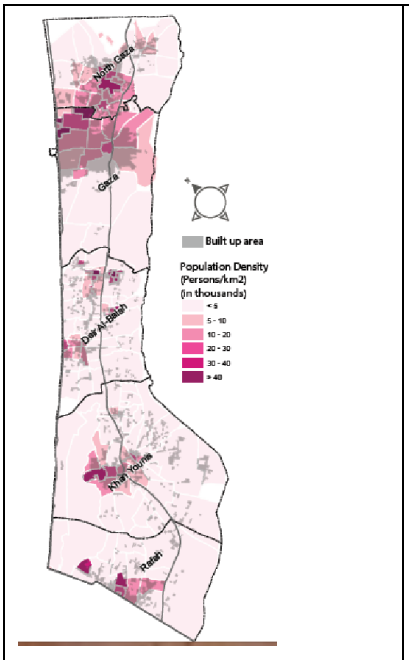
**5.GAZA STRIP:**

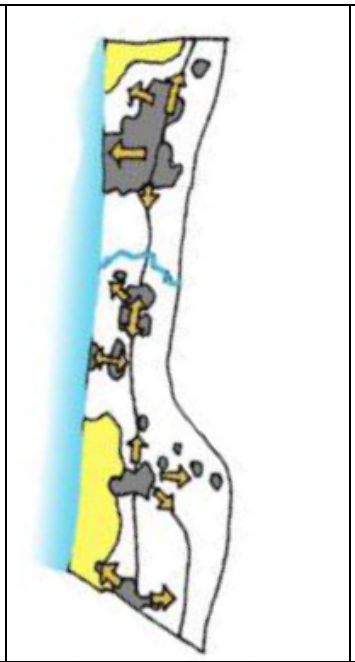
**a.General Description and population:**

Gaza strip is on the eastern coast of the Mediterranean Sea of Palestine with a total area of 360 km2. It is already a small territory which has been further reduced by the buffer zone from Israel. The no-go zone was establish with a width ranging from 2-3 km (GNRD, 2011). The inside of the Gaza Strip is progressively turning into one big, densely-populated urban zone in comparison to other geographical areas.

The total population of Gaza strip was 1.8 million at 2014, and its population growth rates is standing at 3.48%. The Palestinian Central Bureau of Statistics projects has account the population of Gaza will reach 2.13 million by 2020. The number of housing units in the Gaza Strip in 2013 was estimated to 292,000 units and was expected to increase to 333,000 units in 2017 (IUG paper, 2014) with growth rate about 14%.

The Palestinian Authority completed the Gaza Regional Plan in early 1998 in cooperation with other Palestinian National Authority ministries and institutions. The main objective of this effort was the development of a strategic plan for the use of land the conservation of natural resources and protection on the environment with the framework of a comprehensive development framework. The Plan was amended in 2005 in light of political developments, including the Israeli Withdrawal from the Gaza Strip, and the resultant changes wrought upon the land (PECDAR, 2009)



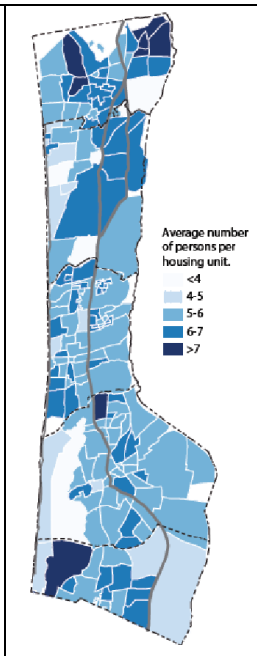



Figure 1: Population Density and The urban extension at Gaza strip (PMOP)
Source: Gaza Urban Profile.(2014)

Figure 2: Housing Statistics Based on PCBS data from the 2007 census (Overcrowding and Tenure) Source: Gaza Urban Profile.(2014)

The map shows that the most dense areas in Gaza are Refugee Camps with densities that exceed 40,000 per ons /km2, followed by the main cities of Gaza, Jabalya, Deir Al Balah, Khan Younis and Rafah Governorates with densities that range between 20,000 to 40,000 persons /Km2

Representing the signs of lack of housing sector balance notably (PCBS, 2014) :

1. The number of families to spending on housing expense of basic needs (22.7% at 2005 to 20.7% at 2007), or to meet the housing need of assault on the lands of others and the establishment of their homes,
2. Rigidity of residential mobility and the direction of many families to accommodation in overcrowded housing.
3. The trend towards vertical or horizontal raise with contrary to the construction regulations

**b.Agriculture and land cover:**

The central agricultural zone of Gaza attracted inhabitants in the past and became the focus for the main mobility routes and it forms the urban backbone of the strip. Gaza Strip is covered by 45% buildings and roads, in 2011 amounted to 88.46 km2, while 42% is agricultural land, bare land (12%) is found mainly in the access-restricted area along the border. The bulldozed agricultural areas about area 63.24 km2. Data discrepancies occur for the abandoned settlement area in Khan Yunis and Rafah. (UN .Habitat December,2014). There is obvious for The Agricultural transformation to urban space within 10 years was about 30 km2.

A total of 46% of agricultural land in Gaza is inaccessible or unusable due to destruction of land during "Operation Cast Lead" and by the "security buffer zone" along Gaza's northern and eastern borders with Israel (Anera, 2005), The buffer zone are unknown and at times extend up to 1.5 kilometers inside the Gaza Strip, which is only 5-12 kilometers wide (GNRD, 2011). Overall, the land restricted area is estimated at 3.4% of Gaza Strip's total land mass, 95% of them are agricultural land and 5% are agricultural roads (Ellis, 2013).

**6.LAND USE AND LAND COVER ANALYSIS:**

Agricultural areas at Gaza strip regional planning classified into agricultural land areas (high-value and medium value), and areas of natural landscape (NSP, 2011). According to this map, the majority of land in Gaza is privately owned (63%). Around 2% of the land is classified as Awaqf (properties donated for religious or charitable purposes). The remaining 35 % are public lands (UN .Habitat, 2014). Agriculture is one of the most affected sectors of the long siege in Gaza; the 35% of Gaza's arable land is not accessible.

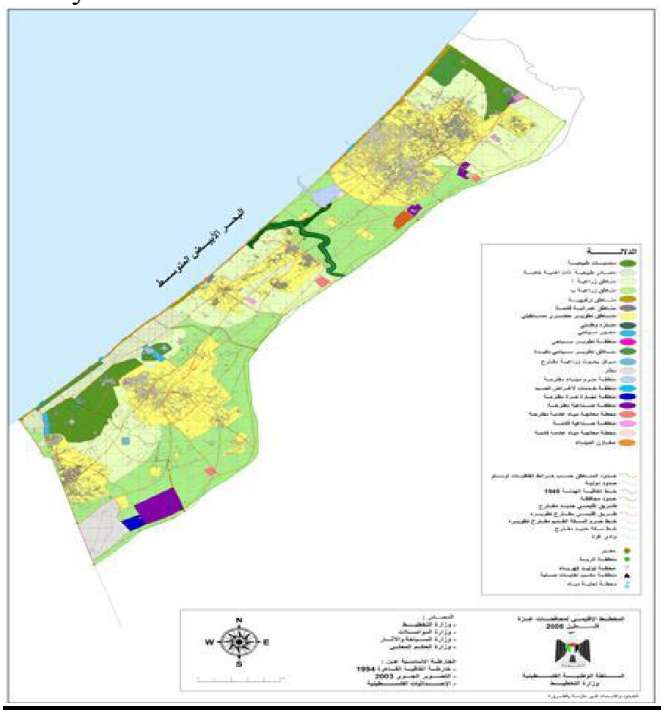


Figure 3: The regional plan Land use Gaza Strip 2005-2015 :(2014) وزارة التخطيطSource

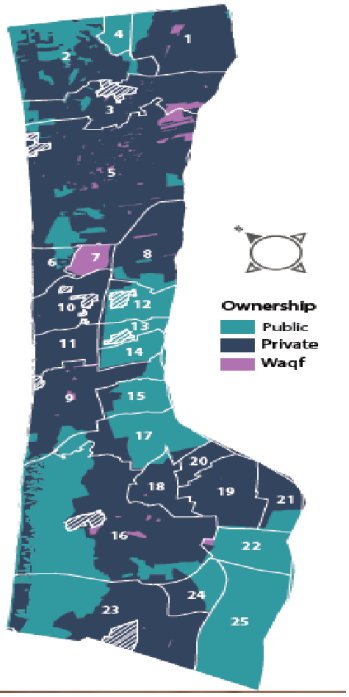



Figure 4: Map of municipalities and land ownership, based on data from the M Planning (MOPAD) Source: Gaza Profile.(2014)

Notes that increasing of urbanized areas about (12%) that causes urban expansion and urban sprawl on non-urbanized. Table (1) refers to LULC changing at 2008 and 2014. The built area at 2008 was 33% (camps and urban areas), non-urbanized area 53%.

Table (1) the land use areas at Gaza strip 2008 and 2014 (UN .Habitat & MOLG, 2014)

| Land use | 2008 | 2014 | Increased ratio |
|---|---|---|---|
| Urbanized areas | 33% | 45% | +12% |
| Non-urbanized | 53% | 42% | -11% |
| Others (airport, industrial areas, tourists, shore, railway, roads, ..etc) | 12% | 13% | +1% |

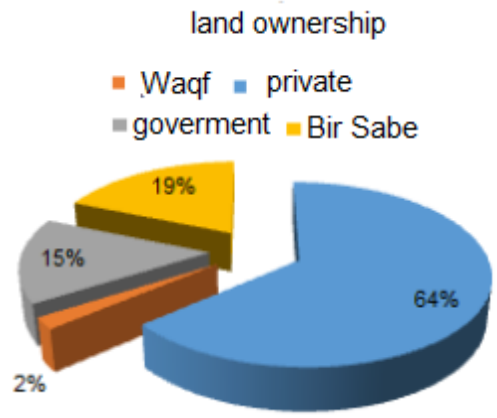



Figure 6: the land ownership 2007

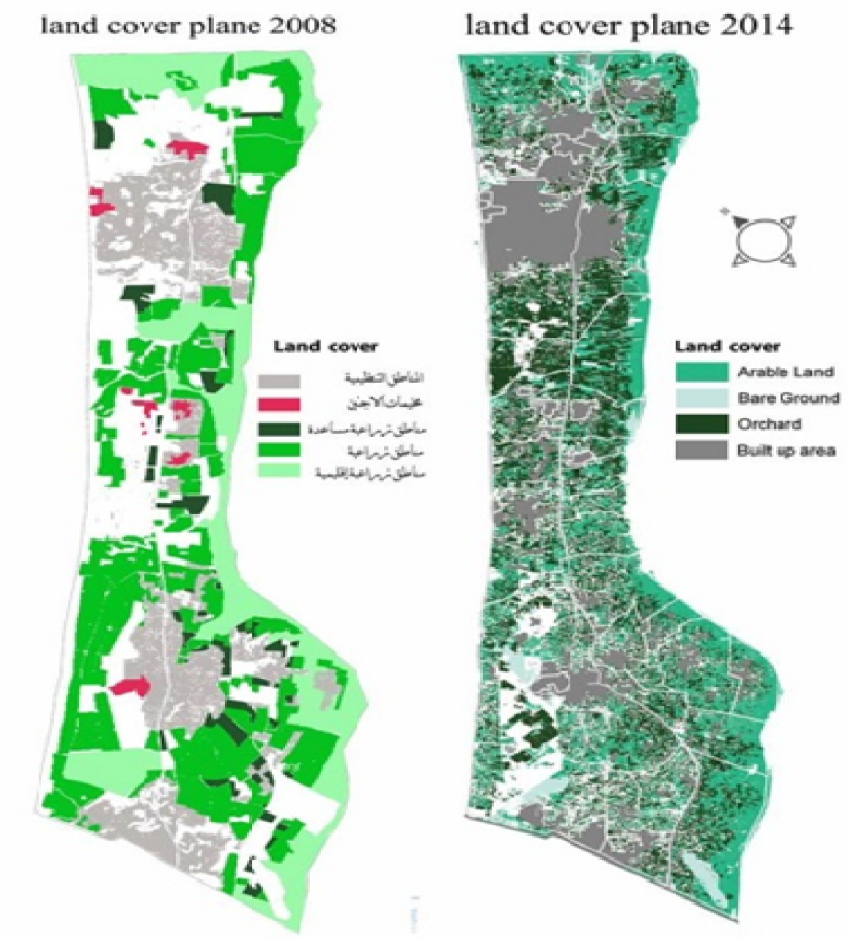



Figure 7: The land cover of Gaza strip 2008 2014 Source: Gaza Urban Profile.(2014)

The maps show that the cities of the Gaza Strip grew randomly without planning thus at the expense of green areas:

a. The high population density and scarcity of lands, where the population is large for an area of the land or the possibility exists to expand reasonable to accommodate the increase in population. So that the cities of the Gaza Strip grew randomly without planning and growth and thus at the expense of green lands areas a year.

b. Most of lands are privately (ownership lands) about 64% , therefore is considered one of the most important reasons for lack of development of green areas within the urban environment of the Strip, fig (6 ).

c. most governmental lands located outside the population centers, which makes it difficult at the same time on the central official authorities and local allocation of land to carry out public projects and task, such as commends public buildings, parks and places of entertainment, building schools, health services, etc.

Factor effects of urban expansion on agricultural land:

–on agricultural expanding vertically

–urbanization in the land is arable, according to the regional plan 2005-2020.

–limit given to build land used in agriculture permits.

–Encourage farmers in farm work and not to neglect agricultural land

## 7.LAND USE SUITABILITY MATRIX :

The matrix proposed a scenario for land use and land cover changing in non-urbanized area in the Gaza strip. It divided on two axis:

– Current land use consists of: Arable, Bare land, Farm land and growers Assistant.

– The Proposed land use consists of: Natural parks, Urban Agriculture, Urban parks and Playgrounds.

The resulting scenario allows to enhance the production of ecosystem services and create leisure activities areas, then define new appropriate land-uses for NUAs within the agricultural and green infrastructure. The method is tested on Dir-AlBalah municipality within the middle Governorate area (Gaza Strip), characterized by a considerable urban sprawl. The study region (Dir Al Balah) was selected because it is located in one of the most agriculture regions at Gaza strip.

Table (2) suitability matrix

| | | **Current land use** | | | |
|---|---|---|---|---|---|
| | land use and land cover | Arable | Bare land | Farm land | Growers Assistant |
| **Proposed land use** | Natural parks | N.C | | N.C | N.C |
| | Urban Agriculture | | | | |
| | Urban parks | N.C | | N.C | |
| | Playgrounds | N.C | | N.C | |
| Colored solid boxes indicate compatibility between prospective and current land-uses according to the supposed scenario purposes; N.C. indicates that prospective land-uses are not compatible with current ones. | | | | | |

**DEIR AL-BALAH AS A CASE STUDY:** Deir al-Balah located over 15300 km2 (PIWP, 2016), south of Gaza City. It is well known for growing date palms, an estimated 20,000 of which covered the landscape south and west of the city in the 1990s. but it reduced to 16,500 palms in 2003( Wikipedia, 1999). The built area considered as 48,30% of the total area that consist of between 7,000 to 8,000 dunams (7–8 km²). table ( 3 )

Table ( 3) the land use and land cover areas at Dir albalah

| Land use and land cover | Area km2 | Area % |
|---|---|---|
| Total city area | 15300 | 100% |
| Agriculture land | 7910 | 54% |
| Built area | 7,390 | 48,30% |
| 1.Residential area | | 35% |
| 2.Industrial | | 3% |
| 3.Tourist | | 5% |
| Note: The Agriculture land 7910 m2, we need to increase it to 11% to preserve per capita 1m2 for a person | | |

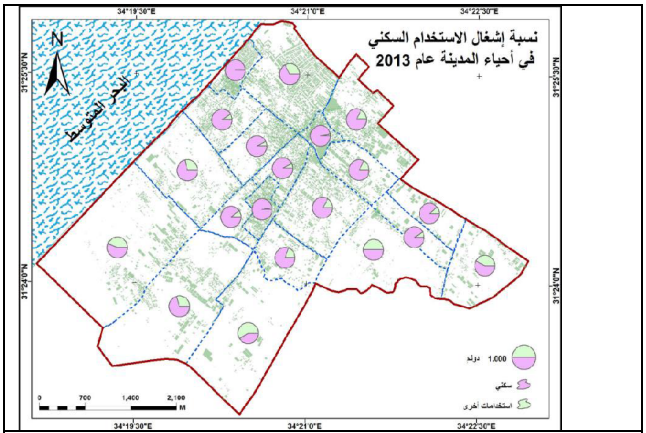



Figure 7: residential density at Dir al-Balah city at 2013. Source: Dirawi (2013)

The city had a population of 70,045 in 2015 stationed at the urban center. (Agenda, 2015)

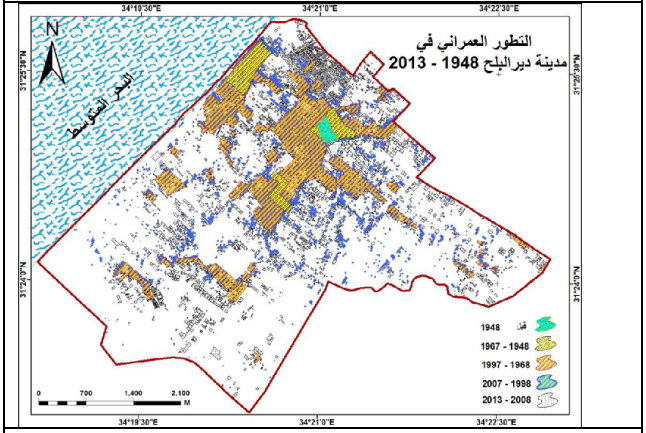



Figure 8: Urban development for Dir al-Balah city 1984-2013. Source: Dirawi (2013)

Private lands represent about 89% of the total area, therefore it is difficult of changing land use. Source: Gaza Urban Profile.(2014)

The study region has high proportion of agricultural land, about 20.59% of the total area, 6.21% agricultural assistance and 6.07% green yards. While the open areas and green spaces was 0.25 - 1.0 to 4.18 m2 per one (Dirawi, 2013).

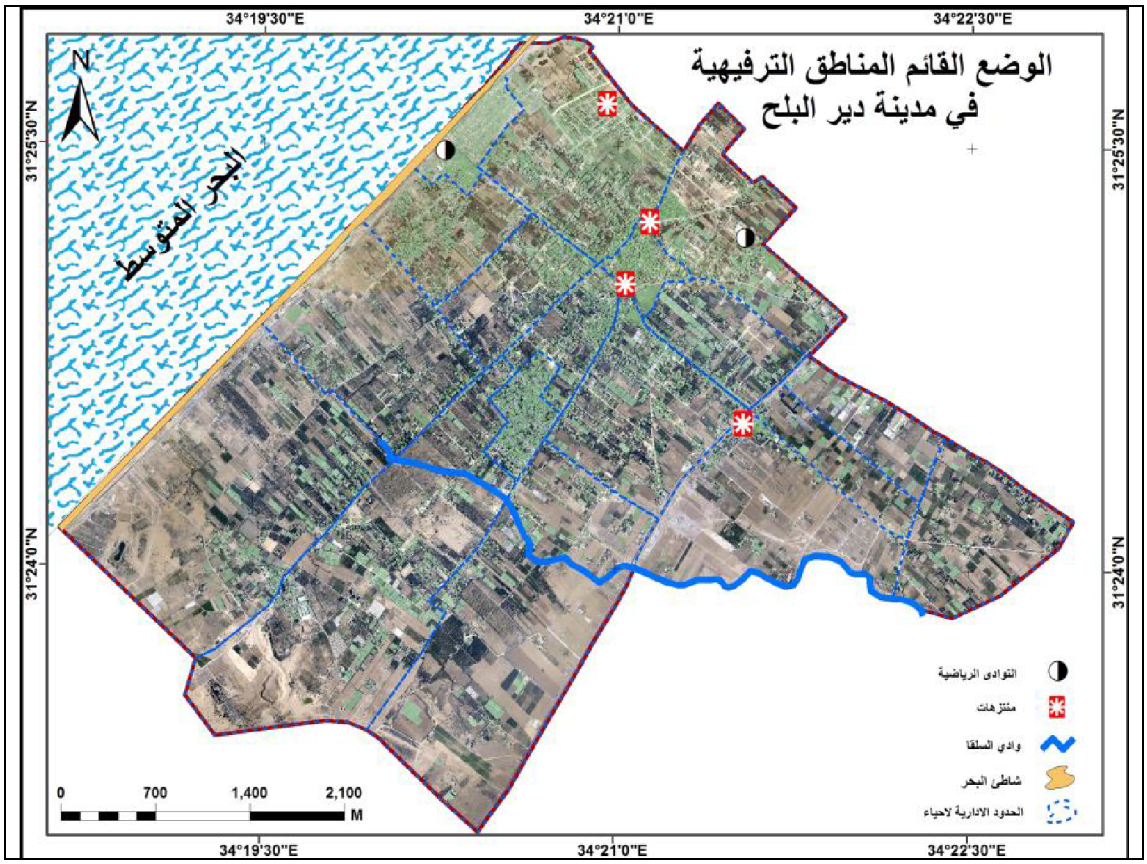



Figure 9: Private lands at Dir al Balah
Source: Dirawi (2013)

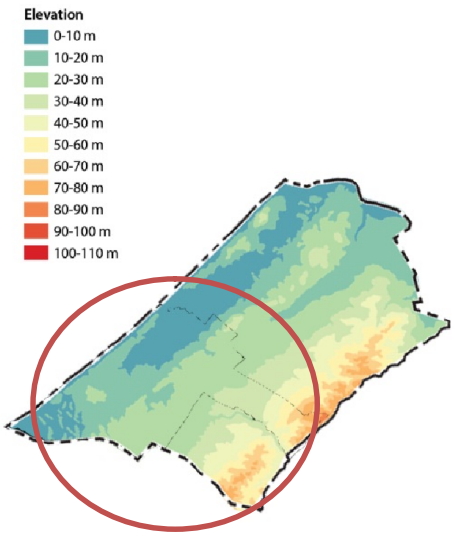



figure (10) The land elevation at Dir al Balah.
Source: Gaza Urban Profile.(2014)

The following figure (12) illustrates the proposed plan for Dir AL Balah. **The study supposed to reach the green land increasing area into 11%, we need to apply the following strategies :**

1. Transform some public ownership to public parks.
2. pull some private ownership for recreational purposes.
3. Preservation of agricultural areas and not to turn them into residential areas by restrict regulations.

pattern as revealed in this study provided a

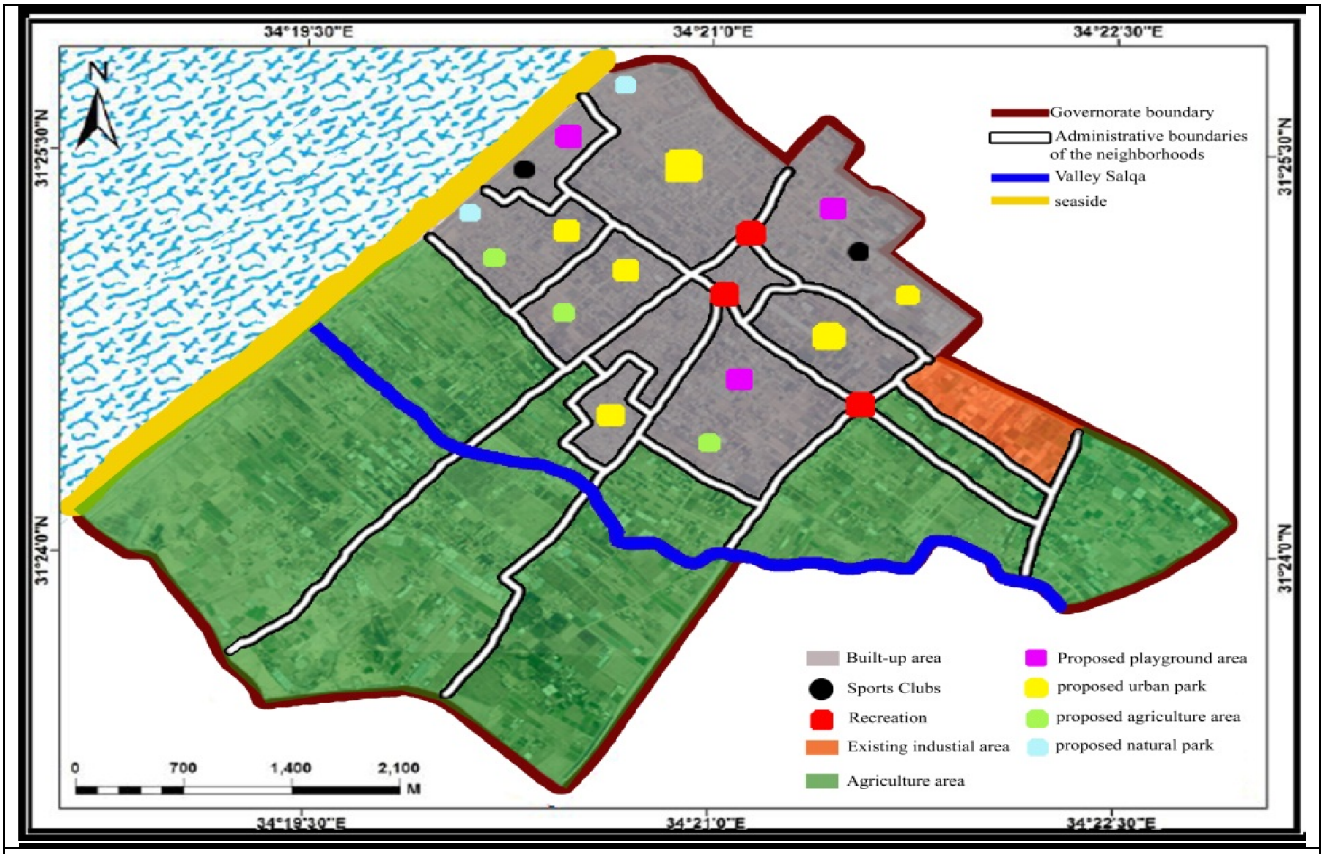



Figure (11) the proposed plan for Dir AL Balah

Notice that the green space areas on the assumption that they represent 5% of the public property of the city area is 55km2.

The increasing rates of urbanization at Dir AL Balah city, lack of prioritization on preservation of NUAs. This scenario is aimed at the protection and enhancing of urban ecosystem services, as a result, the proposed scenario will :

1. Save 11% of non-urbanized area from endangered by urban sprawl, and
2. Save the min rate 1m2/one, and
3. The suggestion will protect the cultural landscape for agriculture phenomena.

## 8. CONCLUSION

° Land use/cover changes are the most common cause of loss of biological productivity and biodiversity in aquatic and terrestrial ecosystems on the local and regional scales lead (Kilica, Evrendilekb, Berberogluc & Demirkesend, 2005).

° Land-use/cover had significantly changed in the Gaza strip. The built-up area increased by 66% and the agriculture land cover reduced up to 73%. This results of land use/cover pointer to the need for all tiers of municipalities and government to put in place appropriate planning regulation to guide the direction of future growth and changes in the land use/cover in Gaza

° On one hand is increasing the increasing rate of urbanization that is putting a strain on limited land resources. On the other hand are weak urban planning policies that have allowed the conversion of some NUAs into illegal land uses such as informal housing, informal business activities.

° The government has to educate citizens about the problem of urban expansion and dangerous through newsletters and magazines distribution of statement damages. And activating the laws on construction sector systems by amendment of the gaps in the law to be used for the benefit of preventing the construction sector on agricultural land.

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محاولة الاستفادة من الخبرات العالمية فى هذا المجال ، حتى نستطيع ان نستفيد من التجارب السابقة ونبدأ من حيث انتهى الاخرون.

توفير التقنيات والأدوات اللازمة لتحقيق متطلبات الاستدامة مثل شركات اعادة تدوير للمواد ووسائل نقل صديقة للبيئة.

محاولة تطوير ماتم دراسته بالبحث وصياغة الرؤية الشاملة والمتكاملة للحرم الجامعى المستدام.

ب.توصيات عامة:

•زيادة التوعية والاعلان عن الاستدامة (الجامعات المستدامة) على الصعيد الاعلامى ودور النشر حتى يبدا هذا الفكر الجديد فى الرواج والانتشار، ويتم ذلك من خلال النشر فى المجلات العلمية والمعمارية المتخصصة، والابحاث والدراسات المعمارية، والبرامج والندوات العلمية والثقافية، وايضا المعارض المحلية والدولية التى تقام على ارض مصر .مع عقد المؤتمرات والندوات التى تناقش اطروحة الجامعات المستدامة ،حيث تعد من الوسائل الفعالة لنشر الفكرة وبداية جيدة لاقناع الوسط المعمارى باهمية المشكلة.

•من الاهمية ان تدخل الدولة نماذج من هذه الجامعات المستدامة ضمن مشاريعها القومية الكبيرة ذات الميزانيات الضخمة وتحت رعاية مؤسسات الدولة، ولكن بالمفهوم الصحيح والمتطور لها وان يتم مراعاة توفر جميع سمات الاستدامة.

•الدور التربوي التعليمي الذي يتوجب أن تضطلع به الجامعات من أجل مساعدة المجتمع في تحسين نوعية الحياة وبالتالي المساهمة في الوصول إلى تحقيق التنمية المستدامة.

•تشجيع المشاريع البحثية التي تأخذ بعين الاعتبار الأبعاد الاجتماعية والاقتصادية والبيئية وفي جميع الاختصاصات.

•في ما يتعلق بالمساواة بين الأجيال، فإن أفضل طريقة لتفسير مبدأ المساواة بين الأجيال هو بالتعبير عنه بمبدأ "المحافظة على الموارد.

•يمكن للتعليم الجامعي أن يلعب دوراً أساسياً في تحقيق التنمية المستدامة من خلال تحقيق المساواة بين الأجيال.

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**شكل (1-8) تصنيف القضايا البيئية**

- ZERO ENERGY-1
- ZERO CARBON-2
- ZERO WASTE-3.

4.اقتراح لنموذج جامعة المستدامة

من خلال هذا الاقتراح سوف يوضح كيفية التوصل لنموذج الجامعة المستدامة وذلك من خلال (الاستدامة داخل الحرم الجامعي، الوعي، الابحاث العلمية فى مختلف التخصصات، الشراكة والتوعية الدولية والمحلية) كما موضح بشكل(4)


شكل( 4)نموذج الجامعة المستدامة

ومن خلال المؤتمرات والندوات وحلقات العمل التي نظمت في جلب الخبراء وصناع القرار إلى مناقشة البحوث ليس فقط فى التنمية أو المسائل التكنولوجية، إلا أن فى قضايا أخرى مهمة مثل الاحترار العالمي، وانبعاثات غازات الاحتباس الحراري، والفقر، ومشاكل السكن والإعاقة المشاكل وغيرها من القضايا الاجتماعية والاقتصادية التي تمكن من تعزيز فهم المسؤولية نحو بيئة مستدامة. يتم تخطيط موقف فريد من جامعة لخلق قادة المستقبل ورجال الأعمال وصناع القرار في البيئة المستدامة من خلال البرامج التعليمية والمناهج الفعال.

ومن خلال الدورات والمناهج الدراسية للمجالات البيئة المبنية، والعلوم الإنسانية، والعلوم البيئية وغيرها للوصول لفهم فعال لتغيير مستقبلنا. وباختصار، لتحقيق الاستدامة فى الحرم الجامعى تتلخص فيما يلي :

نحن بحاجة إلى إنشاء وتقييم أداء الاستدامة عبر المقارنة كل القطاعات في الجامعة والنماذج الناجحة مع بعضها، وسوف تترجم إلى مؤشرات ومقاييس الأداء.

نحن بحاجة إلى الدعوة التغييرات المبتكرة اللازمة باعتبارها العمود الفقري للتنمية المستدامة التنمية في الجامعة.

نحن بحاجة لنشر جهودنا وقصص النجاح لتعزيز والتعرف عليها داخل مجتمع الحرم الجامعي وكذلك باستخدام أدوات وسائل الإعلام المختلفة.

نحن بحاجة إلى تطوير وتسهيل نهج تشاركي من خلال مختلف البرامج والمشاريع التي تنطوي على مختلف أعضاء المجتمع والموظفين والطلاب ومنصات الجمعيات.

نحن بحاجة إلى الاستفادة من الجهود والنتائج، على المزج بين المعرفة والقوة في كليات ومؤسسات مختلفة "يعيشون أمثلة 'تعزيز التنمية المستدامة في الجامعة.

وبدات فعلا جامعات على مستوى العالم فى الوصول الى حرم جامعى مستدام وذلك تم توضيحة فى جدول(1)

جدول (1) الجامعات التي أبلغت جهود الاستدامة

5.التوصيات

على الرغم من ان الدراسة استهدفت الوصول الى رؤية الشاملة والمتكاملة لمفهوم الاستدامة وماهي الجامعات المستدامة،لاثبات امكانية استغلال وتوظيف الاستدامة فى تحقيق اهداف العمارة البيئية فى الحفاظ على البيئة وترشيد استهلاك الطاقة والمياه بالجامعات وتحقيق قيم الجامعة المستدامة، الا انه تبين بعد هذا العرض اهمية تقديم بعض من التوصيات التى من شانها تساهم فى الارتقاء بالجامعات المصرية الى مستوى التى يمكن ان تنافس او تضاهى الجامعات المستدامة عالميا والوصول بمصر الى المكانة التي تستحقها فى مصاف الدول

| جدول: الجامعات التي أبلغت جهود الاستدامة | |
|---|---|
| الجامعة الوطنية الاسترالية | www.anu.edu.au/facilities/anugreen/annual_report.html |
| جامعة ولاية بنسلفانيا | www.bio.psu.edu/Greendestiny/index.shtml |
| جامعة كولومبيا البريطانية | www.sustain.ubc.ca/pdfs/annual2003cb.PDF |
| جامعة فلوريدا | www.sustainable.ufl.edu/indicators.htm |
| جامعة ميشيغان | http://css.snre.umich.edu/css_doc/CSS02-04.pdf |
| جامعة نورث كارولينا | http://sustainability.unc.edu Documents/AnnualReportWeb2003.pdf/ |
| تشابل هيل الحرم الجامعي | www.uvm.edu/greening |
| جامعة فيرمونت | بطاقة التقرير البيئي |

المتقدمة خلال الحقبة الزمنية القادمة ومنها:

ا.توصيات خاصة بالجامعات الحكومية فى مصر:

•الاهتمام بالقرارات تصميمية المستدامة وبخاصة للمشروعات التعليمية مثل توجية المبانى القديمة والحديثة واعتماد المصمم المعمارى والعمرانى للمرحلة الاولى من نشاة الحرم الجامعى بمعايير الاستدامة.

•يجب تقسيم الحرم الى مناطق جغرافية تبعا للكليات.

•المعرفة والتقنيات والأدوات اللازمة لخلق مستقبل مستدام بيئيا" .

•لابد من توفر الإدارة الرشيدة القوامة بما يكفل تحسين الأداء الإداري صوب تحقق هدف التنمية المستدامة بالجامعة المستدامة.

على الجامعات اذا ارادت ان تكون «صديقة للبيئة» ان تحدث ثورة في التعليم وطرقه، وان تدخل تعديلات كبيرة على روحية التعليم العالي الخاضع كلياً لاقتصاد السوق ومتطلباته الاستهلاكية المدمرة للبيئة ولسوق العمل الدولي والمحلي القائم على الربح وتعظيم الثروة. عليها ان تدخل مواد الفلسفة البيئية والفكر البيئي بشكل إلزامي في معظم الاختصاصات المصنفة علمية او عملية، ولا سيما تلك المتعلقة بالهندسة والطب والصيدلة. فليست مهمة الجامعة ان تدرب طلابها على كيفية التوفير في الطاقة المستهلكة داخل الجامعة فقط، بل في ان تدعم البحث العلمي المطور للصناعات الصديقة للبيئة والموفرة للطاقة او لإنتاج الطاقة من مصادر متجددة وترجمتها في قوانين وأنظمة .

عليها ان تخرّج طلابا يعرفون كيف يعيشون لا كيف يعملون فقط.

• يؤدى استخدام الملاقف والافنية الداخلية فى المبانى الى تلطيف كبير لحرارة المبنى .

جودة البيئة الداخلية

أهداف هذه الفئة هي:

أ) توفير مبنى وأنظمتها التي تدعم رفاهية وراحة المستعملين من خلال توفير التهوية الكافية والهواء الخارجي نوعية الهواء الداخلي

ب) للقضاء على تعرض شاغلي المبنى إلى الآثار الضارة للدخان ، وخطر البكتيريا ومسببات الأمراض الأخرى

ج) لتشجيع استخدام مواد لاصقة المنخفضة الانبعاثات، ومانعات التسرب والدهانات والطلاء والأرضيات والسقف وأنظمة للتخفيف من المخاطر الصحية المرتبطة الفورماليديهايد في بناء المنتجات

د) لتعزيز الراحة الحرارية والبصرية والصوتية للمستعملين (بما في ذلك توفير الراحة الضوابط الفردية، عند الاقتضاء لتحسين رفاهية للمستعملين ، والكفاءة الإنتاجية للطاقة، والمرونة في المستقبل.

ج.المواد والمصادر

واستخدام المواد العازلة للحرارة واستخدام البلوكات المفرغة او عمل اسقف مزدوجة او استخدام الاسطح المنحنية (قباب او قبوات) والاسطح المنكسرةواستخدام مواد محلية.

مواد لا تنتج عنها انبعاثات استخدام مواد يمكن اعادة تدويرها

المواد والموارد:

أهداف هذه الفئة هي:

- اختيار المواد: تشجيع اختيار المواد ذات الأثر البيئي المنخفض والتكاليف على مدى دورة الحياة الكاملة للمبنى، وبخاصة.

مواد الإقليمية والمحلية (للحد من الآثار البيئية الناجمة عن وسائل النقل.)

-المواد المتجددة.

-المواد المعاد تدويرها.

- مواد ذات كفاءة عالية (للحد من الحاجة إلى الطاقة صيانة البناء، أو المهارة أو يمكن تفكيكها شكل (1-8) تصنيف القضايا البيئية شكل (1-8) تصنيف القضايا البيئية بسهولة لإعادة استخدامها.)

- إعادة استخدام مواد: لتعزيز إعادة استخدام المواد المستخدمة سابقا وتجنب الهدر.

ملاحظة: يمكن أن يستند إن تحديد الأثر البيئي وتكلفة دورة حياة المواد بشكل خاص على نشر المبادئ التوجيهية الدولية حتى يتم إنتاج مجموعة مواد الوطني أو الإقليمي التوجيهي.

د.ا لطاقة

ويمكن استخدام لوحات خلايا ضوئية وتحويلها الى طاقة كهربية من خلال الاسقف والواجهات الجنوبية والجنوبية غربية وذلك لتوفر الاشعة الشمسية بمصر

الطاقة الشمسية والرياح والطاقة الحرارية الارضية والكتلة الحيوية او مصادر المياه

مزرعة ضوئية شمسية فى الموقع

كفاءة الطاقة:

أهداف هذه الفئة هي:

للحد من استهلاك الطاقة وانبعاثات الكربون من خلال دمج استراتيجيات التصميم السلبي.

لتحسين اختيار المعدات الكهربائية والميكانيكية، لوتقييم المخزون من الطاقة والكربون لكل نظام MEP نموا، وتقليل أثرها على البيئة.

للحد من الطلب على الطاقة لتلبية احتياجات الأحمال في أوقات الذروة استخدام من خلال بناء الكفاءة وخدمات التصميم والموقع على، حيثما أمكن، على توليد الطاقة المتجددة.

لتشجيع توفير مرافق القياس التي تسمح سجلت أداء الطاقة في المباني ومراقبتها للسماح تحسين المستقبل وإثبات الصلاحية.

لتقليل الطاقة المستهلكة من قبل الأجهزة بناء مستخدمة بشكل شائع

ه. المياه

• استخدام مياه الاحواض بعد المعالجة

استخدام الرى بالتنقيط

نباتات قليلة استخدام المياه

كفاءة استخدام المياه:

أهداف هذه الفئة هي:

مساعدة المهنيين في جميع أنحاء البلاد لتحسين نوعية المباني لدينا وتأثيرها على البيئة.

وضع وتنفيذ استراتيجية شاملة للمياه.

تقليل الطلب على المياه الداخلية والخارجية.

تقليل استخدام المياه الصالحة للشرب.

للحد من استخدام المياه الصالحة للشرب عن طريق تشجيع استخدام المياه الرمادية أو إعادة استخدامها وتجنب استخدام المياه الصالحة للشرب نظيفة، حيثما أمكن ذلك.

كفاءة مياه الري.

تقليل استخدام الشرب للري.

و.الابتكار والتصميم

• استخدام معايير للراحة المعاقيين

• الابتكار والتجديد

• التراث والطابع الاقليمى

أهداف هذه الفئة هي:

التراث الثقافي: التصاميم التي تعكس التفوق في التراث الثقافي الوطني والإقليمي، بينما تساهم في الأداء البيئي للمبنى.

الهدف الرئيسى الوصول الى(TRIPLE ZERO)

ان خلق مجبهات عمرانية جديدة قد تصبح فائدة قومية لايمكن الاغفال عنها.

- شبكة الطرق والممرات المشاه وفراغات التجميع
- الاساليب المختلفة لشبكات الطرق والممرات المشاه
- طريق حلقى يحيط بالمنطقة الحرم الجامعى
- شبكة متوازية من الطرق والممرات المشاه
- العوامل الطبيعية (المناخ-الطبوغرفية)

•المناخ السائد فى مصر العربية هو المناخ الصحراوى
•يؤثر المناخ الحار على اختيار نظام البناء المتبع وفى ذلك نجد ثلاثة انظمة هى:
•يتم استخدام نظام تجميع المبانى الحرم الجامعى على افنية داخلية والبناء تحت الارض.
•يتم استخدام نظام التجميع المبانى بطريقة اندماجية لزيادة الظلال الواقعة من مبنى على اخر ،ولتقليل مسافة التنقل بين المبانى.
•تجميع المبانى على افنية داخلية مشجرة وبها مسطحات مائية،ويمكن ان تغطى هذه الافنية ،ويتم توجيه جميع الفتحات المبنى على هذه الافنية، مما يؤدى الى خفض ملحوظ فى درجة حرارة المبنى الداخلية.
•يمكن استخدام النظامين السابقين بصورة واسعة فى مبانى الجامعات الا ان النظام الثالث وهو البناء تحت الارض يحتاج الى بعض التجارب الى ان بنيت امكانية استخدامة فى المبانى العامة
•تنتقل الحرارة من البيئة الخارجية الى المبنى عن طريق الحوائط والاسقف والفتحات
•بالنسبة للحوائط يقل النفاذ الحرارى خلالها بزيادة سمكها.
•تعتبر الاسقف اكثر الاسطح الخارجية انه اعلى النفاذ الحرارى لداخل المبنى حيث انه يتعرض
لاشعة الشمس المباشر طول اليوم ويمكن معالجة السقف باسطح عاكسة ويمكن استخدام لوحات ضوئية وتحوليها الى طاقة كهربية
.التوجيه المبنى

•التوجيه نحو الشمال ضمن الزاوية المحصورة بين الشمال الشرقي والشمالي الغربي يعتبر مثاليا بالنسبة لفضاءات قاعات المطالعة في المكتبة والقاعات الدراسية والمخازن الكتب والمراسم الهندسة وقاعات المشاريع ومختبرات البرمجة وبعض المختبرات المتخصصة الأخرى .
الموقع المستدامة:
أهداف هذه الفئة هي:
-اختيار الموقع: لتشجيع التنمية في المناطق الصحراوية، وإعادة تطوير المناطق العشوائية في المشاريع وتجنب المناطق التي تؤثر سلبا على المناطق الأثرية والتاريخية والمحمية.
-إمكانية الوصول: للحد من التلوث والازدحام المروري من استخدام السيارات وللحفاظ على الطاقة غير المتجددة من خلال تشجيع النقل العام والبديلة.
التوازن البيئي: للحد من الأثر البيئي للمشروع على الموقع والمناطق المحيطة بها، وحماية النظم الطبيعية الموجودة، مثل الحيوانات والنباتات بما في ذلك ممرات للحياة البرية واستخدامات الموسمية والتربة، والمياه الجوفية والهيدرولوجيا من التلف وتعزيز التنوع البيولوجي.
أهداف هذه الفئة هي:
-اختيار الموقع: لتشجيع التنمية في المناطق الصحراوية، وإعادة تطوير المناطق العشوائية في المشاريع وتجنب المناطق التي تؤثر سلبا على المناطق الأثرية والتاريخية والمحمية.
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ب. جودة البيئة الداخلية

التوجيه نحو الجنوب الغربي بزاوية قليلة إمكانية التشميس لفترة ما بعد الظهر أي في الأوقات التي يقل فيها المختصين الاستفادة من هذه الحقيقة في توجيه الصفوف والقاعات الدراسية.

التوجيه نحو الشرق فيسمح به لبعض الفضاءات التدريسية للحصول علي مناورة في تجميع الفضاءات التدريسية ، ولكن يجب أخذ الحيطة في هذا التوجيه و المعالجة الجيدة لفتحات الشبابيك فيه وذلك باستخدام كاسرات الشمس المناسبة.

التوجيه نحو الغرب ضمن الزاوية المحصورة بين الجنوب الغربي وحتى استعمال الغربي توجيها غير مرغوب فيه لكافة الفضاءات التدريسية والإدارية

التوجيه نحو الجنوب ضمن الزاوية المحصورة بين الجنوب الشرقي وحتى الجنوب جنوب الغربي بزاوية 20 مثاليا وجيدا بالنسبة لقاعات التدريس ويعض المختبرات وقاعات السينما مع استعمال كأسرات الشمس الأفقية لحجب الشمس من الدخول في ساعات التدريس

الفتحات

ويتم توجيه جميع الفتحات المبنى على هذه الافنية ، ممايؤدى الى خفض ملحوظ فى درجة حرارة المبنى الداخلية.

الواجهة الشرقية يجب أخذ الحيطة في هذا التوجيه و المعالجة الجيدة لفتحات الشبابيك فيه وذلك باستخدام كاسرات الشمس المناسبة

ب.الاضاءة

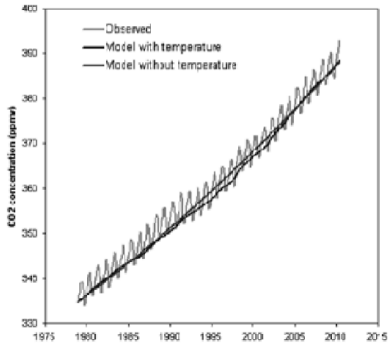
اوالافنية والشخشيخة لتوفير الاضاءة والتهوية الطبيعية

توجيه المبنى فى الحرم الجامعى لتحقيق اقصى قدر من ضوء النهار

فضل اضاءة تاتى من الشرق او الواجهة الشرقية

ج .التهوية و الراحة الحرارية

تمثل الفتحات بعدة طرق منها استخدام المشربيات او كاسرات الشمس بالوضع الصحيح او الستائر




شكل (2) تزايد انبعاث غاز ثانى اكسيد الكربون co2 المسبب للاحتباس الحرارى

ويبدو ان الجامعات قد تأثرت كثيرا بالحملة التي اعلن عنها العام الماضي في الولايات المتحدة الأميركية،عن تعهّد 674 جامعة وكلية في أنحاء الولايات المتحدة خلال الاعوام الأربعة الماضية بأن تصبح صديقة للبيئة. وقدمت 535 منها قوائم للحكومة تبيّن كمية انبعاثاتها من الغازات الضارة، في حين رسمت 320 جامعة خططاً تشرح فيها كيف ستحقق هدفها النهائي ومتى، بعدم توليد أي انبعاثات غازية مضرّة للبيئة على الإطلاق، حسب ما ورد في (نشرة واشنطن)، بالرغم من التشكيك بإمكانية الوصول الى «صفر كربون»، كما تدّعي هذه الجامعات، يمكن لهذه الاجراءات ان يكون لها معنى (بيئي) ما في جامعات كبيرة جدا لا تزال تتزود بالطاقة من جراء إحراق الفحم الحجري وتنتج اطنانا كثيرة من ثاني اوكسيد الكربون المساهمة بتغير المناخ، قد تكون بحجم انبعاثات دول صغيرة. فجامعة «ييل» على سبيل المثال التي تضم ما يقارب 12 الف طالب، تعهدت بأن تخفض انبعاثاتها السنوية بما يقارب 70000 طن من الكربون دون مستويات عام 2005. وكذلك الامر بالنسبة الى جامعات اخرى (في الولايات المتحدة الاميركية) تضم اكثر من 14 و15 الف طالب، وتنتج الجامعة الواحدة منها في السنة ما يقارب 400 ألف طن من الغازات المسببة بتغير المناخ. لا يكفي ان تفرز الجامعات نفاياتها او ان تشجع اعتماد سيارات نقل صديقة للبيئة داخل الحرم الجامعي، بل عليها ان تعلم استراتيجيات الانتاج الدائري لا الخطي والادارة المتكاملة لمخلفات الحضارة وكيفية تغيير سياسات الطاقة والنقل وفلسفتها.

أمضت الجامعات الأميركية الأعوام الأخيرة في السعي لتحويل محطاتها لإنتاج الكهرباء من الفحم الحجري إلى العمل بالغاز وإعادة تجهيز المختبرات وغرف الصفوف والمكاتب ومنامات الطلاب بنوافذ جديدة ومواد عازلة تساعد في وقف هدر الطاقة، وسعت لأن تحصل على تصديق «المجلس الأميركي للمباني الخضراء» على أنها صديقة للبيئة... ولكنها لم تتقدم خطوة في تغيير برامجها ومناهجها نحو الفلسفة البيئية الجديدة المحافظة ولا فسحت المجال للأفكار التي تحد من التنمية ولا تلك التي تعيد النظر باقتصاد السوق والمفاهيم المضللة والمدمرة مثل الرفاهية والفردية والخصصة وتلك الأفكار التي تشجع على حب التملك والاستهلاك... والتي تعتبر مسؤولة عن السلوكيات المسببة بتغير المناخ. والدليل على عدم جدوى تلك التغييرات الشكلية داخل حرم الجامعات وعدم الانتقال الى تغييرات جذرية خارجها، ان الولايات المتحدة الأميركية بقيت الملوث الأكبر في العالم على مستوى الفرد، والبلد الثاني بعد الصين على مستوى الدول !

وفي مختلف أنحاء البلاد، والجامعات تبذل جهودا لخلق تدوير البرامج التي من شأنها أن تساعد على خلق مزيد من "الاستدامة" الجامعة. على سبيل المثال، جامعة فلوريدا يعمل لديها النفايات صفر الخوض في مدافن النفايات بحلول عام 2015.


شكل (3) تصنيف القضايا البيئية

ا.من خلال الاستدامة فى الحرم الجامعى يمكن ان يحقق الصفر الثلاثى:(TRIPLE ZERO)

- الطاقة الصفرية ZERO ENERGY
- الكربون الصفرى ZERO CARBON
- النفايات الصفرية ZERO WASTE

3.توصل لعمل قائمة استرشادية للحرم جامعى مستدام فى مصر-:

الغرض من هذه القائمة هو تحقيق الاستدامة لتعزيز الاستدامة في جميع أنحاء الحرم الجامعي.

الهدف من هذه القائمة هو مساعدة المهندسين المعماريين والمخططين لضمان الحد الأدنى من التدابير المستدامة.

يتم تقسيم القائمة الى خمسة عناصر لتحقيق الاستدامة (الموقع – الطاقة – المياه – مواد البناء – الاضاءة والتهوية) وهى كما يلى :-

ا.الموقع المستدامة

اختيار موقع الجامعة واثره على تخطيط وتصميم المبانى الحرم الجامعى اختيار موقع الجامعة يلعب دورا هاما فى تحديد علاقة الجامعة بالمدينة عند اختيار موقع الجامعة الجديدة تكون البدائل المتاحة:

موقع داخل الحضر(داخل المدينة او على اطرافها(

•موقع خارج الحضر، يتم اختيار البديل المناسب حسب مساحة الارض الكافية ومكان توافرها

•تزيد مساحة الارض المطلوبة للموقع العام من الموقع داخل المدينة الى الموقع على اطراف المدينة الى الموقع خارج الحضر وذلك لزيادة الخدمات بنفس الترتيب

•يعتمد الموقع داخل المدينة على امتداد الراسى للمبانى بينما يعتمد الموقع على اطراف المدينة والموقع خارج الحضر على امتداد الافقى للمبانى الحرم

•عند توافر اكثر من بديل لموقع الجامعة الجديدة تتم المفاضلة بين المواقع عن طريق تكلفة انشاء كل بديل والعائد المتوقع مع ملاحظة ان يؤخذ فى الاعتبار الموقع على اطرف المدينة او الموقع خارج الحضر قد تكون تكلفة انشائية اولية كبيرة الا

# استراتيجية التصميم البيئى للحرم الجامعى فى مصر

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الملخص ـــيتناول هذ البحث توصل لعمل قائمة استرشادية للحرم جامعى مستدام فى مصر **على مستوى الخمس معايير البيئية (الموقع،جودة البيئة الداخلية، الطاقة ، المياة)** الغرض من هذه القائمة هو تحقيق الاستدامة لتعزيز الاستدامة في جميع أنحاء الحرم الجامعي. الهدف من هذه القائمة هو مساعدة المهندسين المعماريين والمخططين لضمان الحد الأدنى من التدابير المستدامة.

**الكامات المفتاحية ـــ ;دليل ارشادى بيئى ;الاستدامة;التصميم البيئى ;**

1 .المقدمه

. يعتبر التعليم هو مقياس الحضارة والتقدم الامم، مما يجعل تطوير تصميم المبانى التعليمية من اول الاهتمامات التى يجب علينا دراستها وحل مشكلاتها لنبدأ التطوير ولنبدأ أولى خطوات النهضة (الجامعات المستدامة). وهى النموذج العالمى لتطوير الجامعات والمجتمع معا وهى ما نحتاجه فى مصر تطوير الجامعات وتفعليها مع المجتمع لتؤثر على الطالب والمجتمع من حوله لتبدأ أولى خطوات التقدم والحضارة .

فقد كان من الواضح أن تغير المناخ أصبح التركيز الرئيسي في السعي لإيجاد حلول مستدامة، هذه التغييرات نحو الاستدامة فضلا عن الفوائد الاقتصادية والمالية. وبالمثل، فإن هذه الجامعات هي المسؤولة عن تدريب أجيال المستقبل من الناحية العملية المستدامة.

بيئتنا المصرية ليست في منأى عن المشكلات البيئية بل تتعرض لعديد من المشكلات منها أزمة الطاقة، والتلوث سواء كان تلوث الهواء أو المياه أو التربة، وتقليل حصة مصر من مياه النيل، والتصحر والمخلفات الصلبة، والتعدي علي الأراضى الزراعية ومن الصعب حصر كل هذه المشكلات ولكن يمكن القول أن بيئتنا تواجه تحدياً حقيقياً.

يساهم العمران إلي حد كبير في هذه الأزمة من خلال الانبعاثات الناتجة عن مواد البناء واستنزاف المواد والموارد داخل المبني واستهلاك الطاقة، لذلك كانت الحاجة إلي النظر للعمارة من مفهوم جديد من خلال التأكيد علي أهمية العلاقة بين العمارة والبيئة، وايقاظ الوعي البيئي في مصر والتعامل مع البيئة كعنصر أساسي في عملية تصميم المبني، لذلك تهتم العمارة البيئية بتكامل العوامل البيئية مع التصميم المعماري.

وبعد تصاعد الأزمة بين الإنسان وبيئته ظهرت الاستدامة في التسعينات من القرن العشرين، كاتجاه بيئي معاصر يدعم التصميم لصالح جودة البيئة، وخلق معايير ومقاييس بيئية ترشد من استهلاك الموارد الطبيعية وتعزز سلامة وصحة الإنسان وكفاءة استخدام الطاقة لاستدامة بقاء الأجيال المستقبلية كرد فعل للتأثير السلبي للتقنيات الحديثة علي البيئة والإنسان.

2 .استراتيجيات لتحقيق التصميم البيئ للحرم الجامعى بمصر

ا. تعريف الجامعة المستدامة

هى "مؤسسة تعالج التعليم العالي ، للتقليل من الآثار السلبية البيئية والاقتصادية، والاجتماعية، والصحة. وذلك من أجل تحسين أداء وظائفها من التعليم والبحث والتوعية ، ومساعدة المجتمع على الانتقال إلى أساليب الحياة المستدامة"

وذلك يتم عن طريق التوعيه والمعرفه من خلال الحرم الجامعى لانه يضم مختلف التخصصات ويضم شباب المستقبل الذين يؤثرون فى المجتمع وبناء المستقبل.


شكل (1) التنمية المستدامة

3.مفهوم الحرم الجامعى المستدامة

لتظليل بعض الضوء على مفهوم الاستدامة في الحرم الجامعي، وهو استعراض الممارسات المستخدمة على نطاق واسع لتحقيق الاستدامة وقياس التحسن التقني نحو الاستدامة.

شرعت الجامعات في مشاريع التطوعية والمبادرات لدمج الاستدامة في نظمها، مما يجعل سياساتها واضحة الأهداف والغايات،وعمل تخطيط استراتيجي فى إطار زمني لتحقيق الحرم الجامعي المستدامة .

اختلفت الاراء حول الجامعات المستدامة فى العالم هل هى جامعة خضراء ام هى المبنى التعليمى الذى يخدم المجتمع ام هى الجامعة التى تعمل بكفاءة ام هى الجامعة الموفره للطاقة ولكن الجميع اتفق انها جامعات تحترم المستقبل وتساعد على التقدم والحضارة للعالم دون اخلال بالتوازن البيئى بعد التشغيل المبنى وتتوافق مع البيئة.

يمكن تطبيقها بنجاح ضمن الواقع الفيزيائي والاجتماعي والاقتصادي للمدن العربية. وبتطبيق تلك التصورات فإنه يمكن ليس فقط الحفاظ على المناطق ذات القيمة التاريخية كرصيد حضاري محلي ووطني وإنساني، وإنما يمكن أيضاً تحويل تلك المناطق إلى أجزاء حيوية في مدننا الجامدة، تساهم في تنمية المدن وتطورها. ويمكن تلخيص تلك التصورات كما يلي:

5-1- تمر عملية الحفاظ على المناطق ذات القيمة التاريخية بالمراحل المتتابعة التالية :

أ-مرحلة تحديد المنطقة والإعلان عنها كـ " منطقة حفاظ " واستغلال مخططات التخطيط العمراني العامة للمدن لتحقيق ذلك.

ب-وضع مخطط تفصيلي لتطوير المنطقة يهدف إلى حماية طابعها التاريخي والى تعزيزها، وإعادة تأهيلها، وإعادة الحياة بها، بدمجها في النسيج الاجتماعي والاقتصادي للمدينة.

ت-تخصيص الموازنات اللازمة للقيام بمشاريع التطوير للمناطق التاريخية، وتنفيذ المخططات التطويرية ضمن خطة عمل وإدارة واضحة وفعالة.

5-2- اختيار الإستراتيجية الخاصة بالحفاظ المعماري الأمثل والأكثر ملائمة للواقع الاجتماعي والاقتصادي والفيزيائي للمنطقة المطلوبة، فما يلاءم منطقة في مدينة ما لا يلاءم مدينة أخرى أو منطقة أخرى في نفس المدينة ، وذلك بعد تحديد التحديات والعوائق الخاصة بكل منطقة واختيار الأسلوب الأمثل للتطوير حسب ما هو موضح في البند 3 من البحث .

5-3- ضرورة مراجعة التشريعات الخاصة بالحفاظ لتكون حازمة في تحقيق أهدافها، وفي نفس الوقت توفر الحوافز لمن يلتزم بالبنود المطلوبة.

5-4- على الجهات المسئولة وخاصة على المستوى المحلي عدم انتظار صدور أو تعديل القوانين الفعالة، فذلك قد يستغرق وقتاً في الوقت الذي فيه عجلة التطوير لا تتوقف ولا تنتظر، بل عليها الاستفادة من التشريعات القائمة وتطوير المناطق ذات القيمة التاريخية من خلال مخططات المدن العامة والتفصيلية .

5-5- تعزيز دور السلطات المحلية في الحفاظ على المناطق التاريخية وذلك ب :

أ-توفير التدريب، وخاصة التدريب على إعداد المخططات التفصيلية الخاصة بالمناطق ذات القيمة التاريخية ووضع الأنظمة العمرانية الخاصة من خلال المخطط التفصيلي، وفي إعداد اقتراحات التطوير، وفي طرق تجنيد التمويل اللازم، وكذلك في إدارة مشاريع التطوير في تلك المناطق.

ب-دعم السلطات المحلية الجادة بالتمويل اللازم بشكل كلي أو جزئي لتطوير المناطق التاريخية وتحقيق المخططات التطويرية لها.

5-6- تعزيز وتفعيل دور المؤسسات الأهلية المهتمة بالتراث المعماري والتاريخي، ودعمها في تحقيق بعض الأمور التي تستطيع القيام بها كدور مكمل ومراقب لعمل للجهات الرسمية، مثل تحفيز مشاركة القطاع الخاص في عملية التطوير، وتجنيد الأموال اللازمة، وغيرها من الأعمال التي تسهم بمجملها في مساعدة الجهات الرسمية في الحفاظ على المناطق التاريخية .

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التاريخية ((Larkhman and Johnes, p. 406. وحيث أن القوانين الخاصة بالحفاظ على المباني والمواقع الأثرية قد سنت منذ أكثر من قرن (البريطاني في 1882م، والأمريكي في 1906م، وفي بعض الدول العربية في العشرينات) ، إلا أن الاهتمام بإصدار تشريعات للحفاظ على طابع المناطق التاريخية بأكملها قد بدأ في النصف الثاني من القرن الماضي بصدور بعض القوانين في الدول الغربية. أما في العالم العربي فقد وردت بعض النصوص المحدودة والخجولة التي تشير إلى أهمية الحفاظ على المناطق التاريخية دون الخوض في أية تفاصيل مقارنة بالتفاصيل الخاصة بالحفاظ على المباني المسجلة ، مثال ذلك قانون حماية الآثار بمصر حيث تنص المادة رقم (21) منه أنه " يتعين أن تراعى مواقع الآثار والأراضي الأثرية والمباني والمواقع ذات الأهمية التاريخية عند تغيير تخطيط المدن والأحياء والقرى التي توجد بها " (الهيئة العامة لشئون المطابع الأميرية،قانون رقم 117 لسنة 1983، 1996، ص 9). وكذلك ورد بقانون التخطيط العمراني بمصر بالمادة رقم (2) " كما يحدد التخطيط مواقع الخدمات العامة ... وكذا المناطق التاريخية والأثرية إن وجدت بهدف تأمينها والحفاظ عليها" (الهيئة العامة لشئون المطابع الأميرية ،قانون رقم 3 لسنة 1982، 1997- ص 6) ، والمادة رقم ( 7) " بعد اعتماد التخطيط العام تبادر الوحدات المحلية إلى ما يلي : أ- إعداد مشروعات التخطيط التفصيلي للمناطق التي يتكون منها التخطيط العام للمدينة أو القرية . (ب) وضع القواعد واشتراطات المناطق والبرامج التنفيذية التي توجه عمليات التنمية في كل المناطق التي يتكون منها التخطيط العام. ويبين التخطيط التفصيلي واشتراطات المناطق ما يلي : ..... 6- الاشتراطات الخاصة بالمناطق التاريخية والسياحية والأثرية بما يكفل الحفاظ عليها وفقاً للقوانين المنظمة لها " (الهيئة العامة لشئون المطابع الأميرية ،قانون رقم 3 لسنة 1982، 1997- ص7 و8).

وبمراجعة التشريعات الخاصة بالحفاظ على المناطق التاريخية تبرز بعض الجوانب المؤثرة والتي تترك بأثرها على عملية الحفاظ والتطوير: الجانب الأول هو اتسام بعض التشريعات كما بالمملكة المتحدة بالقوة والحسم في نصوصها تجاه وجابية تحديد وتعيين المناطق التاريخية ، وتكليف الجهات الواجب عليها القيام بخطوات عملية بهذا الاتجاه، وكذلك تحديد درجات التدخل الممكنة. وأما الجانب الآخر فهو اتسام بعض التشريعات كما بالولايات المتحدة بالمرونة في نصوصها، وفي تحديد درجات التدخل، وكذلك في فرض السياسات الخاصة بالحفاظ عن طريق تقديم الحوافز لمن يقوم ببعض الخطوات مثل الإعفاء من الضرائب مثلاً .

2-4- الحفاظ من خلال التخطيط العمراني : بتفحص قوانين التخطيط العمراني في بعض الدول يتبين أن هنالك مجالاً واسعاً للعمل من خلاله في حماية وتطوير المناطق ذات القيمة التاريخية. فمن خلال بعض الفقرات المحدودة يمكن للمخططين وصانعي القرار حماية وتطوير المناطق ذات القيمة التاريخية بعمل مخططات عامة وتفصيلية للمدن والمناطق المعنية داخل المدن، وقد يبدو هذا الأمر سلاحاً ذو حدين إذ تستغل إدارات بعض المدن وهيئاتها المحلية هذه القوانين في تخصيص عناية خاصة للمناطق ذات القيمة التاريخية وذلك بتحديدها والشروع في وضع الخطط التطويرية لإعادة إحياءها ودمجها في النسيج العمراني والاجتماعي والاقتصادي للمدينة مثل جهود بعض المدن البريطانية في الحفاظ على مناطقها من خلال قانون تخطيط البلدات والريف " Town and Country Planning Act -1971" ، وبالمقابل فقد تتجاهل بعض الهيئات المحلية تطوير المناطق التاريخية ضمن مخططاتها العامة لا وبل يتم اقتراح طرق ومعالم حضرية وأنظمة للبناء تؤدي بشكل مباشر أو غير مباشر إلى تغيير شكل المنطقة الأصلي وتغيير معالمها وطابعها التاريخي .

إن تطبيق سياسات واستراتيجيات الحفاظ للمناطق التاريخية الوارد ذكرها في البند (3) من البحث يمكن أن يصبح أمراً ملموساً في المدن العربية من خلال التخطيط العمراني لتلك المدن. فالمخطط العمراني للمدينة يتم إعداده وتجديده كل فترة زمنية وبالتالي يمكن للمدن أن يتم من خلال تحديث مخططاتها الإجراءات المتتابعة التالية:

أ-تحديد مناطق الحفاظ في المدينة وفقاً للمعايير الخاصة بذلك.

ب-إعلان تلك المناطق كمناطق حفاظ معماري من خلال تحديدها بالمخطط، وبالتالي لا يجوز التغيير أو البناء بها إلا وفق ضوابط خاصة.

ت-عمل تخطيط تفصيلي لتلك المناطق والذي من خلاله يتم تحديد استعمالات الأراضي والمباني بها ووضع أنظمة للبناء من ارتفاعات وارتدادات وطابع معماري ومواد بناء وألوان وغيرها، وتحديد حركة المرور، وغير ذلك من الأمور التخطيطية التفصيلية.

ث-اعتماد المخطط التفصيلي من خلال الجسم التخطيطي القانوني ووضعها موضع التنفيذ.

ج-تطبيق الخطط لتطوير تلك المناطق جزئياً أو كلياً من خلال المشاريع التنموية أو الاستثمارات الخاصة لتصبح تلك المناطق مناطق مميزة وتلعب دوراً هاماً في النسيج العمراني والاجتماعي والاقتصادي للمدينة.

3-4- دور المؤسسات الأهلية : تعتبر مسؤولية إدارة التراث المعماري وحمايته مسؤولية جماعية لا تقتصر على الجهة المكلفة بهذا العمل، وإنما هي مسؤولية المجتمع بأكمله (باوزير، 2009، ص 122). فكل شخص يجب أن تتاح له الفرصة في تحديد قيمة الأماكن وكذلك يشارك في اتخاذ القرارات بشأنها ( English Heritage, 2013, p.20). وتلعب المؤسسات الأهلية المهتمة بالتراث العمراني والتاريخي دوراً هاماً في الحفاظ على المناطق التاريخية وتطويرها. وقد تزامن نشأة ونشاط تلك المؤسسات مع الاهتمام بهذا الموضوع على كافة المستويات الوطنية والمحلية. ولم يقف دور المؤسسات الأهلية المختصة عند ممارسة الضغط على الجهات الرسمية في تطوير المناطق التاريخية، بل تعدى ذلك ليشمل النواحي التالية:

أ-تنظيم الأعمال التطوعية في المناطق التاريخية .

ب-حث القطاع الخاص، وهو قطاع استثماري تطويري هام، على المشاركة في التطوير.

ت-توفير الأموال اللازمة لبعض عمليات التطوير من خلال التبرعات أو المنح أو الصناديق الخاصة.

ث-توفير وسائل الربط بين الدراسات البحثية والأكاديمية من جهة، والجهات الرسمية التنفيذية وصناع القرار من جهة أخرى

## 5- الخلاصة Conclusion:

يخلص البحث في النهاية إلى استنتاج بعض التصورات والنماذج لمواجهة التحديات التي تواجه تطوير المناطق ذات القيمة التاريخية والتي استخدمت بنجاح في دول العالم المختلفة، و

المجاورة، وكذلك توفير مساحات مفتوحة ومرافق ومساحات خضراء كخطوة نحو تحسين واقع الكثافة العمرانية بالمنطقة التاريخية ، وحل بعض المشاكل البيئية مثل الضوضاء والازدحام والتلوث وغيرها.

ب- تنظيم المرور: يعتبر الحفاظ على شخصية الطرقات في المناطق التاريخية بعروضها الضيقة وانحناءاتها وتتابع فراغاتها وساحاتها وملمسها ومواد إنشاءها وتأثيثها جزءاً أساسياً من تكوين شخصية النسيج الحضري في تلك المناطق . وقد ظهرت بعض التوجهات الناجحة لحل مشكلة دخول السيارة ووسائل المواصلات كمتطلب عصري داخل المناطق التاريخية، منها على سبيل المثال تحويل جزء أو كل المنطقة إلى منطقة للمشاة فقط، وتوفير أماكن قريبة لوقوف ومبيت السيارات، واللجوء إلى عمل مواقف تحت أرضية في الساحات العامة داخل المنطقة أو في أطرافها ، واستخدام ما يسمى ب " نظام إدارة المرور في المنطقة التاريخية "، وهو السماح بدرجات معينة من دخول السيارات إلى أجزاء مختلفة من المنطقة ضمن مخطط خاص وغرفة للتحكم . ورغم معارضة سكان المناطق التاريخية وخاصة التجارية منها لفكرة تحويل طرقاتها للمشاة، إلا أن الدراسات أثبتت النجاح الكبير الذي حققته تلك المناطق نتيجة ذلك التحويل (Fitch, 1995, p. 63).

ج- توفير الخدمات الأساسية في المنطقة: من مياه نقية للشرب وخطوط للصرف الصحي والكهرباء وإدخال نظم الاتصالات بها، وذلك كله دون التأثير على طابعها التاريخي.

3-3 – تنظيم حركة العمران والبناء في المنطقة التاريخية: Building Control

تتجه الأفكار في تطوير المناطق التاريخية إلى تنظيم حركة البناء والعمران بما يتناسب مع طبيعة المنطقة بدلاً من منعها بتاتاً كما كان معروفاً من قبل. ويساعد هذا التوجه في الاستجابة إلى بعض التحديات المتمثلة في ارتفاع قيمة الأرض والازدياد السكاني، ويمكن أن يكون تصميم الأبنية الجديدة أو الإضافات حسب التوجهات التالية :

أ – البناء حسب نمط تاريخي Historicizing Design: وهو السماح بالبناء داخل المنطقة التاريخية حسب نمط تاريخي محدد سواء من حيث التصميم الفراغي والشكلي، أو باستخدام عناصر تاريخية تعود لطراز أو أكثر، وفي بعض الحالات يتم تجهيز نموذج لواجهات تاريخية لبناء الأبنية وفقها. من الأمثلة على ذلك ميدان النهضة في آراس – فرنسا ومنطقة جورج تاون بواشنطن والميدان المركزي بهيلدشيم – ألمانيا ، وغيرها .

ب- البناء بأسلوب متناقض مع طابع المنطقة Contrast with the Old: وذلك باستخدام نمط تصميمي أو مواد بناء أو استعمال وظيفي يتسم بالحداثة، وبما يتناقض تماماً مع الطابع التاريخي للمنطقة، بقصد تمييز الزمن ، ولإظهار فلسفة معمارية مميزة وواضحة . أمثلة على هذا الأسلوب الهرم الزجاجي بساحة متحف اللوفر – باريس، وبرج هانكوك في بوسطن .

ج- البناء بأسلوب متجانس مع القديم Homogeneous Architecture : وذلك باستخدام مواد بناء وأساليب تصميمية حديثة، ولكن بتجانس التكوين المعماري للبناء مع طابع المنطقة التاريخي من حيث الكتل والمقياس والنسب وتتابع الفراغات والتشكيل المعماري والعناصر المعمارية كالفتحات . أمثلة على ذلك مشروع وحدات سكنية في ستراسبورغ ومشروع إسكان في بونتفيشو بفلورنسا .

4-3- إعادة تأهيل المناطق التاريخية Urban rehabilitation : وهي سياسة شائعة الاستخدام يطلق عليها أحياناً " تجديد المناطق التاريخية Urban Renewal " والخاصة بتطبيق العديد من الحلول التي تتسم بالمرونة في مداها لتحسين ظروف الحياة في المنطقة التاريخية مثل تحسين الكثافة البنائية، وتحسين الخدمات القائمة والتزويد بخدمات جديدة لازمة، وتعبيد وتحسين حالة الطرق، وترميم المباني التاريخية بالمنطقة وإعادة استخدامها، وذلك للحفاظ على الطابع القديم. وقد وضعت العديد من الحلول للحد من التعارض بين جانبين خاصين بهذا التوجه : الأول يعنى بضرورة الحاجة إلى التغيير في المنطقة التاريخية لتجديدها وتأهيلها، والثاني بالحفاظ على الطابع التاريخي لها ضمن هذا التغيير. ومن ضمن الحلول على سبيل المثال لا الحصر الحفاظ على الواجهات الخارجية للمباني الواقعة بالمناطق التجارية التاريخية، وتحويل داخل المبنى إلى بيئة عصرية مختلفة تماما عما كانت عليه من قبل، وبأساليب وعناصر عصرية " Preserving the Skin Only". ومن الأمثلة على موضوع إعادة تأهيل المناطق التاريخية هو إعادة تأهيل المنطقة التاريخية في مدينة بيرجامو بايطاليا، وإعادة تأهيل المناطق التاريخية بجدة وتونس وفي العديد من المدن البريطانية وخاصة جلاسكو وأدنبرة ويورك وباث .

5-3- تجديد الحياة في المناطق التاريخية: Regeneration and Revitalization of historic areas وهو مفهوم أوسع قليلاً من المفهوم السابق " إعادة التأهيل " لأنه يشمل بالإضافة إلى ترميم المباني القديمة وتحسين الطرق وتوصيل الخدمات، إدراج بعض الخدمات الاجتماعية اللازمة لسكان المنطقة وكذلك لمرتاديها من سياحة داخلية وخارجية، وتوفير فرص العمل للسكان، وإعادة إحياء الحرف التقليدية بالمنطقة . وبذلك لم تعد المنطقة التاريخية مهجورة ومتروكة أو معزولة عن النسيج العمراني والاجتماعي للمدينة، وإنما هي عنصر حي من المدينة يجدد حياته مجمل العناصر الجمالية والاجتماعية والاقتصادية، وبالتالي تتحول المنطقة التاريخية إلى منطقة ذات دور خاص وهام في المدينة الواقعة بها. ومن الأمثلة على هذا التوجه هو تطوير حي ماري بباريس.

4- الجوانب الإدارية والقانونية: Administrative and Legal Issues

تعتبر التشريعات الخاصة بالحفاظ على المناطق التاريخية بمختلف مستوياتها من أهم العوامل لنجاح عمليات الحفاظ والتطوير. ومن خلال استعراض جوانب هذا الموضوع تبرز ثلاث أمور محددة وأساسية يتوجب مراعاتها في مشاريع التطوير العمراني للمناطق التاريخية:

1-4- التشريعات: في الوقت الذي تهتم به التشريعات بتسجيل المباني الأثرية وذات القيمة التاريخية، وبكيفية الحفاظ على تلك المباني المسجلة، فإن هنالك محدودية وعجزاً في التشريعات التي تختص بالحفاظ على المناطق ذات القيمة التاريخية وخاصة في المدن العربية. ويشير خبراء الحفاظ المعماري إلى أنه قد تم الحفاظ على معظم المناطق التاريخية في المملكة المتحدة من التغيير بواسطة التشريعات الخاصة بالحفاظ على المناطق

المخطط الاشتراطات الخاصة بالمناطق التاريخية والسياحية والأثرية بما يكفل الحفاظ عليها وفقاً للقوانين المنظمة لها (قانون رقم 3 لسنة 1982) (الهيئة العامة لشئون المطابع الأميرية ،قانون رقم 3 لسنة 1982، 1997- ص 8). وفي قانون تنظيم المدن رقم 1936/28 في فلسطين فإنه يقتضي أن يتناول مشروع التنظيم المعد عديد من الأمور من ضمنها المحافظة على المواقع ذات الأهمية الأثرية أو الجميلة أو الأماكن المستعملة للعبادة أو المقابر أو الأماكن التي لها حرمة دينية (قانون تنظيم المدن رقم 28 لسنة 1936- مادة 14- ز) (الحايك والدحدوح 1997- ص 237).

ورغم عدم وجود أية مقاييس محسوبة لتعيين واختيار المناطق التاريخية لتصبح (مناطق حفاظ)، إلا أن المحدد الوحيد له هو أن الشخصية المعمارية لتلك المناطق تكون مميزة وتحمل طابعاً معمارياً وتخطيطياً تاريخياً يعود لأحد الأزمنة التاريخية أو أكثر، أو شهدت حدثاً تاريخياً، ويكون نسيجها العمراني متجانس ومتتابع ويمكن تمييزه عن المناطق الحديثة، إضافة إلى بعض العناصر مثل موقع المنطقة وعلاقته بالمحيط، وطريقة فهم الناس للمنطقة واستخدامهم لها، والفراغات المعمارية بها واللاندسكيب، وانفرادية المنطقة وتميزها ببعض الصفات عن غيرها (Historic England, p. 13).

وفي حال تعيين المناطق كمناطق حفاظ فإنه يتوجب أن تعامل كل المنطقة حسب تشريعات خاصة بها تنظم عمليات التطوير والإعمار فيها، ومن هنا تبرز اتجاهات عديدة وتحديات أمام المخططين وواضعي السياسات والاستراتيجيات لكيفية التعامل مع تلك المناطق كما هو مبين في البنود التالية.

2- التحديات التي تواجه التطوير العمراني للمناطق التاريخية : Challenges Facing the Development of Historic Areas

يواجه التطوير العمراني للمناطق ذات القيمة التاريخية بعض التحديات والعوائق التي يزداد تأثيرها في واقع المدن العربية، والتي يمكن تحديدها كما يلي :

2-1 – الموقع: في معظم الأحيان تقع المناطق ذات القيمة التاريخية في مراكز المدن مما يتطلب مرور الطرق ووسائل المواصلات وتوافر العديد من المرافق والخدمات بها على حساب نسيجها الحضري التاريخي.

2-2- القيمة التجارية والعقارية: تزداد القيمة التجارية والعقارية للأراضي والمباني الواقعة في المنطقة ذات القيمة التاريخية كونها تقع في مراكز المدن، مما يشكل ضغطاً باتجاه إعادة استغلالها لكسب المزيد من الاستثمارات.

2-3- صلاحية المباني للحياة: تفتقر بعض المباني في المناطق التاريخية إلى التهوية والإنارة الكافية وكذلك إلى الخدمات الأساسية من مياه وصرف صحي وخطوط هاتف واتصالات وغيرها.

2-4- الازدياد السكاني وعدم قدرة المباني التاريخية على التوسع لاستيعاب هذا الازدياد. ومما يزيد من تأثير هذا العامل هو الاضطرار إلى تقسيم ملكية المباني والأراضي الصغيرة نسبياً أصلاً إلى عدة أقسام بين العديد من الورثة، مما يؤثر في اتخاذ القرار بخصوص البناء الواقع في المنطقة التاريخية .

2-5- غياب التخطيط الملائم: اعتادت أن تعامل المناطق التاريخية مثلها مثل باقي المناطق في المخطط العام والهيكلي للمدينة، وفي بعض الأحوال تحدد تلك المناطق ويجمد التطوير فيها إلى حين إعداد مخطط تفصيلي لها.

2-6- محدودية الوعي تجاه أهمية المناطق التاريخية وعلى مستويات عدة، ويبدو موضوع تطويرها في العديد من المدن ليس على سلم الأولويات نتيجة لمفاهيم خاطئة تعتقد أن هذا التطوير هو عبئ مالي ليس له مردود على السلطة أو المؤسسة المسئولة.

3- التوجهات الخاصة بتطوير المناطق ذات القيمة التاريخية : Historic Areas Conservation and Development Strategies

يستنتج من خلال التجارب العالمية في تطوير المناطق ذات القيمة التاريخية وجود بعض التوجهات المختلفة والمتشابهة، سواء الفكرية والنظرية، أو العملية التي تمارس في شكل مشاريع تخطيط وتطوير. وتأتي هذه التوجهات والسياسات بعد تحديد المناطق التاريخية والإعلان عنها كمناطق ذات قيمة تاريخية خاصة، وتعتبر تلك الخطوة متقدمة لأنه طالما تم تحديدها والإعلان عنها فهذا بحد ذاته بداية الاهتمام بها وشمولها برعاية خاصة، أو على الأقل حمايتها من التغيير. ويمكن حصر التوجهات والأفكار الخاصة بتطوير المناطق ذات القيمة التاريخية في خمسة أطر كالتالي:

3-1- تجميد التطوير في المناطق المعينة Freezing Development: بتركها كما هي وإيجاد مراكز حضرية جديدة، وبذلك تفصل تلك المناطق حضرياً عن محيطها. ورغم المميزات التي من الممكن تحقيقها جراء هذا التوجه، والمتمثلة في إبقاء الحال كما هو والحفاظ عليه من التغيير، إلا أن تلك السياسات قد تؤدي إلى تحويل تلك المناطق لمناطق متخلفة عمرانياً داخل المدينة، مما يؤدي إلى هجرة السكان وتحول مبانيها ومناطقها إلى مناطق مهجورة " خرابات " . وقد تعمد بعض السلطات المحلية إلى تجميد التطوير في تلك المناطق والتحرر من مسئولياتها تجاهها بحجة الحاجة إلى مزيد من الوقت لعمل مخططات تفصيلية لها( Architect's Journal, p. 12).

3-2- تعزيز المناطق التاريخية والحفاظ على شخصيتها : Enhancement of the special urban character of the historic conservation areas

إن الحفاظ على شخصية المنطقة التاريخية يعني بالأساس المعالجة الدقيقة والمسئولة لكل العناصر التي تساهم في تشكيل التكوين الخاص بأي عنصر أو بمجمل العناصر بتلك المنطقة. فبالإضافة إلى تحسين المظهر للمنطقة فإن بعض التحسينات المادية سيكون لها أهمية ووسيلة لتحقيق الأهداف المرجوة (Pichard, 1996, p. 226). وحيث أن المناطق التاريخية قد بنيت لتحقيق جوانب المنفعة والجمال، وكذلك لتحقيق المتطلبات الاجتماعية لساكنيها، فإن السؤال المطروح هنا هو كيف يمكن العيش داخل تلك المناطق في وقت تختلف به الاحتياجات تماماً عن ذي قبل؟ ومن هنا تأتي فكرة تعزيز وتحسين المناطق التاريخية والحفاظ على شخصيتها وذلك من خلال معالجة القضايا التالية:

أ – الكثافة البنائية والعمرانية : تستدعي إمكانية العيش بشكل عصري داخل مناطق الحفاظ إلى إجراء تغييرات في الكثافة العمرانية بإزالة بعض الأبنية أو أجزاء من أبنية ليست ذات قيمة تاريخية للسماح بدخول الشمس وخلخلة الهواء في الأبنية

# إعادة تأهيل المناطق ذات القيمة التاريخية: بين الإشكاليات والحلول العصرية المبدعة

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**ملخص ABSTRACT**

من أهم القضايا التي برزت أمام المخططين في المدن في العصر الحديث هي إدراكهم لأهمية التراث العمراني واعتبارهم بأن الحفاظ عليه هو بمثابة عثرة في مواجهة احتياجات التطوير العمراني الحديثة، في الوقت الذي أثبتت تجارب بعض المدن بأن الحفاظ على المناطق التاريخية وإعادة إحيائها قد ساعد على حماية الرصيد الحضاري لتلك المدن، وفي نفس الوقت ساهم في تحسين ظروف السكن والخدمات لمواطنيها، وزاد من فرص السياحة الداخلية والخارجية لها.

يتناول هذا البحث الإشكالات التي تعيق التطوير الحضري للمناطق ذات القيمة التاريخية بهدف الحفاظ عليها وإعادة إحيائها، وفي نفس الوقت الحلول العصرية المبدعة التي تم تبنيها وممارستها في العديد من دول العالم، وخاصة تجربة المدن البريطانية في هذا المجال، وعلاقة كل ذلك بواقع المدن العربية.

وقد تم تصنيف وتبويب تلك الإشكالات في جزأين رئيسين في البحث: أولاها هو إشكالات فلسفة واستراتيجيات الحفاظ على المناطق التاريخية فيما يتعلق بتحديد درجة وشكل التدخل المطلوب والمناسب والجدل القائم بين فلسفة الحفاظ على طابع المنطقة ، وبين مواكبة العصر من استخدام أنماط ومواد بناء وتكنولوجيا حديثة. أما الجزء الثاني فهو عن الجوانب القانونية والإدارية المتعلقة بالآليات الفعالة لإدارة وتخطيط مشروعات الحفاظ العمراني.

ويخلص البحث في النهاية إلى وضع تصور لنماذج الحلول العصرية والمبدعة لإعادة إحياء المناطق ذات القيمة التاريخية والتي استخدمت بنجاح في دول العالم المختلفة ومدى تطبيقات ذلك ضمن الواقع الفيزيائي والاجتماعي والاقتصادي للمدن العربية. وبتطبيق تلك النماذج فإنه يمكن ليس فقط الحفاظ على المناطق ذات القيمة التاريخية كرصيد حضاري محلي ووطني وإنساني، وإنما يمكن أيضاً تحويل تلك المناطق إلى أجزاء حيوية في مدننا الجامدة، تسهم في تنمية المدن وتطورها.

**كلمات مفتاحية: الحفاظ المعماري – التطوير الحضري- المناطق التاريخية- استراتيجيات الحفاظ- إحياء**

**مقدمة:**

يكتسب الحفاظ على المناطق ذات القيمة التاريخية أهمية خاصة كونه يحقق أهدافاً حضارية تتمثل في إبراز العمق الحضاري للمنطقة الواقع بها هذا التراث المعماري، وأهدافاً اقتصادية واجتماعية تتمثل في إعادة الاستخدام وتشجيع السياحة، ويزداد الموضوع أهمية في حال وجود بعض الإشكالات والتحديات المتعلقة بفلسفة واستراتيجيات الحفاظ العمراني وبالجوانب القانونية والإدارية الخاصة بالحفاظ على المناطق التاريخية .

وبعد تاريخ طويل من ممارسة الحفاظ على المباني التاريخية والأثرية كعناصر منفردة، فقد ظهرت في الفترة الأخيرة صحوة عالمية نحو الحفاظ على القيم الفريدة في المناطق ذات القيمة التاريخية، وهي المناطق التي تشكل بمبانيها وطرقاتها وتخطيطها وسكانها قيماً تاريخية خاصة تستدعي الحفاظ عليها. وبذلك أصبح الحفاظ المعماري جزءاً من فكرة أوسع تتعلق بإدارة وتخطيط المدن والمناطق الحضرية.

وقد قطعت بعض الدول في العالم شوطاً في اختيار مناطق ذات قيمة تاريخية في جنبات مدنها، وفي وضع التخطيط المناسب والموازنات اللازمة لتطوير تلك المناطق التي أضحت تلعب دوراً هاماً في التنمية الاجتماعية والاقتصادية للمدن، ولم يخل عالمنا العربي من بعض المحاولات الجدية والناجحة في هذا الإطار، ولكنها لم تزل محدودة، وما زال شبح اندثار هذا الرصيد الحضاري العربي قائماً إلى أن يتم وضع السياسات والاستراتيجيات الجدية والمستندة على أسس علمية خاصة بالحفاظ عليه.

وسيتناول هذا البحث شرح لأهم الخطوات المتعلقة بالحفاظ على المناطق ذات القيمة التاريخية والمتمثلة في تحديد تلك المناطق، والتحديات التي تواجه التطوير العمراني للمناطق التاريخية، والسياسات المتعلقة بالحفاظ من جوانب عدة فكرية وعملية وتخطيطية وقانونية، مع طرح أمثلة من واقع التجربة العالمية في هذا المجال، ومدى ملائمة ذلك لواقع المدن العربية.

## 1- اختيار وتعيين المناطق التاريخية: Designation of Historic Areas

تعتبر المنطقة ذات القيمة التاريخية منطقة غير محدودة المساحة، فقد تكون جزءاً من مدينة أو قد تكون قرية أو بلدة بأكملها، بشرط أن يكون هذا الجزء أو الكل ذو أهمية تاريخية خاصة. وحسب التشريعات في المملكة المتحدة فإنه يتوجب على كل سلطة محلية من وقت لآخر أن تحدد أية أجزاء داخل حدود نفوذها تشكل مناطق ذات قيمة معمارية أو تاريخية خاصة، وأن تعين تلك المناطق كمناطق حفاظ ( Town & Country Planning Act 1971, s277(1)). وفي قانون التخطيط العمراني بمصر فإن التخطيط يحدد مواقع الخدمات العامة وخاصة المطارات وخطوط السكك الحديد وشبكات الشوارع والمرافق العامة وكذا المناطق التاريخية والأثرية إن وجدت بهدف تأمينها والحفاظ عليها، وفي البند رقم (6) من اشتراطات المناطق بالمخطط التفصيلي في المادة رقم (7)يشترط أن يبين

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