A CRITICAL REVIEW OF WATER STUDIES IN CONSTRUCTION INDUSTRY

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ABSTRACT

Water is not only a basic need of human beings, but also a strategic economic resource. However, the distribution of water throughout the earth is diverse. At present, water is a challengeable natural resource for many countries and some studies predicted that the world will face a water dilemma in 2025-2030, if not consumed in sustainable way. Moreover, population growth, climate change, and industrialisation are critical factors that impact on the water sector and ultimately result in freshwater shortage and continued water pollution. The current practice considers water as a separate sectoral box in many economic evaluations although water is an integrated resource in many industries. Therefore, the time has come to think out of the box with the cohesiveness of sustainable development. It is a known fact that the construction industry too uses water in almost all the activities and without water no more construction is possible. However, water management during construction is given less attention by the industry stakeholders at present. This is despite an upsurge in the demand for construction activities both in building and civil engineering projects due to speedy industrialisation to cater for the population growth. This paper is based on the literature review of an on-going PhD research. The paper critically reviews the secondary data on water studies conducted in the construction industry. The views and findings on water handling during the physical construction, and strategies towards sustainable water consumption in construction industry are also discussed. In addition, the paper identifies four critical drivers that impact on sustainable practices of water use during the physical construction phase.

Keywords: *Construction Industry; Sustainable Use; Water Efficiency; Water Resource.*

1. INTRODUCTION

Water is different from other natural resources. As Chellaney (2013) states, there are substitutes for many resources including oil, but none for water. Similarly, countries can import fossil fuels, minerals and resources from the biosphere, but hardly import water, which is essentially local. With reference to the literature available on water resource, substantial growth in population, industrialisation and potential future climate change such as global warming will exacerbate the demand for water. Joyce (2012) states that, the difference between increasing demand for water and limited water availability creates a gap that is translated into water scarcity. However, limited freshwater is a major constraint on sustainable development (Khalfan, 2002; Horne, 2012). This implies the requirement of sustainable strategies for better management of water resource in all the sectors. Construction industry is one of the main pillars of economy in any country. It consumes large amount of natural resources including water. Hence, construction activities always have the potential to affect the surrounding environment. Strategic Forum for Construction Water Group reports that relatively little work has been carried out to date on water sustainability at construction sites (Waylen *et al*., 2011). On the other hand, water conservation is received relatively low priority in comparison to the focus on reducing waste and improving the carbon footprint. The Strategic Forum for Construction Water Subgroup highlighted some issues of water use in the construction activities and identified number of targets pertaining to the more efficient use of water and water usage on construction sites (Waylen *et al*., 2011). Many researchers emphasise the requirement of establishing water saving policies, guidelines, concrete actions and technologies to reduce water consumption and wastage during the construction (McComack *et al*., 2007; Houser and Pruess, 2009; Sala *et al*., 2013). Therefore, the paper aims to critically review the previous studies, which were carried out in the construction industry in terms

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of water handling, monitoring, conservation, and strategies that adopted during the physical construction phase. In addition, the paper will discuss critical drivers that will impact on sustainable practices of water use during the construction. In this study, the terms 'construction' and'construction phase' were used to explain the physical construction works from the whole project life cycle.

2. RESEARCH METHODOLOGY

Research methodology is a systematic and scientific way of solving any research problem. Therefore, it is vital to choose the appropriate research methodology in order to establish clear links between the research objectives and the research outcome. As Tan (2002) says, if research is to be systematic, it should follow a series of steps which is called as the research process. Thus, as in any research work, conducting a systematic literature review enriches and reinforces the research process initially. Iqbal (2007) explains that literature review is required to identify any gap in the knowledge and a successful researcher claims a gap in the existing knowledge with evidence. This paper is based on the comprehensive literature review of an on-going PhD research. Thus, findings of comprehensive literature review presented the consequences of water resource in the purview of sustainability, its application in construction industry and then identified few sustainable drivers which impact on sustainable water use during the construction phase. Finally, the paper elaborates the existing research done and way forward. Mainly, literature evidence was taken referring journal articles, books, published and unpublished bibliographies, conference proceedings, industry reports and documents. During the literature survey, key terms such as water efficiency, water consumption, conservation, quality, sustainability, and construction were used for review.

3. WATER RESOURCE IN THE PURVIEW OF SUSTAINABILITY

3.1. WATER AS A DEMANDING COMMODITY

This is a known factor that ninety - seven per cent of all the water on the earth is salt water which is not suitable for drinking and even for some construction activities. Only three per cent of all the water is fresh water, and from that only one per cent is available for drinking water. The other two per cent is sealed in frozen ice and cannot be easily accessed. Donge *et al*., (2008) clearly illustrate the distribution of earth's water as shown in Figure 1. Therefore, all the people on the earth are relying on such a small percentage of all the water on earth. This only makes sense the importance of preserve and conserve of the natural gift to sustain for future generation. However, still many people in the world feel water as an unlimited resource and considered as a cheap commodity because of that value of water as a commodity is hidden in many consumptions.

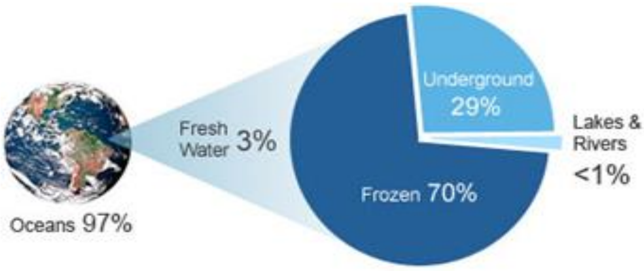

Figure 1: Distribution of Earth's Water
Source: Donge *et al.* (2008)

However, Donge *et al*., (2008) mention, pollution and contamination are a significant threat to water supply. On the other hand due to industrial expansion around the world, demand for water is rising at an alarming rate. Moreover, Biswas (2004) explains, water problems of the world are neither homogeneous, nor constant or consistent over time. They often vary significantly from one region to another, even within a single country, from one season to another, and also from one year to another. This statement is further supported by Figure 2 and 3 on some water demand statistics available. Figure 2 illustrates the forecasted figures on global water consumption with the global population. It shows the differences between the two values go up. Further, Figure 3 elaborates Asia's future water demand. This clearly indicates the tremendous increase of water demand in Asia compared to other regions.

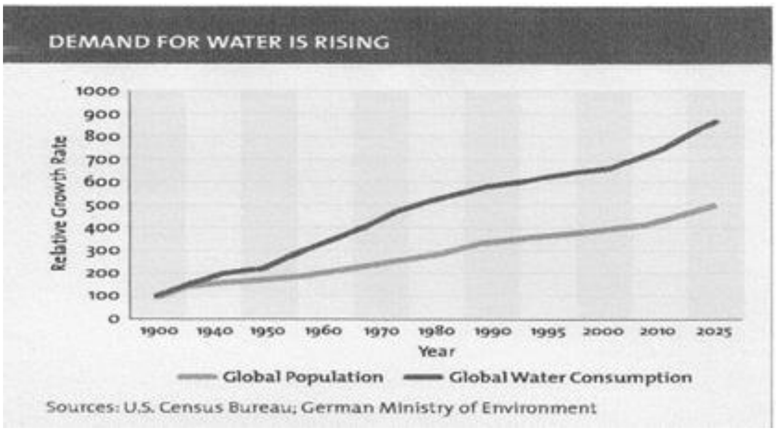

Figure 2: Demand for Water
Sources: adapted from Donge et al. (2008)

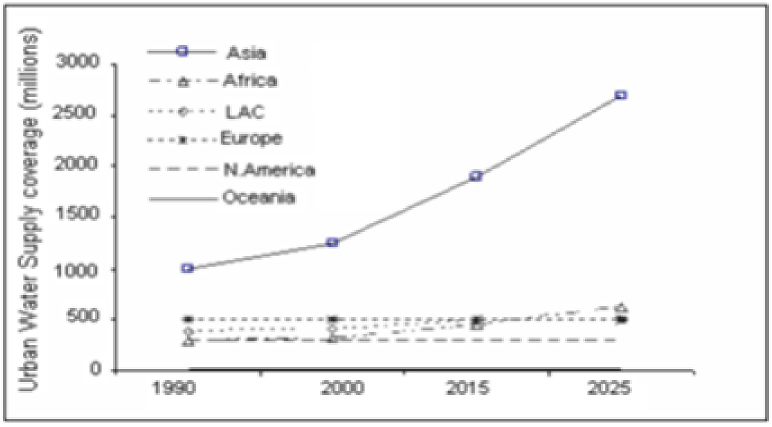

Figure 3: Asia's Future Water Demand
Source: Corcoran *et al*. (2010)

Sala and Wolf (2013) point out that industrial production and many services depend on continuous availability of freshwater and it is directly a threat for supplying safe drinking water in future. Moreover, the global water intelligent (2010 cited Rayan *et al*., 2013) forecasted there is a strong growth in global water industry spending capital expenditure in next few years on water infrastructure (6.5%), wastewater treatment (7.8%), desalination (8.6%), and recycling (9.4%). These facts well supported to establish water is a highly demanding commodity for the world in near future. As Zbigniew and Kundzewicz (1997) claim, water shortage is therefore likely to be the most dominant problem in the forthcoming century, jeopardising sustainable development.

3.2. WATER IN THE PURVIEW OF SUSTAINABILITY

The term sustainability can have different meaning to different people as well as to different discipline. However, any sustainable actions protect, preserve, and restore the integrity of the earth's life support systems. As Abidin (2009) mentions, sustainable development philosophy was introduced in 1987 in the Brundtland report and subset to this philosophy is sustainable construction. Water is an integral part of the ecosystem, a natural resource and a social and economic good (Zbigniew and Kundzewicz, 1997; Gleick, 1998). The European commission scientific and policy report mentions that water is more than an archetypal resource for which sutainability assessment is needed in order to preserve quality and quantity of the resource for present and future generations (Sala *et al*., 2013). Therefore, reducing water consumption and protecting water quality are key objectives of sustainable construction. Gleick *et al*. (1995 cited Gleick, 1998) offers a working definition of sustainable water use as "the use of water that supports the ability of human society to endure and flourish into the indefinite future without undermining the integrity of the hydrological cycle or the ecological systems that depend on it". This paper refers ***sustainable use of water*** as minimise and eliminate unnecessary water use and wastage with minimal damage to the environment, society and to the economy.

Zbigniew and Kundzewicz (1997) explain that the availability of water in adequate quantity and quality is a necessary condition for sustainable development. In addition, knowledge and understanding of freshwater resources is also essential for sustainable development. Therefore, hydrological observations should be recognised as an essential component of sustainable water resource development. Robert *et al*. (2006) recognise that when actual amount extracted was below the sustainable level of extraction it was not a problem but over-extraction and subsequent overuse of river systems provide significant pressure. Gleick (1998) mentions that sustainability criteria layout specific social goals that could, or should be attained and offer some guidance for future water management. Further, The European commission scientific and policy report highlights requirement of generating concrete actions that will result in more sustainable consumption styles and patterns than awareness about the environmental consequences of human consumption behaviour for water resource (Sala *et al*., 2013).

The desired endpoints described in the UN and UNSGAB (2011) stressed that no country can meet its development objectives without improving the way it manages its water since water allocation to various economic sectors is a difficult exercise, and huge water wastage along with the supply chains. As Devaraja (2013) expresses, water losses may form of either apparent loss (physical- water leaks in pipes) or real loss (Non-physical- illegal consumptions, errors of measuring apparatus, administrative losses and free water supply). UN and UNSGAB (2011) highlights that if the demand for energy increases the demand for water will also rise and need to have an effective water pricing system. Similarly, Savenije and Van der Zaag (2002) state that having a price for water will give a clear signal to the users that water is indeed a scarce good that should be used sparingly. Moreover, it will stimulate conservation, may curb demand and encourages the use of water for high value uses.

4. WATER INPUT IN THE CONSTRUCTION INDUSTRY

4.1. THE CONSTRUCTION INDUSTRY

The nature of the construction industry is large, dynamic, and complex. It plays an important role in the economic growth of a country (Hussin *et al*., 2013). Construction work involves buildings, engineering (civil) projects, renovation, alterations, or maintenance and repair of building or civil projects (Behm, 2008). In general, the construction industry differs from other industries based on the products, stakeholders, processes, and the operating environment. Chen (1998) argues that there could be no economic activity without construction. Construction industry is a major contributor to economic growth (Chan, 2009). It has strong linkages with other sectors of the economy (Chen 1998; Rameezdeen *et al*., 2008). In Sri Lanka, according to the central bank report (2013), construction industry contributes 8.7% to the Gross Domestic Product (GDP) of the country. Spence and Mulligan (1995) mention the construction industry causes significant environmental stress. It is a known factor that construction of a building uses a lot of energy, water, and other resources throughout the construction life cycle that is pre-construction, construction and post-construction. Crawford and Pullen (2011) recognises that buildings are directly responsible for only around 12 percent of global water consumption through the production of building materials, construction and other supporting processes.

Guggemos and Horvath (2006) explain that although construction phase is shorter, the impact is more significant and if construction phase is neglected, the associated processes and materials are not optimised for environmental performance. Therefore, many researchers are concerned about how to improve construction practices in order to minimise the negative impacts on the natural environment (Holmes and Hudson, 2000; Cole *et al*., 2005; Pahwa, 2007; Hussin *et al*., 2013). As global interest on sustainability has grown steadily (Abidin, 2009), recently, the concept of sustainable or green building construction has come to the forefront of the construction industry. Hussain *et al*., (2013) mention green building practices are environmentally responsible and resource efficient throughout the buildings' life cycle. With that scenario, green or sustainable building rating systems which provide an effective framework for assessing building environmental performance and integrating sustainable development into building and construction processes (Cole, 2003 cited Ali and Nsairat, 2009). According to the findings of Waidyasekara *et al*., (2013), in terms of water efficiency addressed in building project life cycle, the priority given for the water consumption during the physical construction phase is ignored by many green rating systems including Green[SL]. For instance, in Abu-Dhabi, construction works completely depends on the desalinated water, however, no credits have been allocated for water monitoring and handling during the construction phase in the Pearl building rating system (PBRS). Whereas, rating systems Green Rating for Integrated Habitat Assessment (GRIHA) in India and Building Research Establishment's Environmental Assessment Method (BREEAM) in the UK have given credential for water sustainability during the construction. Waidyasekara *et al*. (2013) argue that need for a better sustainability assessment for water handling during the physical construction phase. Next section explains the views and key findings of water related studies conducted in the construction industry.

4.2. *WATER STUDIES IN THE CONSTRUCTION INDUSTRY: VIEWS AND RESEARCH FINDINGS*

It is widely documented, water studies in many sectors in terms of management, reuse, and recycling. However, strategic forum for construction water subgroup reports that relatively little work has been carried out to date on water sustainability on construction sites although water used for different activities and processes at the construction project level (Waylen, *et al*., 2011). The sections 4.2.1 and 4.2.2 reflect views and key research findings that conducted on water resource management in construction industry.

4.2.1. *VIEWS ON WATER USE ON CONSTRUCTION SITES*

Table 1 documented some views made by researchers regarding the body of knowledge exist in terms of water resource management in construction industry.

Table 1: Views on Water Use on Construction Sites

Views On Water Use in Construction	Source of Reference
Current knowledge of where water is used on construction sites and the volumes involved are limited during the construction lifecycle.	Waylen *et al*. (2011)- SFfC
Impacts from the construction phase are ignored or simply approximated, because the analysis is complicated or the impacts are thought to be small.	Guggemos and Horvath (2006)
Significant water quantity is consumed in the extraction, production, manufacturing, delivery of materials to site and the actual on-site construction process during buildings operation- i.e. embedded water	McComack *et al*., (2007)
Quality and quantity of water are important parameters that impact on strength of some construction works. Some concrete strength has failed due to wrong water cement ratio added in the mix.	Utraja (2010)
With the global warming, it requires more attention and investigation to save water and reduce water footprint for goods and services	Ilgar (2011)
By overcoming challenges such as value for money, work environment and habit, it was suggested water use on construction can be reduced.	Waylen *et al*., (2011)- SFfC
Amount of water consumed by the construction is unknown and not adequately measured	Goodrum (2008)
Requirement of establishing water saving policies, guidelines, concrete actions and technologies to reduce water consumption and wastage during the construction. Inappropriate incentives and institutions often hinder effective use of water during the construction.	McComack *et al*., (2007); Crawford and Pullen (2011); Houser and Pruess (2009); Sala *et al*., (2013)
Certain construction activities use water cause impact on the cost of energy	Waylen *et al*. (2011)- SFfC
Price increase of water used for construction remains unknown and requirement of changes to the water tariff system.	Goodrum (2008); Savenjije and Van der Zaag (2002)

According to Table 4, many scholars highlighted and are convinced that the requirement of future studies need to be addressed in the subject area. In other words, the attention paid on such research work is limited. Waidyasekara *et al*. (2012) state, there exist a vacuum in the area of water management body of knowledge in the construction industry compared to other industries. Apart from the views emphasised by some authors, Section 4.2.2 discusses the findings of some water researches that conducted in the construction industry through the comprehensive literature survey available in the built environment.

4.2.2. RESEARCH FINDINGS

The strategic forum for construction (SFfC) water subgroup in the UK is conducting series of research studies on water usage on construction sites. The group is made up of key representatives from the construction and manufacturing industries and the regulatory agencies such as the Environmental agency. Nine case studies were selected by the strategic forum for construction group (SFfC) to observe the construction water management process (Waylen *et al*., 2011).During the survey, discussion had with contractors and construction site employees, and the following key water using processes on construction on sites were identified.

- Sites cabins and temporary accommodation
- General site activities including tool washing
- Wet trades, such as brickwork, screeding, concreting and plastering
- Groundwork, including road and wheel washing
- Hydro- demolition
- Cleaning of tools and plant equipment, lorry washing
- Commissioning and testing of building plant and services
- Domestic and welfare water consumption

In addition, during the survey, it was found that water requirement is unique at construction sites. Among the water using activities, dust suppression, cleaning, commissioning and testing and domestic and welfare were identified as high water using activities. It was found good housekeeping that is reporting/repairing leaks, turning off taps which can assist construction sites to reduce its overall water use. Furthermore, creating a culture within the construction sector that changes staff's attitudes and behaviour to accept ownership of water efficiency is fundamental in improving the use of water in an efficient manner. However, during the survey, none of the sites audits were able to provide evidence of providing their site staff with regular awareness training on water efficiency. As a solution it suggested three strategies such as value for money, work environment and habit to reduce water usage on construction sites.

The result of seventeen non-residential case studies conducted by McComack *et al*., (2007) in Australia identify that considerable amount of water is embodied in construction. Moreover, it was found that the water embodied in building materials was significant, particularly steel, concrete and carpet. Ilgar (2011) also identifies steel production seems to consume higher amount of water compared to other building materials and the estimated total amount of water used for producing 4.06 million tons of steel is 12.18 [million m^3/year]. Greenroads^{TM} manual v1.5 (n.d) specified cement production relies heavily on water as well in road and building construction. In addition, concrete mixing, concrete curing, dust control, construction equipment washing, vegetation establishment, geotechnical boarings, adding water to backfill materials/soil compaction, pipe flushing and pressure testing, and site clean-up are other on site construction water uses in both road and building construction projects.

On the other hand, the Queensland Government (2007) identifies dust suppression, cleaning, slurry work, pressure washing of concrete and other surfaces, concrete cutting, pressure test of water lines, washing construction vehicles before leaving the site, and increasing a soil's water constant for compaction as some of the activities that use water in construction projects. One of the studies conducted by SFfC of Waste and resources action programme (WRAP) on water audits on construction sites in the UK, it was found that the largest barrier to improve water efficiency on site was the lack of quantitative information due to the use of unmetered stand pipes and a faulty water meter. Thus they have suggested to utilise robust metering and monitoring system on site to overcome the identified issues (Waylen *et al*., 2011).

Further, the SFfC group proposed the water hierarchy which can be used during the physical construction. The water hierarchy shows how to prevent or reduce use of potable water through alternative sources, reuse and recycle. Fernando (2007) shows that applying 're-use' concept in the batching plant process, $2m^3$ per day can be re-used. This result derived through one case study conducted in Sri Lanka and the water used for cleaning the batching plant is subjected to filtering process and reuse for concrete production. Implementation of stages of water hierarchy during the physical construction phase from beginning to end is one of the significant areas however that have not been studied in depth so far. With regard to water sources for construction work, Greenroads™ manual v1.5 (n.d) identifies, natural water bodies, potable water supply pipe lines, and storm water as usual sources for construction work. Waidyasekara *et al*., (2012) claim that many construction projects get water for the construction works through public main especially around the urban areas in Sri Lanka. Although, drinking water or potable water is subject to competing demands by human, at present demanded by the construction industry too. Some construction activities need potable water standards. For instance concreting, rendering, and curing works. On the other hand, such standards are not required for activities like cleaning, washing vehicles, tools, and dust controlling. Ramachandran (2004) mention that one of the structural engineers Dr. A.R. Santhakumar in India said that if contaminated water is used, the life of the structure comes down from about 60 years to about 20 years. Unfortunately, yet many builders do not realise the importance of that and hence quality comes down. Further, the above named engineer mentioned that in normal construction, the water demand is roughly 10 to 20 percent of the volume of brick and concrete used. However, this can be reduced by modern techniques and recommends a more steel intensive construction. The vice president and head of Larsen and and Turbo Limited in India explains that the construction of a 100,000 sq. ft. multi-storey structure requires about 10 million liters of water for production, curing and site development activity and also a double lane flyover can consume 70 million liters of water on the similar scale (Ramachandran, 2004). Furthermore, he claims that the water shortage in Chennai was leading to delays in work and was increasing the unit cost of construction.

It was found that limited studies conducted on water resource management in construction industry by organisations and individual researchers although plentiful number of water researches available in other sectors. Cost of water is relatively cheap compared to the total project construction cost may be a reason behind that scenario. However, Hussin *et al*., (2013) identify construction industry as one of the largest polluters to the environment. Although, cost of water is insignificant yet, by considering future dilemma in the water resource it is pertinent to make correct decisions at the proper time in the construction industry since it is considered as a water intensive industry. Thus, the study identified many aspects which can impact to enhance the sustainable water practices during the construction will be controlled by the project itself and external entities based on the literature search. Considering each aspect, the authors identified four drivers namely, managerial, economic, environmental and social. The next section elaborates each driver with a brief explanation.

5. DRIVERS FOR ENHANCING SUSTAINABLE WATER PRACTICES DURING CONSTRUCTION

Bourg (2010) defines water efficiency is the planned management of water to prevent waste, overuse, and exploitation of the resource. Effective water efficiency planning seeks to "do more with less" without sacrificing comfort or performance. There are number of strategies that can be employed to reduce the amount of water consumed. Aforementioned literature findings proved that requirement of sustainable practices in order to enhance the water efficiency from beginning to end of the construction project. It is well known, protection and conservation of natural resources is one of the fundamental principles concern in sustainable construction. Therefore, incorporating sustainable practices ensure positive impact on communities throughout the nation. Like in many other sectors, efficiency of water use in construction can be done at two stages. That is during the project level and the national level. US Environmental protection agency (2012) divided water efficiency practices into two categories as (i) engineering practices which is based on modifications in plumbing, fixtures, or water supply operating procedures and (ii) behavioural practices which is based on changing water use habits. After the critical literature review, the following four drivers identified in order to enhance or uphold the sustainable water practices during the physical construction as shown in Table 2.

Table 2: Drivers for Enhancing Sustainable Water Practices during the Construction

Drivers for Sustainable Practices	**Description**
Managerial drivers	This explains the project specific drivers which are directly linked with the construction management process. A sheer number of project specific documents are available to control the project performance at different stages (e.g. conditions of contract, specifications, bills of quantities, construction program, sustainable rating system etc.). According to the guideline prepared by Road and Traffic Authority in Australia, in construction monitoring program should be linked to other contract documents and pre-construction monitoring should be undertaken during the environmental impact assessment (EIA) phase of the project to minimise the water issues and enhance water conservation efficiently. In addition, planning and management schedules for on- site activities and organisational policies impact on enhance the sustainable water practices.
Economical drivers	Howard (2003) explains that economic value of water based on a society's willingness to pay for it. Joyce (2012) argues that, the true value of water is still not reflected in all water related decision-making due to the existence of various socially constructed barriers. It is widely documented that requirement of changes to the water tariff system that is effective pricing system to free from water dilemma and impress the value and minimise wastage and misuse of water (Savenjije and Van der Zaag, 2002; Goodrum, 2008; IMWI, 2010; UN- Water, 2012; Horn, 2012). Water quantity, cost of water and water pricing are sub-economical drivers to be considered further.
Environmental drivers	Ofori (1992) recognises many of the site activities are potential source of water pollution. On the other hand, water is used in managing environmental pollution on construction sites as well. As Robert *et al*., (2006) say, over allocation and over use of river systems provide significant pressure. As Horn (2012) states quantification of water to sustain the environment is needed though it is difficult and a challengeable task. Holmes and Hudson (2000), Cole *et al*. (2005) and Pahwa (2007) identified that necessity of conditions for protecting natural resources and environmental impact due to construction. As Byrne (2011) explains, in water consumption 'fit for purpose" approach should be adopted that using potable water for all the purposes. Availability of water resource, sustainable water use, government regulations, and organisational policies identified as sub- environmental drivers.
Social drivers	The Workplace Health and Safety Queensland (2007) stated, as long as workplace health and safety is safeguarded, preservation of drinking supplies is the next most important priority in a construction site. In simply, quality of water for the workers as well as for the construction activities is critically impact on the project performance. Moreover, recent literature has shown that value of increasing public awareness towards water and environment (Eroksuz and Rahman, 2010). US Environmental protection agency (2012) divided water efficiency practices into two categories as engineering practices and behavioral practices. Thus, mainly quality of water, safety, behavior and attitudes are identified as sub-drivers in the social category.

A commitment to sustainable use of water through appropriate policies and investments, and conducting research and developments will lead to a more water secured world .The main survey broadly will consider the impact of each driver by identifying its sub-drivers and responsible parties in order to come up with appropriate actions and approaches to enhance sustainable water practices during the construction. In addition, the results will intend to identify the responsibilities according to the project level and the national level further. Section 6 elaborates the input of secondary data findings to formulate the research aim and the way forward of the study.

6. CONCLUSIONS AND THE WAY FORWARD

Although, water as the world's one of the most valuable assets, it is widely documented that water will be a challengeable resource faced by the world in near future if not taken proper actions towards water conservation and water efficiency to keep it as a sustainable resource. Water resource management puts effort on optimising the use of water and minimising the environmental impact of water use on the natural environment. Reviewing the extensive published literature, it was able to identify the research knowledge in terms of water resource management in the construction industry. Many studies hitherto have highlighted the importance of water quantity and quality that impact on the project performance and requirement of a better sustainability assessment for water handling during the construction. In addition, previous studies discussed some strategies such as water hierarchy, water audit and action plans to minimise wastage and misuse of water during the construction to enhance sustainable practices. Further, many researchers highlighted the importance of wastewater discharge methods from sites whereas unsustainable practises lead water pollution, and damage the environment. Like many other sectors, it was proved that existing requirement of sustainable practices in terms of water as a natural resource during the construction. Hence, reviewing the literature, the authors identified the following four drivers such as managerial drivers, economical drivers, environmental drivers, and social drivers in order to overcome existing issues and unsustainable practices. Organisational policies, project documents and planning and management were identified as some managerial drivers. It was identified cost of water, water pricing and water quantity are some economical drivers that enhance sustainable practices. Consequently, availability of water resource, government regulation and sustainable water use are considered under the environmental drivers. Quality of water, safety, user behaviour and attitudes are some social drivers that impact on proper use of water during the construction. Moreover, the authors believe that there is a strong link between each driver to uphold sustainable water practices during the construction.

Currently water stress is at marginal level in Sri Lanka. It was proved water is a scarce resource (Wijesiri, 2004). Similar to many other countries, Non-Revenue Water (NRW), wastage of treated water, absent of proper systems for cost recovery and ground water contamination are some critical issues in the Sri Lankan water sector too (Gamini and Werellagama, 2013; Menikdiwela, 2013). This paper was able to provide evidence to say even though resource optimisation is one of the main objectives under the sustainable construction, less attention has been paid on water resource in terms of sustainable practices. Strategic forum for construction group endorsed that to reduce water usage on construction sites it is important to have a clear understanding of where water is used, how much is used, where water is being wanted, and what behaviours and / or technology can be introduced to successfully reduce water wastage during the construction. There is no firm evidence of extensive research on water reduction techniques in Sri Lanka in order to uphold sustainable use of water during the construction. Thus, how water is used at a construction site from the beginning to end of a project in sustainable way is essential but still poor approaches could be seen in Sri Lanka as much as in many other developing countries. This paper looks at theoretical aspects in order to produce a conceptual framework as the next step of the study which can be used to develop best practice guidelines to uphold the sustainable use of water during the physical construction of building projects life cycle.

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