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Research Article

Implementation of Low Carbon Construction Activities in Order to Optimize Water Consumption on the Construction Site

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Abstract: The number of law carbon construction project had increased tremendously across Malaysia over the recent years. In fact, there is no doubt on the necessity of development law carbon construction and benefits that have for the society, specifically for the construction companies. In order to make significant inroads into the low carbon construction practices, the industry needs to improve its energy usage and natural resources consumed in all its construction site activities. This study attempts to evaluate the sources of CO_2 emission regarding water usage during construction project; secondly, to identify effective optimization method with regard to water usage in construction activities; and finally, to provide a plan of actions to minimize CO_2 emissions during construction activities. SPSS version 20 was used to analyse the collected data. 385 questionnaires were distributed to the construction companies in Malaysia. The findings revealed that, despite the importance of low carbon construction, not many companies are serious enough to cut down their natural resource consumption. The particular phenomena, myriad of contractors and construction firms in Malaysia have not yet paid attention binding themselves to carbon construction and green building's constitution in general by contrast to common construction activity. The location of the site for water is the main way for the law carbon construction and has been highlighted as the main reason of ignorance of the current situation within the construction sector. Indeed, introducing optimization methods is vital for contractors and supervisors of the sites to be motivated regarding inequality on usage of water during construction project, which lead to carbon dioxide creation. In addition to optimization water consumption, monitoring the usage of water during construction activity can play as a main role.

Keywords: Construction site, energy, low carbon, Malaysia, natural resource, water consumption

INTRODUCTION

There are a number of studies stressing on climate change as an important and real issue (Houghton *et al*., 2001). The Protocol of Kyoto in 1997, made attempts to find a solution for the climate change that is the outcome of greenhouse gas produced by construction, manufacturers, factories and transport sections (Dunn, 2002; Climate Change Secretariat, 2002). Industrial revolution has changed the life of human and this change is growing fast in the 20^{th} century. Thriving and developing in the industries have yielded innovative technologies that in turn have provided human with a better condition of life. We certainly pay for such a change by losing the natural environment. Global warming, paucity of natural resources, pollution of air, shortage of water and the critical change in climate are a few, but not all, negative consequences of employing modern technologies and using abundant energy without paying attention to their detrimental effects on planet, environment and more importantly future generations (Moxon, 2012).

The main reason for the rising amount of greenhouse gases at the atmosphere can be investigated in the inconsiderate fossil fuel use that is the main resource in cities, transport sectors and constructions. This type of increase in fuel consumption also results in global warming. Since 1880 the world temperature determined by the NASA's Goddard Institute for Space Studies Average has arisen to 1.4°F (equal to 0.8°C), much of such an increase has occurred in recent years. The Intergovernmental Panel on Climate Change (IPCC, 2001) of the United Nations stated that the last two decades of the 20th century could be regarded as the hottest years in the 400 years ago or more likely in the several millennia. “EL Niño of the century” has announced that since 1975, 1998 has been the hottest year (Christy and Spencer, 2003). All these numbers are trying to show one thing that an impending crisis is threatening the planet; therefore, all countries that are supervised by United Nation have made attempts to control greenhouse gases, more particularly CO_2 emission so that to slash the increasing temperature and finally to alleviate its impact on human life.

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Building has an influential role in decreasing energy consumption and in result positively supports the agenda of climate change- construction has a great share in emitting CO_2 to the atmosphere in the modernized societies (Roaf *et al*., 2004). Building is one of the parts of the society that require a great amount of energy-in the EU alone, around 40% of energy use is connected to the use, construction and deconstruction of buildings (Runci, 1999). In spite of remarkable progression in the directives to upgrade the efficiency of energy use in building (e.g., the EU Energy Performance of Buildings Directive), the structured nature of building procedures and the complicated procurement of construction have introduced some problems in implementation and promoting the instruments (Casals, 2006).

Today we have faced new challenges. Recently climate change has become a disputable issue since it has major effects on our lives. Climate change has reached to its critical point and is an important environmental issue. The issue has been exacerbated by population growth intensifying human influence on the planet and certainly has pernicious consequences if it is not considered deeply and carefully. Construction industry is also considered as one of the major contributors to the environmental damage. Because of this damage, law carbon construction was passed to alleviate the damage through sustainability and having law carbon construction (Moxon, 2012).

The amount of gases in atmosphere has reached a shocking level, maximizing the natural greenhouse influence. The greenhouse effect is a kind of procedure through which greenhouse gas (CO_2), occurring naturally in the atmosphere, absorbs radiation of surface of earth making the atmosphere warm and our planet a place of living. However, great amount of greenhouse gas intensifies this effect. Built in the atmosphere it forms a blanket surrounding the earth. This process gradually heats the earth up causing global warming and climate change (Wee-Kean *et al*., 2009). It is believed that developed countries are responsible for the highest amount of emissions of carbon per person and that the United Arab Emirates, the US and Australia are considered as the three top countries in terms of carbon emissions. Developing countries have changed this pattern and China has become the top country in emitting carbon and India in third rank while US is still in the second rank (Moxon, 2012).

CARBON DIOXIDE IN CONSTRUCTION

Before embarking on the issue of law carbon implementation in construction industry, it seems necessary to shed more light on the definition of what the spread of CO_2 as a greenhouse gas is meant in construction. A very exhaustive and comprehensible explanation of this concept paves the ways for the project to achieve its goals (Moxon, 2012). It also seems important to give a vivid and overall view of objectives of greenhouse in construction in order to clarify these parts. Identification of goals and objectives of greenhouse is very vital and useful. As it is clear, CO_2 is considered as a part of greenhouse gases although greenhouse includes some other gases as well. In this study our focus will be on carbon dioxide because CO_2 is the most gas emission in construction. Built environment has a potential role in decreasing the energy use and positively contributing into the agenda of climate change-construction is regarded as the main CO_2 producer in the industrialized countries (Roaf *et al*., 2004). Construction has remarkable energy requirements. In EU only, there is around 40% of energy use related to building use, construction and deconstruction (Runci, 1999).

WATER SAVING DEVICES AND PRACTICES: GENERAL ACTIVITIES

In the following lines, the water use will be discussed in the site construction:

Water supply: The type of water and wastewater are used and generated respectively by the site's activities determine how much is paid for supply of water and wastewater disposal by company. Generally speaking, the water source for each site is either surface water or mains water (McNab *et al*., 2011).

In Malaysia, several charging schemes are considered for wastewater and mains water (sewerage, trade effluent charges and surface water). The amount paid for these schemes depend on the used volume, the size of meter, the service provider and rateable value. Thus, mains water is more highly priced than the direct abstraction. Activities of using water in the construction site are not supposed to have potable standard.

Construction water use: The possible effect of tap water release pertains to the proximity of a water body, chlorine's concentration in the water, the water release's volume and the accessible capacity of dilution in the water body (Construction Water Use Guidelines, 1997). The following is a list of activities in the construction that lead to tap water release (Construction Water Use Guidelines, 1997; McNab *et al*., 2011):

- Breaks of mains water
- Roads of watering for controlling dust
- Spraying concrete
- Water addition to the backfill materials
- Cleaning the equipment
- Cleaning up the site

General awareness: The very first factor that needs to be taken into account in order to manage the water tap release is to have a clear understanding of the relationship between the environmental resources in surrounding and the construction site and also to realize the activities that are perilous for the resources in the site. The central parameters that have potential risks for tap water release are as follows (Construction Water Use Guidelines, 1997):

Table 1: Audit data request

Data	Purpose
Personal protective equipment requirement	To ensure the team fully complied with the on-site health and safety rules during the auditing activities.
Copy of water Supply Contract (or the terms of supply) and wastewater disposal arrangements	To understand the supply and charging arrangements which will assist us consider if there is a financial benefit to water efficiency or simply and environmental benefit. This data can assist prepare an economic argument for any water saving devices or practices.
Copies of water and effluent bills	This tariff optimisation task will ensure the site is benefiting from the lowest fixed and variable costs.
Site map	To understand the site layout and water using areas.
Description of construction project	To provide an understanding of the project construction stages in relation to water efficiency and to assist compare against future construction projects.
Estimate of construction site users and associated operating plan	To understand the expected domestic use of water for assistance in constructing a water mass balance. This will be compared against actual 24 h flow monitoring data to check for consistency and to identify any improvement opportunities.
Meter inventory	To build a picture of water use and on site flow monitoring strategy.
Water using equipment inventory	To understand water using processes on site.
Domestic arrangements	To understand the water use for domestic arrangements on site (e.g., temporary toilet or fixed water supply).
Other water sources) borehole supply, river abstraction, tankered supply, etc.)	To provide data on all water sources supplying the construction site so an accurate and representative water mass balance is constructed and cost impact is understood.

Mcnab *et al*. (2011), Phase I

- The closeness of water body to the site
- The aquatic sources are in danger in the water body
- Potential water's volumes that could be released from the construction site
- The flow and size of the closest water body
- Tap water's chlorine's concentration

Location of site: Concerning the possible dangers of consuming water tap in the site, the following factors should be considered (Construction Water Use Guidelines, 1997):

- The distance to the closest water body such as lake, creek and stream
- Any significant feature of environment like hatchery in the local water body
- The path flow from the water body to the construction site (like storm water system or overland)
- The possible discharge of flow points
- The flow and size of the closest water body

Volume of water: It is clear that the more volume of water is used in the site, the more dangers will be faced. For instance, washing equipment by hose does not introduce similar danger as washing the equipment with fire hose does (Construction Water Use Guidelines, 1997).

Nature of the water body: It is very important to realize the water body's nature that is close to the site in order to measure the possible risk. As an example, the rivers and creeks' flow changes considerably over time. The greater the flows, the more ability creeks have in order to dilute the water tap release. More specifically, the same water tap's volume pouring to the Fraser River could not have similar possible effects as to a small-sized creek (Construction Water Use Guidelines, 1997) (Table 1).

Our theory is to track the pipe which starts from water supply of the site to the point of use. This could help lowering the risk of missing activities of water using that could be ignore from staff's sight.

Water jet pump: Materials and techniques in the construction process can make the emission of CO_2 vary significantly. Thus, the expansion of reservoir embankment in the construction was divided into relocating road, waste disposal, appurtenant, water supply and pumping station. The emission of CO_2 in each of the given processes was individually measured according to the construction equipment, materials and transformation.

Sookack *et al*. (2011) in a study argued that water jets and other machines for water supply cause CO_2 emission. Further, they stressed more on the water jet that could be useful for identifying this step of the sections in the construction. Concerning the equipment, water jet pumps seem to be the main source of emission. They are mostly used for piling the sheet pile in the procedure of cofferdam. It seems that the emission caused by water jet pumps is quite high since their operation time is long due their low efficiency in the piling process.

In result, the water supply construction has the most emission in the whole process and in the sector of equipment; water jet pumps have the highest emission because of their low efficiency in the procedure of piling. The calculation of carbon footprint in the Water Bureau comprised of emission produced from the following resources:

- Electricity consumption for distribution of pump stations, groundwater, lighting and other uses of facilities.

- Fleet fuel-ignition of gasoline, diesel and biodiesel fuels for heavy machinery, power tools, transportation as it is stated that these sectors can be utilized for water supply (Sookack *et al*., 2011).

What is more important among these sections is electricity used to bring water to the construction site. As it has been mention before, electricity is one of important components for producing CO_2 on the site. Therefore, when water jets are used on the site, CO_2 is created by using electricity for bringing water to the site. It is also created by other machines that do the same activity.

Housekeeping: Establishing a culture on the construction site in order to change the attitudes of staff to acknowledge priority of water efficiency is vital step for developing water use in an impressive way. Efficient housekeeping (repairing/reporting leaks, closing taps that are not used and generally efficient water use) can help construction site decrease the total use of water. The range of attitudes toward water use varies considerably across the site. Some believe that water use should be lessened without considering its cost effect while some emphasize that water is a cheap source and have attitude of "don't pay, don't care". No evidence was found in the audited sites to indicate that there is awareness training for staff on the efficiency of water use. This is a good area to be improved. In that respect, contractors should make sure that staffs know how much water is used and targets of water efficiency used on the site. Therefore, general issues of housekeeping need to be examined in the workshops to advocate the culture of efficient water in the projects. Finally, if there are any applications of water using which are significantly important (such as plant of concrete batching), particular training is required for the operators (McNab *et al*., 2011).

Monitoring and targeting: How much a site is monitored varies from site to site. In some cases there is no monitoring while in other cases there is a staff responsible for regular meter readings. Construction companies are supposed to consider four important areas which are presented below in order of priority:

- Make sure that water use on the site has been quantified
- Regularly record the water use
- Have Key Performance Indicators (KPIs) to help knowing the water efficiency track
- Establish targets of improvement according to KPI data or consumption

Embodied water: Embodied water shows the net consumed water in different processes of building, from material extraction to the final product. The annual savings of water based on a presupposed performance of 255 ML are as follows:

Table 2: Indicative indices for embodied water

Biulding material	KL/m^2 GFA	Structure group	KL/m^2 GFA
Steel	9.00	Finishes	10.5
Concrete	3.50	Substructure	6.00
Glass	7.50	Roof	5.75
Other metals	7.00	Windows	2.00
Direct water	0.75	Direct water	8.25
Other items	22.0	Structure group	0.50

- Picking up appliances and fittings with high performance 40 ML
- Harvesting rainfall for use of potable water 40 ML
- Treatment of grey water and re-use (supposing 1 is conducted) 160 ML
- Treatment of black water and re-use (supposing 1 is conducted) 55 ML

This refers to the possible overall saving of approximately 255 ML the potential overall saving is assessed according to the basis of net purchase of water. However, practical limitations could hinder this potential (Brockman, 2007). Embodied water is similar to the embodied energy showing the net water used in different phases of construction from extraction of resource to the final phase. The embodied water in a typical building illustrates fifteen years' worth of operational water (such as garden watering) or even ten times of habitable space (Deakin University, Architecture and Building Website, 2007). No values have been mention in the literature for embodied water in the high rise buildings. The closest estimation is for 3-floor constructs (Crawford and Treloar, 2005). This estimate is not precise; however, it renders indicative values shown in Table 2.

Projected grey water treatment and reuse: In conventional design, there is no difference between grey and black water. Both of them are directed through drains of subsurface sewer on the site. In addition, the proposal has no reuse of grey water on the site (Brockman, 2007).

Potential impacts to the environment: In addition to the emission of CO_2 by consuming water on the site, the entry of chlorine into water body could be very perilous. Its present could kill aquatic creatures such as fish. The chemical processes of chlorine's effects have not been completely identified. One of its effects has to do with gill membranes. Damage to this part could prevent fish from normal breathing (Construction Water Use Guidelines, 1997). The possible influence of release of tap water depends on several factors including closeness to water body, chlorine' concentration in the water, volume of released water and dilution capacity of water body.

CARBON REDUCTION TIPS

Saving water:

- Conduct tests of leakage on concealed piping and examine the tanks overflowing, worn tap washers, waste and other possible defects in the system of water supply.
- Immediately repair the taps dripping.
- Decrease the pressure of water to the nadir of practical level.
- Accumulate the consumed water for purpose of cooling, washing yards and cleaning floor.
- On holidays and at night, turn the water supply system off.
- Make sure that hot water pipes run as shortly as possible and that pipes of cold water are far away from heated areas.
- Put publicity materials and posters in notice boards to promote the conservation of water.
- Identify the water requirements of each facility and often examine usage.
- Consume reclaimed water for use of non-drinking (Guidelines to Account, 2010).

General preventative measures: There are several preventative steps to reduce the danger of environmental impacts. One of the given steps is that all constructors and works should be aware of the possible effects of tap water release. This can be accomplished through meetings of the site at the beginning of the project to argue the issues and mitigation measure on the site. The other step is to place notices showing the importance of direct release of tap water in the dangerous areas (Construction Water Use Guidelines, 1997).

It is essential to inform all constructors of the potential risks of tap water release. The general preventative considerations that could be conveyed to the site personnel are as follows:

- Water conservation.
- After use, quickly turn off hoses and taps.
- Never allow a hose or pipe to discharge into a ditch, storm drain, creek, or other kinds of water body.
- If possible, allow water to penetrate into the ground and not to run off the construction site.
- If there is any pond on the site, guide the extra water to them.
- Berm the regions that have a danger of tap water release with bags of sand or other materials to let contaminate.
- If possible, consume non-chlorinated water resources including ponds on the site.
- If it is necessary, build ponds for water detention. Sunlight, time and air can also reduce the strength of chlorine (Construction Water Use Guidelines, 1997).

METHODOLOGY

Introduction: The international trend is toward creating a cleaner and better environment for coming generations. The emergency of stopping worldwide emissions has made researchers to circumvent new ways to curb the emissions. A number of countries have predestined some goals regarding the pollutants, which are supposed to be reached by middle of the current century. The influence of activities of the construction on the environment obligates examining the pollutants that are used in some ways in the construction activities (Shaik and Samuel, 2009).

Why focus on Malaysia: In the last two decades, the construction industry in Asian region has grown dramatically and is poised to continue the growth (Bon and Crosthwaite, 2000; Raftery *et al*., 2004). The construction boom signifies the co-existing scenarios of resources being well utilized or unfortunately wasted. The study on the fast economic growing regions in Asia is thus important (Chan *et al*., 2009).

Malaysia is a south-eastern country in Asia with an area of 329,847 km^2. According to the report of Department of Statistics Malaysia, Malaysia has a population of about 29 million with 2% growth rate of population in 2010 accompanied with 71% urbanization. The government of Malaysia has started a series of developing programs to be fully identified as a developed country in 2020. These programs have changed Malaysia into a country at top speed of development and industrialization. The rapid rate of urbanization has made the country face serious environmental problems such as pollution of air and water in cities like Johor Bahru, Penang and Kuala Lumpur. Cutting trees and tapering off the forests areas with the purpose of urbanizing and expanding industrial zones have introduced new threats to the natural environment in Malaysia.

Simply concluding, the more population grows, the more activities human will have. The only critical result of increase in human population and then activities is environmental problems discussed above (Houghton, 2004).

In Malaysia construction industry is derived from wealth generation that has developed economic, social and building infrastructure. Thus, construction industries with all its branches are dealt with and concentrate on the best projects of construction. Construction sectors engaged 800, 000 workers in the projects comprising 8% of total employees in the world. Construction industry is considered as one of the most productive sections which have a constant relationship with economy (Fong *et al*., 2008).

It is argued that construction industry is more likely to have the greatest impact on the environment and society due to its broad territory of activities. The

Table 3: Number of contractors by grade

Grade	Bidding Limit	2006	2007	2008	2009
G1	Not exceeding RM200.000	36.141	34.581	34.060	33.633
G2	Not exceeding RM500.000	6.937	7.300	7.516	8.095
G3	Not exceeding RM1.000.000	10.043	10.572	10.963	10.981
G4	Not exceeding RM3.000.000	2.140	2.340	2.420	2.613
G5	Not exceeding RM5.000.000	2.816	3.078	3.363	3.673
G6	Not exceeding RM10.000.000	1.003	1.065	1.206	1.437
G7	Unlimited	3.736	4.191	4.285	4.326
Foreign	Unlimited	163	163	164	166
Total		62.979	63.290	63.977	64.924

CIDB Malaysia

relevant evidence from recent research in this part has divulged that in 2007 progress growth in construction industry was 5.3% which has contributed 2.1% of total Gross Domestic Product (GDP) in Malaysia (Fong *et al*., 2008).

Regarding this undesirable condition, advocating green buildings has never been felt so essential than today since the increase in emission of greenhouse gases is constantly changing the patterns of climate. In 1990 the government of Malaysia has enacted the Green Building Index in order to approach sustainable construction development and to intensify the natural environment. In Malaysia, exemptions from stamp duty and tax breaks are respectively granted to the building owners who want to have GBI certificates and buyers who want to purchase houses with GBI certificates. These actions launched by government develop and backbone green buildings across the whole country and make it more enticing for people.

Why water-related construction activities in focus? Water and Energy are essential elements for the well-being of the societies. The world energy consumption for water distribution is about 7% of the global energy (Coelho and Andrade-Campos, 2014). Nowadays an increased distance between populations and water sources is observed due to population growth, leading to fast expansions of several water networks. At the same time, the global water consumption has quadrupled in the last 50 years and it is expected that this value would continue to increase. Consequently, the immediate consumers supply without any planned strategy has led to inefficient operated systems, increasing the energy costs for water supply and distribution (Coelho and Andrade-Campos, 2014).

Target respondents and sample selection: As this study concentrated on the CO_2 emission in relation to water usage during construction period in Malaysia, using the interview for collecting data was not possible because of large scope and shortage of time, manpower as well as financial resources. Therefore, questionnaire survey as an effective method had been selected to collect data for this study. Questionnaires are more suitable to this study than interview because questionnaires make it faster to key in data, are well-structured and do not take much time as time is very valuable for the study. The noticeable shortcoming of questionnaires is that a low rate of them is returned. Regarding this problem, all the questionnaires were submitted to respondents by hand and was tried to collect them on spot. Even by using this method, only 31% of distributed questionnaires were returned.

Using this kind of tool in the present study can make the contractors wary of their activities' effect on the environment by showing the major factors contributing into CO_2 emission. This study helps them conscious of which part in the activities of construction is more critical and requires a greater amount of attention in order to lower the CO_2 emission and create greener construction or activity.

A total of 385 sets of questionnaires were handed to the respondents. Questionnaires were distributed in main districts of Malaysia and Construction Company to have comprehensive survey. A total 31 (8%) questionnaires were received and data was analyzed. Frequency analysis was used as preliminary analysis. This method will show the frequency and the percentage. In order to generate the results the researcher had used the Statistical Packages for Social Science (SPSS), version 20.

- **Registered contractors by grade:** As of 31st December 2010, CIDB Malaysia's record showed a total of 64,924 registered contractors in 2009. More than 80% or 52,709 of the contractors were registered under G1, G2 and G3 grades; while the rest consisted of contractors registered under G4-G7 grades and foreign contractors (Shaffii, 2010). Actually the G7 of contractors registered can be considered in this research, because of the big range of penetrate that have on construction.

According to Table 3, to achieve reliable data 385 questionnaires were distributed to be adopted with the standard sample size.

Design of the questionnaire: Therefore finding the affordable and acceptable main object for construction activity can be helpful for optimizing usage of water in construction site. The data which are collected in the section A and B of questionnaire are fruitful for this

Table 4: Section B part 1

The location of site
Water main breaks
watering roads for dust control
spraying concrete
adding water to backfill material
Equipment cleaning
Site clean-up
use of equipment
insulated site accommodation
Time working in the night

Table 5: Section C

Use water from the mains
Use surface water
Reuse grey water
Use water harvested from rainfall
Reduce water pressure to the lowest practical level
Ensure all areas of site water consumption are quantified.
Record site water consumption on a regular basis.
Create Key Performance Indicators (KPIs) to assist tracking of water efficiency.
Utilize consumption or KPI data to set improvement targets.
Determine water requirements for each facility and check usage frequently.
Change staff attitude towards water usage
Organizing workshop for effective water consumption
Place posters and other publicity materials in prominent places to encourage water conservation.

purpose and provide the accurate estimate for the usage of these water factors of carbon emission on site. The main feature of this study is to evaluate sources of CO_2 emission in relation to water usage during construction period and optimize this factor which focuses on project managers, engineers and architects, who work on construction sites. It is necessary to look at the topic from their point of view.

- **Summary of questionnaires:**

Section A: In this part, respondents were asked basic questions. This section provided clear vision about respondents their background. This section consists following items:

- Gender
- Age
- Work experience in construction development projects
- Education level
- Job position
- Involvement in construction project

Section B: In this section the questionnaire divided to two main parts. Firstly, respondents were asked to answer 10 questions. The aim of this part is to find out the usage level water in construction activity. It is important to find out the main usage sector for water in constructions site for purchasing to low carbon construction, as they influence in creating more carbon dioxide (Table 4).

Section B, part 2: This section considers on optimizing water consumption on site. It provides details about water usage on site in three important parts that can be counted as Supply Water, Monitoring and Targeting and Housekeeping. Totally section C has thirteen questions. In Section C tried to find effective method for decreasing water consumption (Table 5).

ANOVA: ANOVA (Analysis of Variation) is a statistical analysis that estimates the differences between various group responses or a test to determine differences in means (Trochim, 2001). A One-Way Analysis of Variance analyses the variance of a quantitative dependent variable by a single independent variable. I used one-way ANOVA procedures to compare means between different elements of water consumption to establish if differences in the strand scores existed. For example, I used ANOVA to determine whether the effect of site location and the other elements that used on consumption of water (a dependent variable) is significantly differing between locations. I selected ANOVA rather than t-tests because the independent variables have more than two groups.

DATA ANALYSIS AND FINDINGS

An overview is obtained by calculating the mean, median and modal values in Table 2 and 3. These measures of dispersion are used to assess the homogenous or heterogeneous nature of the collected data (Bernard, 2000). Analysis of the collected data shows relatively close values of means, medians and modes, with low values of variance and standard deviation. This contras the acceptable quality and homogeneity of the collected data as well as a reasonable low degree of dispersion resulting in reliable findings (Chan *et al*., 2009).

Section B part 1: The level water consumptions: In this section, questions were asked to identify the main water usage that related to construction site activity from supervision of site and respondent's point of view. It is essential to find out levels of water consumption to achieve low carbon construction, with finding the main way of using ware at construction site we can manage it and try to decrease this way of using and with attention to this and decrease the carbon emission during construction on site. In addition funding these barriers will make Greenhouse Gasses (GHG) decreasing and make contractor or anyone else who is related to the construction activities aware about this way and their relativeness to carbon emission part. Also it's definitely related to the first research question of the paper that is evaluated sources of CO_2 emission in relation to water during the construction activities.

Table 6: Rank of factors for water-related to construction activities

	Mean	SD	Mode	Min	Max	Sum	Rank
The location of site	3.4667	0.97320	3.00	2.00	5.00	104.00	1
Water main breaks	2.8710	0.92166	2.00	1.00	5.00	89.000	7
Watering roads for dust control	3.3871	0.84370	4.00	1.00	5.00	105.00	2
spraying concrete	3.2903	1.00643	4.00	1.00	5.00	102.00	3
Adding water to backfill material	2.7097	0.93785	3.00	1.00	4.00	84.000	8
Equipment cleaning	3.0323	0.87498	3.00	1.00	5.00	94.000	5
Site clean-up	3.2258	1.11683	4.00	1.00	5.00	100.00	4
Use of equipment	2.9677	0.79515	3.00	1.00	4.00	92.000	6
Insulated site accommodation	3.0323	0.94812	3.00	1.00	5.00	94.000	5

SD: Standard Deviation

Generally this section separated to two different sectors. First is the water-related to construction activity. This part tried to give the question that came out of the literature review and have the most effective power in the consumption of water and as following that have effect on creating carbon dioxide and generally Greenhouse Gasses (GHG).

Rank of factors for water-related to construction activities: According to the data, the location on the site with a mean 3.46 is the most important factor in the level of water usage during construction activities as respondent's point of view. Watering roads for dust control is the second factor with a mean 3.38. Spraying concrete was third effective element with a mean 3.29. Site clean-up, insulated suite accommodation, use of equipment, Water main breaks and adding water to backfill material located at lower positions (Table 6).

ANOVA Test among water-related construction activities: The Appendix A shows the output of the ANOVA analysis in a growth model for Water-Related Construction Activities. We can see the F ratio that is equal to 2.176 and the significance level is 0.03 (p = 0.03) *, which is below than 0.05. Therefore, the mean lengths of water usage in construction activities are not all equal. The Post hoc test was conducted (Appendix A) to elaborate between which construction activities the differences are. The result showed, the usage of water between location of the site and adding water to backfill material are significantly different ($p<0.05$). The location of the site with mean (3.46) have highest level and adding water to backfill material with (2.70) mean is variable with less effect.

The location of site: According to the result, 35.5% of respondents stated that, the location of the site about water consumption has average role to the level of usage of water and can have good effect on water usage, 29.0% confirmed, it is a high factor among agents. 16.1% of research respondents rated the site location is very high as a factor and the same as they 16.1% believed that the site location is not an important factor or is better to say they say it low affect factor on water usage on site construction.

Watering roads for dust control: Watering roads for dust control is foundation for construction site activity. Generally this rule is applicable and needed for almost all construction sites and activity. This section attempts to identify the importance of watering roads for dust control during construction activity on the site as a factor from contractor or supervisor' point of view. 48.4% of respondents confirmed that, water roads for dust control is high effect factor, 35.5% believed that, this item was an average factor for site usage of water.

Spraying concrete: Sometimes spray concrete concept perceived as a temporary alternative style via contractor or supervisor for construction site activities. Therefore, supervisor must use water on concrete and spray part of it for a period of construction activity. This part intends to find out, may this spray concrete and generally water used in concrete considers as factor for construction activities consumption of water and as continuing for low carbon in construction or not, 35.5% of respondents believed that, this issue has high effect of water usage, 32.3% Confirmed that, spray concrete for construction site is an average factor.

Rank of facts: water usage on site: In this section, study aims to find out the ways to optimize water used on construction sites from respondent's experience and point of view and will try to identify the method that is the effective ways for decreasing water usage. Based on the information that founded on literature review, optimizing method of water usage could be separated in three parts. The first section is supplied water, it's a component of five parts that tried to defend the rich method of water supplying can be more effective on optimizing water consumption. Second part is Monitoring and Targeting that try to realize with monitoring and the method which included in it will be able to optimize water or not. Finally the last part is about the Housekeeping method that is on giving awareness to the personnel can find any method to optimize water usage.

Rank of factors for optimizing water usage on site: By understanding their preferences, designing more effective and efficient method for optimizing water consumption and to stimulate contractor to decreasing their water usage, Table 7 show all the rank of the ways that respondents chosen. By using this method for optimizing water usage, as resultant reduction of

Table 7: Rank of factors for optimizing water usage on site

	Mean	SD	Mode	Min	Max	Sum	Rank
Supply water							
Use water from the mains	3.77	0.66881	4.00	2.00	5.00	117.00	5
Use surface water	2.90	1.13592	4.00	1.00	5.00	90.00	10
Reuse grey water	2.77	1.05545	2.00	1.00	5.00	86.00	12
Use water harvested from rainfall	3.12	1.14723	3.00	1.00	5.00	97.00	9
Reduce water pressure to the lowest practical level	2.80	1.24952	2.00	1.00	5.00	87.00	11
Monitoring and targeting							
Ensure all areas of site water consumption are quantified	4.06	0.89202	4.00	2.00	5.00	126.00	1
Record site water consumption on a regular basis	3.93	0.77182	4.00	2.00	5.00	122.00	3
Create Key Performance Indicators (KPIs) to assist tracking of water efficiency	3.45	1.17866	4.00	1.00	5.00	107.00	7
Utilize consumption or KPI data to set improvement targets	3.41	1.05749	4.00	2.00	5.00	106.00	8
Determine water requirements for each facility and check usage frequently	3.80	0.83344	4.00	2.00	5.00	118.00	4
Housekeeping							
Change staff attitude towards water usage	3.96	0.65746	4.00	3.00	5.00	123.00	2
Organizing workshop for effective water consumption	3.45	0.92516	4.00	1.00	5.00	107.00	7
Place posters and other publicity materials in prominent places to encourage water conservation	3.61	0.80322	4.00	2.00	5.00	112.00	6

Table 8: The appropriate construction methods to minimize the CO_2 emission

The 5 first factors for optimizing water usage on site	Ensure all areas of site water consumption are quantified Change staff attitude towards water usage Record site water consumption on a regular basis Determine water requirements for each facility and check usage frequently Use water from the mains

Carbon dioxide on construction activities, can have managed water usage and cleaner construction activities.

As this mention on the Table 8 rank one is Belonging to Monitoring and targeting part, the ensure all areas of site water consumption are quantified is the first important factor, as follows this factor there is (in Housekeeping section) Change staff attitude towards water usage. Again, the third part is included to Monitoring and Targeting section; it is Record site water consumption on a regular basis. As respondents' idea forth part are Determine water requirements for each facility and check usage frequently. The supply water section contains fifth level in this category as a respondent opinion with Use water from the main part.

Generally, the majority of the respondents had more believers on Monitoring and Targeting section. The answers showed that after monitoring and targeting section Housekeeping section get next level in this arrangement and last space in belonging to the Supply Water section.

ANOVA test among water usage on site: The Appendix B shows the output of the ANOVA analysis for logging in optimizing water usage. The F ratio is equal to 6.602 and the significance level is 0.000 ($p<0.001$). Therefore, the mean lengths of Water Usage on Site are not all equal. Post hoc tests reveal the usage of water from the mains significantly differ with surface ($p<0.05$), Reuse grey water ($p<0.01$) and also Reduce water pressure to the lowest practical level ($p<0.01$).

In addition, the mean usage water of Equipment cleaning ($p<0.01$) and Site clean-up ($p<0.05$) significantly differ from Time working in the night. It emerged that Time working in the night is and effective variable that has 3.67 mean and it is very high compare other variables.

The usage of water after using surface water are significantly different from ensure all areas of site water consumption are quantified ($p<0.001$), this record site water consumption on a regular basis ($p<0.05$), change staff attitude towards water usage ($p<0.001$) and Determine water requirements for each facility and check usage frequently ($p<0.05$).

The usage of water through reusing grey water is significantly different from ensure all areas of site water consumption are quantified ($p<0.001$), Record site water consumption on a regular basis ($p<0.001$), Determine water requirements for each facility and check usage frequently ($p<0.01$), change staff attitude towards water usage ($p<0.001$) and Place posters and other publicity materials in prominent places to encourage ($p<0.05$).

Use water harvested from rainfall is significant different from Ensure all areas of site water consumption are quantified with ($p<0.05$) and change staff attitude towards water usage ($p<0.05$).

Usage of water after reducing water pressure to the lowest practical level is significantly different from, Ensure all areas of site water consumption are quantified with ($p<0.001$) Record site water consumption on a regular basis ($p<0.001$), Determine water requirements for each facility and check usage frequently ($p<0.01$), Change staff attitude towards water usage ($p<0.001$).

According to Appendix B it's emerged that the questionnaire had strongly significantly with each other and the numerical difference is too much among the top method to decrease water usage and down method in this category.

Ensure all areas of site water consumption are quantified: Another method in optimizing water consumption (sub-section of monitoring and targeting) that was introduced to respondents was ensure all areas of site water consumption are quantified. According to the results, for 51.6% of respondents are agreeing on this factor for optimizing water consumption, 32.3% of respondents stated strongly agree with quantifying of the water consumption method. Although 6.5% of respondents are somewhat agreeing with mentioned method, Mean 4.06 and sum (126 of 155) shows that ensure all areas of site water consumption are quantified element can be considered as an important factor to optimizing water consumption.

Change staff attitude towards water usage: According to the results, for 58.1% of respondents are agreeing with Change staff attitude towards a water usage method for optimizing water consumption, 22.6% of respondents somewhat agrees with this way and finally 19.4% as respondent strongly agree with this and see it as a very important factor that can achieve for them optimizing water usage on sites. Mean 3.96 and sum (123 from 155) shows that change staff attitude towards water usage is considered as an important factor of optimizing.

Record site water consumption on a regular basis: Another optimizing method which introduced to respondents was Record site water consumption on a regular basis for construction sites. According to the results, 51.6% of respondents stated that they are agreeing with this way for optimizing and see it as effective way, 22.6% of respondents believed are strongly agreeing about recreation of water consumption that will happen with this way, but on the other side 22.6% of respondent are Somewhat Agree about this way that mentioned. On the opposite side just 3.2% of respondents ignored it as a factor that can optimize the usage of water and are disagreeing about it. A mean 3.93 and sum (122 from 155) locate this was at middle level among the other factors and methods.

Determine water requirements for each facility and check usage frequently: It reveals that, the majority of respondents 67.8% were strongly agreed or agree that determine water requirements for each facility and check usage frequently is decent for optimizing water consumption and sites. On the other hand, 25.8% of respondents were Somewhat Agree that the determination water requirements are sufficient for site optimizing. Only 6.5% of respondents stated that they disagree about the being decent of the mentioned method. A mean 3.80 and sum (118 from 155) confirm significant level of determining the water requirements for each facility and check usage frequently way for optimizing water consumption.

Use water from the mains: Results show that, 61.3% of respondent confirmed that they are agreed about Use water from the mains can be an effective and important way to optimize water, 25.8% stated that respondents are Somewhat Agree about Use water from the main factor, 9.7% of respondents are Strongly Agree with it. In opposite side, 3.2% of respondents stated that Use water from the mains is not attractive and important for them and they disagree with this optimizing way. Mean 3.77 and sum (117 from 155) show the level of water from the main importance as an effective method for optimizing water consumption (as respondents believe) on construction site activities.

DISCUSSION AND RECOMMENDATIONS

To achieve accurate data for this study wide range of respondents were asked to answer the questionnaires. Different education, ages, job position and work experience in construction development projects have been covered by this study. As this study concentrates on low carbon construction, therefore Involvement in construction project was necessary to be determined as well as having good results as their experience of the respondent. The sample can be representative of the construction site (and its useable for contractor and supervisors for their construction activities) which the results will be applicable there.

The first objective of this research was, to evaluate sources of CO_2 emission in relation to water usage during construction period. This section is about evaluating sources of CO_2 emission that came out of water consumption during construction activity:

- As a result of this study for the first separated part about resources of water usage, it was found that “The location of the site” was perceived as the most important factor as respondents idea for water usage and they see it as an effective method for water consumption and low carbon construction.
- “The watering roads for dust control” was the second factor that respondents see it as an effective factor on water usage.
- “The spraying concrete” and generally “The water used for concrete” was another item that increasing water usage during construction activities and as result the carbon dioxide creation.

The main objective of this study is to identify effective usage to optimize water usage in construction activities to decreasing carbon dioxide and having low construction. The optimization is directly related to Energy Efficiency (EE) and using Renewable resources, as continuing using and working with this to factor optimizing will be achieved. As I mentioned in above, optimizing water consumption is divided into 14 sections.

In the first section optimizing water separated to “Supply water”, “Monitoring and Targeting” and “Housekeeping” parts. The new method must be effective as well as earliest ways of using water in construction activities are for supervisors. According to the results, "Monitoring and Targeting" method are more effective from other methods, first and third and fourth effective part (from respondent idea) are belonging to this section:

- "Ensure all areas of site water consumption are quantified for purchasing greener homes" is the most optimizing ways for water consumption.
- Accordingly, by introducing a new special method to water optimizing is "Change staff attitude towards water usage" that is belonging to "Housekeeping" section.
- "Record site water consumption on a regular basis" is in third.
- And "Determine water requirements for each facility and check usage frequently" is on forth section.
- "Use water from the mains, Place posters and other publicity materials in prominent places to encourage water conservation", is another effective way for optimizing water usage in construction activities.

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Appendix A: Water-related construction activities

ANOVA

Water-related construction activities

	S.S	df	Mean square	F	Sig.
Between groups	15.3600	8	1.920	2.176	0.030
Within groups	237.402	269	0.883		
Total	252.763	277			

Post Hoc tests:

Multiple comparisons:

Dependent variable: Water-related construction activities Tukey HSD

					95% confidence interval	
(I) Factor	(J) Factor	Mean difference (I-J)	S.E.	Sig.	Lower bound	Upper bound
WR1	WR2	0.59570	0.24060	0.248	-0.1567	1.3481
	WR3	0.07957	0.24060	1.000	-0.6728	0.8320
	WR4	0.17634	0.24060	0.998	-0.5761	0.9287
	WR5	0.75699*	0.24060	0.047	0.0046	1.5094
	WR6	0.43441	0.24060	0.679	-0.3180	1.1868
	WR7	0.24086	0.24060	0.986	-0.5115	0.9933
	WR8	0.49892	0.24060	0.494	-0.2535	1.2513
	WR9	0.43441	0.24060	0.679	-0.3180	1.1868
WR2	WR1	-0.59570	0.24060	0.248	-1.3481	0.1567
	WR3	-0.51613	0.23862	0.433	-1.2623	0.2301
	WR4	-0.41935	0.23862	0.710	-1.1656	0.3269
	WR5	0.16129	0.23862	0.999	-0.5849	0.9075
	WR6	-0.16129	0.23862	0.999	-0.9075	0.5849
	WR7	-0.35484	0.23862	0.861	-1.1011	0.3914
	WR8	-0.09677	0.23862	1.000	-0.8430	0.6494
	WR9	-0.16129	0.23862	0.999	-0.9075	0.5849
WR3	WR1	-0.07957	0.24060	1.000	-0.8320	0.6728
	WR2	0.51613	0.23862	0.433	-0.2301	1.2623
	WR4	0.09677	0.23862	1.000	-0.6494	0.8430
	WR5	0.67742	0.23862	0.109	-0.0688	1.4236
	WR6	0.35484	0.23862	0.861	-0.3914	1.1011
	WR7	0.16129	0.23862	0.999	-0.5849	0.9075
	WR8	0.41935	0.23862	0.710	-0.3269	1.1656
	WR9	0.35484	0.23862	0.861	-0.3914	1.1011
WR4	WR1	-0.17634	0.24060	0.998	-0.9287	0.5761
	WR2	0.41935	0.23862	0.710	-0.3269	1.1656
	WR3	-0.09677	0.23862	1.000	-0.8430	0.6494
	WR5	0.58065	0.23862	0.270	-0.1656	1.3269
	WR6	0.25806	0.23862	0.976	-0.4881	1.0043
	WR7	0.06452	0.23862	1.000	-0.6817	0.8107
	WR8	0.32258	0.23862	0.914	-0.4236	1.0688
	WR9	0.25806	0.23862	0.976	-0.4881	1.0043
WR5	WR1	-0.75699*	0.24060	0.047	-1.5094	-0.0046
	WR2	-0.16129	0.23862	0.999	-0.9075	0.5849
	WR3	-0.67742	0.23862	0.109	-1.4236	0.0688
	WR4	-0.58065	0.23862	0.270	-1.3269	0.1656
	WR6	-0.32258	0.23862	0.914	-1.0688	0.4236
	WR7	-0.51613	0.23862	0.433	-1.2623	0.2301
	WR8	-0.25806	0.23862	0.976	-1.0043	0.4881
	WR9	-0.32258	0.23862	0.914	-1.0688	0.4236
WR6	WR1	-0.43441	0.24060	0.679	-1.1868	0.3180

Appendix A: Continue

	WR2	0.16129	0.23862	0.999	-0.5849	0.9075
	WR3	-0.35484	0.23862	0.861	-1.1011	0.3914
	WR4	-0.25806	0.23862	0.976	-1.0043	0.4881
	WR5	0.32258	0.23862	0.914	-0.4236	1.0688
	WR7	-0.19355	0.23862	0.996	-0.9398	0.5527
	WR8	0.06452	0.23862	1.000	-0.6817	0.8107
	WR9	0.00000	0.23862	1.000	-0.7462	0.7462
WR7	WR1	-0.24086	0.24060	0.986	-0.9933	0.5115
	WR2	0.35484	0.23862	0.861	-0.3914	1.1011
	WR3	-0.16129	0.23862	0.999	-0.9075	0.5849
	WR4	-0.06452	0.23862	1.000	-0.8107	0.6817
	WR5	0.51613	0.23862	0.433	-0.2301	1.2623
	WR6	0.19355	0.23862	0.996	-0.5527	0.9398
	WR8	0.25806	0.23862	0.976	-0.4881	1.0043
	WR9	0.19355	0.23862	0.996	-0.5527	0.9398
WR8	WR1	-0.49892	0.24060	0.494	-1.2513	0.2535
	WR2	0.09677	0.23862	1.000	-0.6494	0.8430
	WR3	-0.41935	0.23862	0.710	-1.1656	0.3269
	WR4	-0.32258	0.23862	0.914	-1.0688	0.4236
	WR5	0.25806	0.23862	0.976	-0.4881	1.0043
	WR6	-0.06452	0.23862	1.000	-0.8107	0.6817
	WR7	-0.25806	0.23862	0.976	-1.0043	0.4881
	WR9	-0.06452	0.23862	1.000	-0.8107	0.6817
WR9	WR1	-0.43441	0.24060	0.679	-1.1868	0.3180
	WR2	0.16129	0.23862	0.999	-0.5849	0.9075
	WR3	-0.35484	0.23862	0.861	-1.1011	0.3914
	WR4	-0.25806	0.23862	0.976	-1.0043	0.4881
	WR5	0.32258	0.23862	0.914	-0.4236	1.0688
	WR6	0.00000	0.23862	1.000	-0.7462	0.7462
	WR7	-0.19355	0.23862	0.996	-0.9398	0.5527
	WR8	0.06452	0.23862	1.000	-0.6817	0.8107

*: The mean difference is significant at the 0.05 level

WR1	The location of site
WR2	Water main breaks
WR3	Watering roads for dust control
WR4	Spraying concrete
WR5	Adding water to backfill material
WR6	Equipment cleaning
WR7	Site clean-up
WR8	Use of equipment
WR9	Insulated site accommodation

Appendix B: Water usage on site

ANOVA

Water Usage on Site

	S.S	df	Mean square	F	Sig.
Between groups	74.6850	12	6.224	6.602	0.000
Within groups	367.677	390	0.943		
Total	442.362	402			

Post Hoc tests:
Multiple comparisons:
Dependent variable: Water usage on site Tukey HSD

					95% confidence interval	
(I) Factor	(J) Factor	Mean difference (I-J)	S.E.	Sig.	Lower bound	Upper bound
WU1	WU2	0.87097*	0.24662	0.027	0.0488	1.6931
	WU3	1.00000*	0.24662	0.004	0.1779	1.8221
	WU4	0.64516	0.24662	0.304	-0.1770	1.4673
	WU5	0.96774*	0.24662	0.007	0.1456	1.7899
	WU6	-0.29032	0.24662	0.994	-1.1125	0.5318
	WU7	-0.16129	0.24662	1.000	-0.9834	0.6608
	WU8	0.32258	0.24662	0.985	-0.4995	1.1447
	WU9	0.35484	0.24662	0.968	-0.4673	1.1770
	WU10	-0.03226	0.24662	1.000	-0.8544	0.7899
	WU11	-0.19355	0.24662	1.000	-1.0157	0.6286
	WU12	0.32258	0.24662	0.985	-0.4995	1.1447
	WU13	0.16129	0.24662	1.000	-0.6608	0.9834
WU2	WU1	-0.87097*	0.24662	0.027	-1.6931	-0.0488
	WU3	0.12903	0.24662	1.000	-0.6931	0.9512
	WU4	-0.22581	0.24662	0.999	-1.0479	0.5963

Appendix B: Continue

	WU5	0.09677	0.24662	1.000	-0.7254	0.9189
	WU6	-1.16129*	0.24662	0.000	-1.9834	-0.3392
	WU7	-1.03226*	0.24662	0.002	-1.8544	-0.2101
	WU8	-0.54839	0.24662	0.575	-1.3705	0.2737
	WU9	-0.51613	0.24662	0.669	-1.3383	0.3060
	WU10	-0.90323*	0.24662	0.017	-1.7254	-0.0811
	WU11	-1.06452*	0.24662	0.001	-1.8866	-0.2424
	WU12	-0.54839	0.24662	0.575	-1.3705	0.2737
	WU13	-0.70968	0.24662	0.172	-1.5318	0.1125
WU3	WU1	-1.00000*	0.24662	0.004	-1.8221	-0.1779
	WU2	-0.12903	0.24662	1.000	-0.9512	0.6931
	WU4	-0.35484	0.24662	0.968	-1.1770	0.4673
	WU5	-0.03226	0.24662	1.000	-0.8544	0.7899
	WU6	-1.29032*	0.24662	0.000	-2.1125	-0.4682
	WU7	-1.16129*	0.24662	0.000	-1.9834	-0.3392
	WU8	-0.67742	0.24662	0.232	-1.4995	0.1447
	WU9	-0.64516	0.24662	0.304	-1.4673	0.1770
	WU10	-1.03226*	0.24662	0.002	-1.8544	-0.2101
	WU11	-1.19355*	0.24662	0.000	-2.0157	-0.3714
	WU12	-0.67742	0.24662	0.232	-1.4995	0.1447
	WU13	-0.83871*	0.24662	0.041	-1.6608	-0.0166
WU4	WU1	-0.64516	0.24662	0.304	-1.4673	0.1770
	WU2	0.22581	0.24662	0.999	-0.5963	1.0479
	WU3	0.35484	0.24662	0.968	-0.4673	1.1770
	WU5	0.32258	0.24662	0.985	-0.4995	1.1447
	WU6	-0.93548*	0.24662	0.011	-1.7576	-0.1134
	WU7	-0.80645	0.24662	0.060	-1.6286	0.0157
	WU8	-0.32258	0.24662	0.985	-1.1447	0.4995
	WU9	-0.29032	0.24662	0.994	-1.1125	0.5318
	WU10	-0.67742	0.24662	0.232	-1.4995	0.1447
	WU11	-0.83871*	0.24662	0.041	-1.6608	-0.0166
	WU12	-0.32258	0.24662	0.985	-1.1447	0.4995
	WU13	-0.48387	0.24662	0.757	-1.3060	0.3383
WU5	WU1	-0.96774*	0.24662	0.007	-1.7899	-0.1456
	WU2	-0.09677	0.24662	1.000	-0.9189	0.7254
	WU3	0.03226	0.24662	1.000	-0.7899	0.8544
	WU4	-0.32258	0.24662	0.985	-1.1447	0.4995
	WU6	-1.25806*	0.24662	0.000	-2.0802	-0.4359
	WU7	-1.12903*	0.24662	0.000	-1.9512	-0.3069
	WU8	-0.64516	0.24662	0.304	-1.4673	0.1770
	WU9	-0.61290	0.24662	0.387	-1.4350	0.2092
	WU10	-1.00000*	0.24662	0.004	-1.8221	-0.1779
	WU11	-1.16129*	0.24662	0.000	-1.9834	-0.3392
	WU12	-0.64516	0.24662	0.304	-1.4673	0.1770
	WU13	-0.80645	0.24662	0.060	-1.6286	0.0157
WU6	WU1	0.29032	0.24662	0.994	-0.5318	1.1125
	WU2	1.16129*	0.24662	0.000	0.3392	1.9834
	WU3	1.29032*	0.24662	0.000	0.4682	2.1125
	WU4	0.93548*	0.24662	0.011	0.1134	1.7576
	WU5	1.25806*	0.24662	0.000	0.4359	2.0802
	WU7	0.12903	0.24662	1.000	-0.6931	0.9512
	WU8	0.61290	0.24662	0.387	-0.2092	1.4350
	WU9	0.64516	0.24662	0.304	-0.1770	1.4673
	WU10	0.25806	0.24662	0.998	-0.5641	1.0802
	WU11	0.09677	0.24662	1.000	-0.7254	0.9189
	WU12	0.61290	0.24662	0.387	-0.2092	1.4350
	WU13	0.45161	0.24662	0.833	-0.3705	1.2737
WU7	WU1	0.16129	0.24662	1.000	-0.6608	0.9834
	WU2	1.03226*	0.24662	0.002	0.2101	1.8544
	WU3	1.16129*	0.24662	0.000	0.3392	1.9834
	WU4	0.80645	0.24662	0.060	-0.0157	1.6286
	WU5	1.12903*	0.24662	0.000	0.3069	1.9512
	WU6	-0.12903	0.24662	1.000	-0.9512	0.6931
	WU8	0.48387	0.24662	0.757	-0.3383	1.3060
	WU9	0.51613	0.24662	0.669	-0.3060	1.3383
	WU10	0.12903	0.24662	1.000	-0.6931	0.9512
	WU11	-0.03226	0.24662	1.000	-0.8544	0.7899
	WU12	0.48387	0.24662	0.757	-0.3383	1.3060
	WU13	0.32258	0.24662	0.985	-0.4995	1.1447
WU8	WU1	-0.32258	0.24662	0.985	-1.1447	0.4995
	WU2	0.54839	0.24662	0.575	-0.2737	1.3705

Appendix B: Continue

	WU3	0.67742	0.24662	0.232	-0.1447	1.4995
	WU4	0.32258	0.24662	0.985	-0.4995	1.1447
	WU5	0.64516	0.24662	0.304	-0.1770	1.4673
	WU6	-0.61290	0.24662	0.387	-1.4350	0.2092
	WU7	-0.48387	0.24662	0.757	-1.3060	0.3383
	WU9	0.03226	0.24662	1.000	-0.7899	0.8544
	WU10	-0.35484	0.24662	0.968	-1.1770	0.4673
	WU11	-0.51613	0.24662	0.669	-1.3383	0.3060
	WU12	0.00000	0.24662	1.000	-0.8221	0.8221
	WU13	-0.16129	0.24662	1.000	-0.9834	0.6608
WU9	WU1	-0.35484	0.24662	0.968	-1.1770	0.4673
	WU2	0.51613	0.24662	0.669	-0.3060	1.3383
	WU3	0.64516	0.24662	0.304	-0.1770	1.4673
	WU4	0.29032	0.24662	0.994	-0.5318	1.1125
	WU5	0.61290	0.24662	0.387	-0.2092	1.4350
	WU6	-0.64516	0.24662	0.304	-1.4673	0.1770
	WU7	-0.51613	0.24662	0.669	-1.3383	0.3060
	WU8	-0.03226	0.24662	1.000	-0.8544	0.7899
	WU10	-0.38710	0.24662	0.938	-1.2092	0.4350
	WU11	-0.54839	0.24662	0.575	-1.3705	0.2737
	WU12	-0.03226	0.24662	1.000	-0.8544	0.7899
	WU13	-0.19355	0.24662	1.000	-1.0157	0.6286
WU10	WU1	0.03226	0.24662	1.000	-0.7899	0.8544
	WU2	0.90323*	0.24662	0.017	0.08110	1.7254
	WU3	1.03226*	0.24662	0.002	0.21010	1.8544
	WU4	0.67742	0.24662	0.232	-0.1447	1.4995
	WU5	1.00000*	0.24662	0.004	0.17790	1.8221
	WU6	-0.25806	0.24662	0.998	-1.0802	0.5641
	WU7	-0.12903	0.24662	1.000	-0.9512	0.6931
	WU8	0.35484	0.24662	0.968	-0.4673	1.1770
	WU9	0.38710	0.24662	0.938	-0.4350	1.2092
	WU11	-0.16129	0.24662	1.000	-0.9834	0.6608
	WU12	0.35484	0.24662	0.968	-0.4673	1.1770
	WU13	0.19355	0.24662	1.000	-0.6286	1.0157
WU11	WU1	0.19355	0.24662	1.000	-0.6286	1.0157
	WU2	1.06452*	0.24662	0.001	0.2424	1.8866
	WU3	1.19355*	0.24662	0.000	0.3714	2.0157
	WU4	0.83871*	0.24662	0.041	0.0166	1.6608
	WU5	1.16129*	0.24662	0.000	0.3392	1.9834
	WU6	-0.09677	0.24662	1.000	-0.9189	0.7254
	WU7	0.03226	0.24662	1.000	-0.7899	0.8544
	WU8	0.51613	0.24662	0.669	-0.3060	1.3383
	WU9	0.54839	0.24662	0.575	-0.2737	1.3705
	WU10	0.16129	0.24662	1.000	-0.6608	0.9834
	WU12	0.51613	0.24662	0.669	-0.3060	1.3383
	WU13	0.35484	0.24662	0.968	-0.4673	1.1770
WU12	WU1	-0.32258	0.24662	0.985	-1.1447	0.4995
	WU2	0.54839	0.24662	0.575	-0.2737	1.3705
	WU3	0.67742	0.24662	0.232	-0.1447	1.4995
	WU4	0.32258	0.24662	0.985	-0.4995	1.1447
	WU5	0.64516	0.24662	0.304	-0.1770	1.4673
	WU6	-0.61290	0.24662	0.387	-1.4350	0.2092
	WU7	-0.48387	0.24662	0.757	-1.3060	0.3383
	WU8	0.00000	0.24662	1.000	-0.8221	0.8221
	WU9	0.03226	0.24662	1.000	-0.7899	0.8544
	WU10	-0.35484	0.24662	0.968	-1.1770	0.4673
	WU11	-0.51613	0.24662	0.669	-1.3383	0.3060
	WU13	-0.16129	0.24662	1.000	-0.9834	0.6608
WU13	WU1	-0.16129	0.04662	1.000	-0.9834	0.6608
	WU2	0.70968	0.24662	0.172	-0.1125	1.5318
	WU3	0.83871*	0.24662	0.041	0.0166	1.6608
	WU4	0.48387	0.24662	0.757	-0.3383	1.3060
	WU5	0.80645	0.24662	0.060	-0.0157	1.6286
	WU6	-0.45161	0.24662	0.833	-1.2737	0.3705
	WU7	-0.32258	0.24662	0.985	-1.1447	0.4995
	WU8	0.16129	0.24662	1.000	-0.6608	0.9834
	WU9	0.19355	0.24662	1.000	-0.6286	1.0157
	WU10	-0.19355	0.24662	1.000	-1.0157	0.6286
	WU11	-0.35484	0.24662	0.968	-1.1770	0.4673
	WU12	0.16129	0.24662	1.000	-0.6608	0.9834

*: The mean difference is significant at the 0.05 level

WU1	Use water from the mains.
WU2	Use surface water.
WU3	Reuse grey water.
WU4	Use water harvested from rainfall.
WU5	Reduce water pressure to the lowest practical level.
WU6	Ensure all areas of site water consumption are quantified.
WU7	Record site water consumption on a regular basis.
WU8	Create Key Performance Indicators (Kpis) to assist tracking of water efficiency.
WU9	Utilize consumption or KPI data to set improvement targets
WU10	Determine water requirements for each facility and check usage frequently
WU11	Change staff attitude towards water usage
WU12	Organizing workshop for effective water consumption
WU13	Place posters and other publicity materials in prominent places to encourage water conservation.

REFERENCES

Bernard, H.R., 2000. Social Research Methods: Qualitative and Quantitative Approaches. Sage Publishing Ltd., London.

Bon, R. and D. Crosthwaite, 2000. The Future of International Construction. Thomas Telford Ltd., London.

Brockman, M.D., 2007. Land and Environment Court Proceedings. Environmental Defender's Office Ltd.

Casals, X.G., 2006. Analysis of building energy regulation and certification in Europe: Their role, limitations and differences. Energ. Buildings, 38(5): 381-92.

Chan, E.H., Q.K. Qian and P.T. Lam, 2009. The market for green building in developed Asian cities: The perspectives of building designers. Energ. Policy, 37(8): 3061-3070.

Christy, J. and R. Spencer, 2003. Global temperature report 1978-2003. Earth System Science Center, The University of Alabama, US.

Climate Change Secretariat, 2002. A Guide to the Climate Change Convention and its Kyoto Protocol. United Nations Framework Convention on Climate Change (UNFCCC). Retrieved from: http://unfccc.int/resource/guideconvkp-p.pdf.

Coelho, B. and A. Andrade-Campos, 2014. Efficiency achievement in water supply systems: A review. Renew. Sust. Energ. Rev., 30: 59-84.

Construction Water Use Guidelines, 1997. Construction Water Use Guidelines: For Release of Municipal Tap Water to the Environment. Retrieved from: http://www.metrovancouver.org/about/publications/Publications/ConstructionWaterUseGuidelines.pdf.

Crawford, R.H. and G.J. Treloar, 2005. An assessment of the energy and water embodied in commercial building construction. Proceedings of the 4th Australian LCA Conference. Sydney, February 2005.

Deakin University, Architecture and Building Website, 2007. Treloar, G. Profile. Faculty of Science and Technology, Deakin University.

Dunn, W., 2002. Infant/Toddler Sensory Profile Manual. Psychological Corporation, New York.

Fong, W.K., H. Matsumoto, C.S. Ho and Y.F. Lun, 2008. Energy consumption and carbon dioxide emission considerations in the urban planning process in Malaysia. J. Malays. Inst. Planners, 6: 101-130.

Guidelines to Account, 2010. Guidelines to Account for and Report on Greenhouse Gas Emissions and Removals for Buildings (Commercial, Residential or Institutional Purposes). Hong Kong.

Houghton, H., 2004. Global Warming. 3rd Edn., Cambridge University Press, New York.

Houghton, J.T., Y. Ding, D.J. Griggs, M. Noguer, P.J. Van der Linnden, X. Dai, K. Maskell and C.A. Johnson, 2001. Climate Change 2001: The Scientific Basis. Cambridge University Press, Cambridge.

IPCC, 2001. Climate change 2001: The scientific basis. Contribution of Working Group I to the 3rd Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, New York.

McNab, D.J., M. Lynch and P. Young, 2011. Auditing of water use on construction sites-phase I. Working together for a world without waste, WAS908-004. Retrieved from: www.wrap.org.uk/construction.

Moxon, S., 2012. Sustainability in Interior Design. Laurence King Publishing Ltd., City Road, London, pp: 192.

Raftery, J., M. Anson, Y.H. Chiang and S. Sharma, 2004. Regional Overview. In: Chiang, Y.H. *et al*. (Eds.), the Construction Sector in Asian Economics. Spon Press, London.

Roaf, S., D. Crichton and F. Nicol, 2004. Adapting Buildings and Cities for Climate Change. Architectural Press, Oxford.

Runci, P.J., 1999. Energy research and development in the European Union. PNNL-12218, Battelle Memorial Institute, Pacific Northwest National Laboratory Technical Report, Richland, Wash, May.

Shaffii, N., 2010. Malaysia country report. Construction Industry Development Board, Malaysia.

Shaik, S.S. and T.A. Samuel, 2009. Methodology for estimating emissions in underground utility construction operations. J. Eng. Design Technol., 7(1): 37-64.

Sookack, N., S. Younghwan, B. Taeho, P. Jaesung and C. Wooseok, 2011. Characterization of carbon dioxide emissions during constructing of reservoir embankment using life cycle assessment method. Department of Rural Systems Engineering, Seoul National University, 599 Gwanak-ro, Gwanak-gu, Seoul, 151-921, Korea.

Trochim, W.K., 2001. The Research Methods Knowledge Base. Atomic Dog Publishing, Cincinnati, OH.

Wee-Kean, F., M. Hiroshi, H. Chin-Siong and L. Yu-Fat, 2009. Energy Consumption and Carbon Dioxide Emission Considerations in the Urban Planning Process in Malaysia. Retrieved from: eprints.utm.my/6626/.