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A STUDY OF LIQUID WASTE MANAGEMENT PRACTICES IN CONSTRUCTION PROJECTS IN AUSTRALIA

Shiyamini Ratnasabapathy[1], Srinath Perera[2] and Mary Hardie[3]

ABSTRACT

The construction industry is increasingly under pressure to improve environmental performance and reduce environmental degradation, which often results from carbon emissions and a high volume of waste generated from unprecedented levels of development associated with urbanisation and industrialisation. Construction projects consume a significant amount of water at the same time; they generate liquid waste (LW) from several wet processes during construction on-site, which is often unmetered. At the same time, LW or wastewater generated from construction projects is detrimental to the environment and human health, adversely polluting the surface and groundwater as well as the ground soil. It is, therefore, indispensable to manage LW appropriately while utilising the water efficiently. Limited studies have paid attention to explore the importance of effective liquid waste management (LWM) practices in construction projects and their implications on environmental sustainability. This study aimed to investigate the current practices of LWM in construction projects through the analysis of expert user views and quantitative data analysis while providing an account of LWM related legislative requirements. Moreover, this study estimated the average volume of water consumed for tool washing and water saving for different types of projects and compared it against the use of sustainable LWM systems, notably a closed-loop washout system employed in construction projects. The outcome of this study has the potential to add new and under-measured factors to the current LWM systems and to promote sustainable LWM practices in construction projects. While it highlights issues related to LWM, it provides criteria that can be considered for the green rating of buildings.

Keywords: *Construction Projects; Closed Loop System; Liquid Waste Management; Trade Wastewater; Water Usage and Saving.*

1. INTRODUCTION

The construction industry is increasingly concerned with improving its environmental performance and reducing environmental destruction, which often results from unprecedented levels of rapid development in the sector. The depletion of natural resources, increased global warming and pollution are stimulating the construction industry to pay more attention and be responsive to the issues related to environmental, social and economic sustainability (Park and Tucker, 2017). As such, the future reputation of the industry depends on the careful and responsible use of finite resources as well as how well the industry addresses and responds to the potential unintended damage made

[1] Western Sydney University, Australia, S.Ratnasabapathy@westernsydney.edu.au
[2] Western Sydney University, Australia, srinath.perera@westernsydney.edu.au
[3] Western Sydney University, Australia, m.hardie@westernsydney.edu.au

to the natural environment. The main resources from the natural environment, which are considered as the inputs for sustainable management practices as well as the environmental performance assessment of a construction project include water, fossil fuels and land consumption (Xing, et al., 2009).

Being a water-intensive industry, water becomes a key resource component in any construction project due to the diverse nature of the typology of buildings, involving several wet trades and processes associated with the application of different construction materials and technologies (Nový, et al., 2019). While a large volume of water (technological water) is consumed for production, a considerable amount of liquid waste (LW)/wastewater (resulting from operational water) is generated from construction sites. The sources of which generally include construction runoff, stormwater/groundwater collected on-site, spray water from dust suppression, wastewater generated from cleaning of heavy equipment/vehicles and some construction activities, such as airlifting processes of bored piling (Wong, 2002; Nový, et al., 2019). At the same time, LW generated from various processes needs to be properly managed either on-site or off-site as it may contain toxic substances or gases and hazardous solid materials which are harmful to the environment and human health and have a high potential to pollute the groundwater and the ground soil (Wong, 2002). The concentration of suspended solids in LW generated from cleaning of equipment/vehicles and tool washing varies with the construction process and is one of the major pollutants to the environment (Fan, et al., 2013).

The solids in LW also can cause blockages, resulting in overflows and strong odours released to the environment and problems in downstream wastewater treatment plants as well (CleanaWater, 2020, Icon Water, 2020). Subsequently, it will result in heavy fines for construction companies and affect the progress of construction activities (Wong, 2002). Therefore, each construction site requires proper on-site washing out facilities to treat LW/wastewater appropriately before it is discharged. Some past research studies have focused on water efficiency during the construction stage and captured various measures to improve the efficiency of water use during the operational stage of a building (Carragher, et al., 2012) and water-saving measures in different phases of a construction project (Wu, et al., 2020). Limited studies have paid attention to the necessity of appropriate liquid waste management (LWM) practices in the construction sector. The construction sites have a high potential to achieve water savings by improving the efficiency of operational water use during the construction stage (Waidyasekara, et al., 2016). However, water saving by enhancing on-site washout facilities has received less attention among academics and practitioners. There are knowledge gaps around the amount of water consumed for the washing and cleaning processes on-site during the construction stage. In particular, the benefits of using proper and sustainable LWM systems are under-recognised and rarely studied. This study is an attempt to investigate the current status of LWM practices in construction projects in Australia through the following set objectives:

- To identify the legal obligations and regulations related to on-site LWM for the construction projects;
- To identify the sources of LW generated from construction projects;
- To identify the current management methods practised on-site and possible pathways of managing LW on-site;
- To evaluate the volume of water used for the tools washing process on-site;

- To estimate the volume of water-saving when personalised washout systems are implemented on-site for LWM and
- To identify barriers for implementing effective LWM practices/systems on-site.

2. LITERATURE REVIEW

2.1 POSITIONING LIQUID WASTE IN THE CONSTRUCTION SECTOR

An appropriate definition of LW is important to provide a consistent means to determine whether LW generated on-site is suitable for treatment and disposal at landfill sites or into public sewerage networks. According to Environmental Protection Authority, New South Wales - EPA NSW (2014), waste is classified as LW (with no requirement for further assessment for classification), if the waste (other than special waste) meets the following criteria: (1) has an angle of repose of less than 5 degrees above horizontal; (2) becomes free-flowing at or below 60 degrees Celsius or when it is transported; (3) is generally not capable of being picked up by a spade or shovel and (4) is classified as LW under an EPA gazettal notice. In Australia, LW is divided into three main streams: sewage, trade waste, and hazardous liquid waste (Randell, 2012). The waste classification system in Australia varies across jurisdictions and there are considerable inconsistencies in the classification and definition of waste across the states and territories. However, LW classifications and definitions for sewage and trade waste were found to be reasonably consistent at the national level. At the same time, trade waste has not been included as an LW stream for the construction sector consistently across the jurisdictions. Despite, the fact that construction falls under the industrial sector, LW generated by this sector has not been included either under the category of industrial trade wastewater or commercial trade wastewater in NSW. As such, there is no waste category available to include LW/wastewater generated particularly from construction activities. However, wastewater generated by building and construction activities has been classified as 'Liquid trade Waste' in the Australian Capital Territory (ACT) (Icon Water, 2020). According to Liquid Trade Waste Regulation Guidelines 2009 (NSW Office of Water), liquid trade waste includes all LW other than sewage of a domestic nature.

Besides, some basic construction materials such as cement, stone and abrasives have been included under the category of discharging industrial trade wastewater. Similarly, some of the processes associated with the construction developments (which include medium/high-density developments, mixed developments, commercial and industrial developments) have been included as the 'deemed process' for the requirements to meet pre-treatment, backflow prevention and other requirements under the category of commercial trade wastewater in NSW. Those deemed processes include slab formation (no discharge from this process to the sewer is allowed) and wash water generated by the washing of painting and plastering tools such as brushes, trays and spatulas (Sydney Water, 2020). Considering the requirement for approval to discharge the trade wastewater as a deemed process, wastewater generated during the construction stage can be included under the category of 'Commercial Trade Waste' as the construction industry falls under the category of secondary manufacturing industries. However, the construction industry is one of the industries, which largely fails to recognise that the industry is responsible for managing LW to comply with the relevant legislation (Perera, et al., 2021).

2.2 LEGAL REQUIREMENTS FOR LIQUID WASTE/WASTEWATER DISCHARGE FROM THE CONSTRUCTION SECTOR

Many developed countries have established local and national regulations that define the quality of the water that is permitted to discharge into the public sewer. Those regulations set some limitations for the values of some of the properties of water such as suspended solids (SS), acidity (pH), biological oxygen demand (BOD) and chemical oxygen demand (COD) (Nihon Kasetsu Corporation, 2020). According to the Environment Protection (Water Quality) Policy 2015, South Australia (SA) and hence by law, certain types of pollutants that are likely to be generated from the building and construction industry should not be discharged into the stormwater system from any construction sites. The Code of Practice for the Building and Construction Industry (SA) strongly recommends that all construction sites need to follow erosion, sediment and drainage control management practices at sites. Such practices are required to ensure the pollutants do not enter the stormwater system and the construction sites fulfil the legal obligations and general environmental duties related to the Water Quality Policy. In order to comply with these water quality-related regulations, most jurisdictions require pre-treatment and approvals from relevant authorities prior to the discharge of trade waste to the sewerage network. Pre-treatment is the process of treating trade wastewater appropriately using suitable items of equipment before discharging it to the sewer.

The review found that not all the EPAs across the nation have inclusions in the trade waste related aspects that are specifically associated with construction activities. EPAs of Victoria (VIC), Queensland (QLD) and SA and the Department of Water & Energy of NSW Government have only addressed some of the legal requirements, procedures and guidelines relevant to sediment control and discharge of contaminated water from construction sites. The review of legal requirements, policies and guidelines revealed that not all the jurisdictions have established regulations related to stormwater water pollution prevention and approval for the discharge of trade wastewater generated particularly from construction sites. While the LW classification system in Australia varies across jurisdictions, there are considerable inconsistencies in regulations related to LW generated from the construction sector across the states and territories. However, general requirements and guidelines have been established for all the businesses and/or other industries that intend to install a wash down area connecting to the sewer. The construction industry is one of kind to follow those general requirements and guidelines as there has been a lack of specific requirements and guidelines established for the construction industry and those need to be consistent across the jurisdictions.

3. RESEARCH METHODOLOGY

This research primarily employed a mixed-method approach comprising quantitative and qualitative methods of data collection and analysis to achieve its objectives. The approach combines a comprehensive literature review, expert interviews with industry professionals; a review of LWM related documents and a quantitative analysis of raw data. Initially, a comprehensive literature review was carried out to understand the definition of LW/wastewater, the main sources of LW, and the classification and characteristics of LW in general. The review also assisted to find the key LWM pathways, guidance for LWM and relevant regulations/legislation stipulated for LWM across the different states and territories in Australia and currently practised in the construction industry.

Following the literature review, three semi-structured interviews were conducted with industry professionals to identify and understand the current LWM practices in construction projects. The purposive sampling method was used to select the interviewees for the interviews by targeting professionals based on their knowledge, experience and involvement with a minimum of five years of experience in on-site construction project management. The purposive sampling method is considered appropriate for this type of study related to LWM, to which a limited number of experts, who can contribute to the study are available as the primary data sources (Dudovskiy, 2022). The interviewees included top-level managers with more than 20 years of industry experience in project management and represented their working experience in different types of construction projects. The profile of the participants who were interviewed for this study is presented in Table 1.

Table 1: Profile of the interview participants

Interviewee Code	Experience (years)	Position	Size of the Organization
IW 1	20	Director	Medium
IW 2	28	Project Manager	Large
IW 3	30	Construction Manager	Large

The interview participants were asked to provide their opinion and comments on the current status of LWM practices followed in construction projects. The interviews, which were semi-structured with some guide questions mainly focused on identifying the main sources of LW, on-site LWM practices/procedures, pre-treatment requirements, regulations established for managing LW on-site and the barriers for implementing proper on-site LWM services. Qualitative data collected through the interviews were analysed using content analysis methods and the analysed data were used to assess the current status of LW/wastewater management practices and related issues.

The quantitative data were collected from an organisation that provides a fully automated closed-loop washout solution for construction and maintenance sites that require on-site washout facilities for wet trades. The organisation uses a stand-alone, mobile system (hereinafter named Washbox) that does not consume water from the water main, hence requiring no plumbing connections and discharging wastewater into the main sewer/stormwater drain after tool washing. As a closed-loop system, it processes and recycles the wastewater (including the required treatment) once the tank is filled and thus wastage of water is kept very minimal. Possible water wastage is expected from the process of evaporation and spillages only. Solids from LW are allowed to settle at the bottom of the tank after the wastewater is stirred and it is then extracted and sent to the solid waste recycling facility. No shovel is required to remove the solid waste as used in traditional washing facilities, which use either a drum or plastic wheelie bins for tools washing. Figure 1 illustrates a typical Washbox system used for tools washing on-site. The Washbox system was selected because of its specific features that provide a holistic washout solution for on-site tools washing.

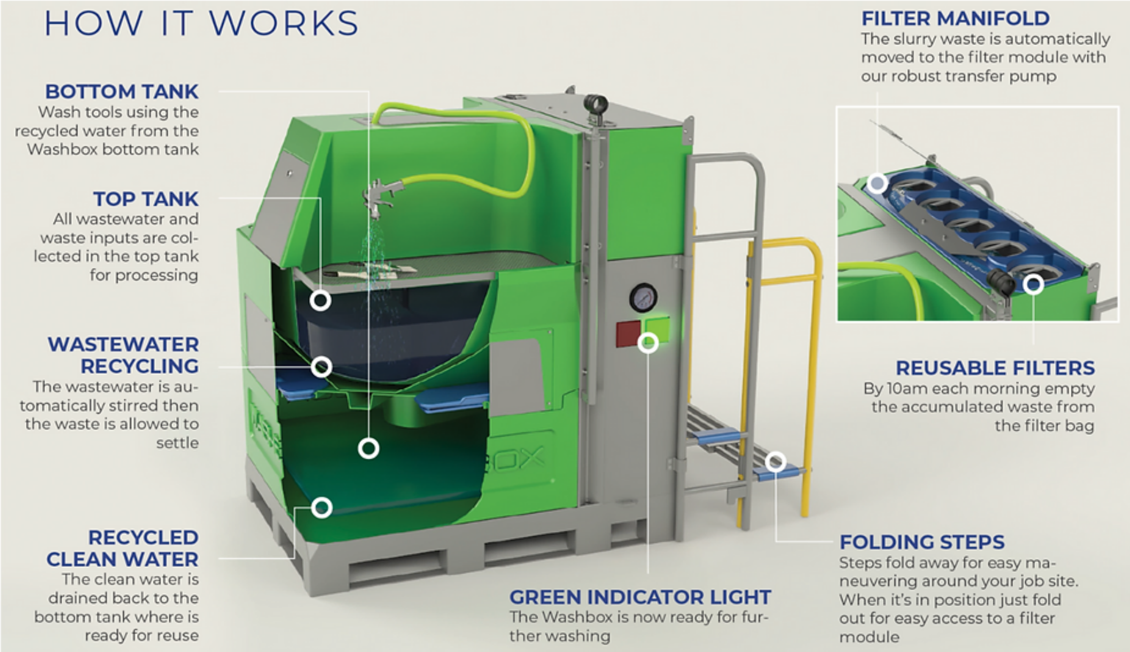

Figure 1: Structure and functioning of a closed-loop Washbox system

Source: Washbox (2022)

Altogether, data from 29 projects, which employed Washbox system for tool washing were considered for the final analysis. These projects were categorised into 8 groups based on their functions. Raw data collected for the analysis include the gross floor area (GFA) of the projects, the volume of water usage when the Washbox is used for tool washing and the volume of water from the water main during the time the Washbox system was functioning on-site. These figures were then used to estimate several data points related to the study such as possible water usage if Washbox system was not used on-site. It enabled the calculation of the possible volume of water savings that can be achieved in tool washing with the use of Washbox system for different types of projects handled by different sizes of builders/developers. GFA of the projects was used to calculate the water usage per square meter of a building for cross-comparison purposes. The following formula (Eq. 01) was used to estimate the water saving by the closed-loop Washbox system.

$$\text{Total water saving} = M - T \qquad \text{(Eq. 01)}$$

$$M = (T / f) * F$$

Where, T - Total water usage when Washbox is used

M - Total water usage when Washbox is not used

F - The average flow rate of the water mains (20 litre/minute)

f - The flow rate of the nozzles of the Washbox system (4.7 litre/minute)

The flow rates of the water main and the Washbox system were collected from the organisation, which provided the washout facilities. It should be noted that due to limitations in data availability for different types of projects, it is difficult to generalise the conclusions. As such, the analysis provided is indicative and preliminary. The following section summarises the analysis of the expert interviews and the data collected from the Washbox system.

4. FINDINGS AND DISCUSSIONS

This section summarises the findings from interviews and analysis of the water usage and water saving in different types of construction projects using the data collected from a series of projects where the closed-loop Washbox system was employed on-site by large and medium-sized builders. It is worth mentioning that all project types except Defence projects have used alternative LWM methods in addition to Washbox system. As such, water usage and saving per m² data may not be accurate. Still, the single data point reflecting a Defence project exclusively used Washbox system as the method of LWM on site.

4.1 LIQUID WASTE MANAGEMENT PRACTICES: ANALYSIS OF USER VIEWS

This section presents the findings from interviews, particularly the current status of the LWM practices in the construction sector based on the views of top-level industry professionals and project-related document reviews. The interview analysis highlighted some important aspects of LWM that could help to reveal the under-measured factors, and inefficiency in legislation and act as indicators for measuring environmental performance. These aspects are briefly discussed with some high points with the reference to the interviewees' code.

Planning for LWM: Planning for managing LW on-site is not specifically considered at the development application stage of a project and planning is carried out during the construction stage only (IW2, IW3). Hence, there is generally no separate section included for LWM either in the general Waste Management Plan (WMP), Environment Management Plan (EMP) or Construction Environment Management Plan (CEMP) unless it is specified as a client's requirement in the conditions of the contract (IW1, IW2, IW3).

Sources of LW: Table 2 presents the sources of LW identified from the interview. The Washbox system has been mostly employed for tool washing for some trades that generated LW mixed with chemicals, powders, dyes and solids from tool washing, in the middle or latter part of the construction phase.

Table 2: Sources of liquid waste generated from construction projects

Trades	Source/Activity	Interview Code
Excavation	Sediment slurry runoff from rock excavation/piling, cleaning and cooling of machinery by water after or while operating	IW2, IW3
Concreting	Classic concrete washout, curing of concrete elements, cooling concrete cutting and machines	IW1, IW2, IW3
Painting/staining	Washing of tools such as brushes, rollers, trays, tins, etc.	IW1, IW2, IW3
Tiling	Washing tools used for grouting, bedding	IW1, IW2, IW3
Rendering/plastering	Washing tools used for mixing materials and rendering	IW1, IW2, IW3
Plasterboard-gyprock	Washing tools used for joining	IW1, IW2, IW3

Trades	Source/Activity	Interview Code
Brickwork/blockwork	Washing tools used for bonding and cleaning - acid washing	IW1, IW2, IW3
Others	Runoff from hydraulic and mechanical sprinklers during testing	IW2, IW3

LWM Methods and Data Reporting: Managing LW on-site is generally handled by the principal contractor (PC) of the project. Typically, the PC hires wheelie bins or 44-gallon drums and installs them on-site for tool washing (IW1, IW2, IW3). In a project site where there is no proper washout service employed to manage the LW, the LW generated from tool washing and washouts from concrete and brick/blockwork are discharged into the main sewer once the solids have settled at the bottom of the drum/sediment bin (which includes filters) and extracted. Yet, the wastewater is not treated before discharging and inspected by any authorities unless it is reported by third parties/public (IW1, IW2, IW3). Often it is common practice that discharging happens even before solids are completely settled. No water is allowed to run off the street or storm waterlines (IW2). The LW removed from the project site by a specialised LMW service contractor is managed (transporting, recycling, treatment and disposal) off-site. However, some PCs, who are concerned with environmental sustainability used to employ personalised washout systems like Washbox to facilitate LWM on-site (IW1, IW3).

There has been no formal reporting involved with LW generated from the trades such as painting, tiling, plastering/rendering, plasterboard and acid washing, except for the LW which is managed off-site by a specialised contractor (who holds the licence to manage LW) (IW1, IW2, IW3).

Cost of LWM: Generally, there is no cost specifically allocated in the budget to employ any washout facilities, like Washbox system on-site. Hence the cost of employing a washout facility becomes a burden to the PC as the cost is not covered under the contract. However, the cost involved in the managing of LW off-site by a specialised contractor is generally estimated and included in the budget (IW2). For some wet trades, such as concreting, painting and plastering, the trade cost will generally include the cost associated with tool washing and cleaning (IW1, IW2, IW3). The interviewees suggested that the cost for LWM services should be allocated in the budget and the PC should not be disadvantaged by bearing that cost. The cost can be paid by the developer or client as an allowance (IW1, IW2, IW3). There is a potential for saving in the cost of LWM services by sharing the services among the wet trades involved on-site (IW1).

Legal Requirements: Compared to solid waste management, following legal compliance in handling, processing and discharging LW is still in its infancy. The PC is required to make sure that they fulfil the compliance and comply with the auditors and inspectors from relevant authorities (IW2). Besides, the local council or relevant authorities such as EPA is responsible to investigate, inspect and fining the contractors who fail to comply with the requirements/conditions of a development application (non-compliance). Application to discharge the trade waste is required at the stage of a development application (DA) and it is the responsibility of the builder/developer to get approval or inform the local authority about their plan to manage the LW during the construction stage (IW1, IW2, IW3).

Barriers for LWM: The major barriers for implementing proper LWM methods in construction projects are found to be as follows;

1. Perceptions of the higher cost involved in employing a washout facility like Washbox and low margin of contractors (IW1, IW2, IW3).
2. The developers are not required to account for measures in managing LW in their sustainability goals and as such, there is no allowance provided in tender conditions (IW1, IW2).
3. Lack of strong sustainability and/or environmental policies followed by some builders' organizations that encourage inefficient LWM or apathy in implementation of such policies where these do exist (IW1, IW2, IW3).
4. Lack of standard procedures for LMW, systematic inspection procedures and fines for not fulfilling compliance specifically for the construction industry (IW2, IW3).
5. Lack of education or training in the tertiary education sector to improve the awareness or knowledge on the impact of LW generated in particular from construction projects and the benefits of implementing effective LWM systems on-site (IW1).
6. Lack of demand from the client to initiate personalised LWM services and pay for the services (IW1, IW2).

4.2 ANALYSIS OF WATER USAGE AND WATER SAVING BY PROJECT TYPE AND SYSTEM USER

4.2.1 Water Usage by Project Type

Figure 2 indicates the average total amount of water used for different types of projects when Washbox systems were used. Compared to other types of projects, residential projects indicate a very low usage of water when Washbox systems are used despite the greater involvement of wet finishing trades in residential buildings. Defence indicates a very high (almost 4 times as residential) usage because the data are based on data from a single project.

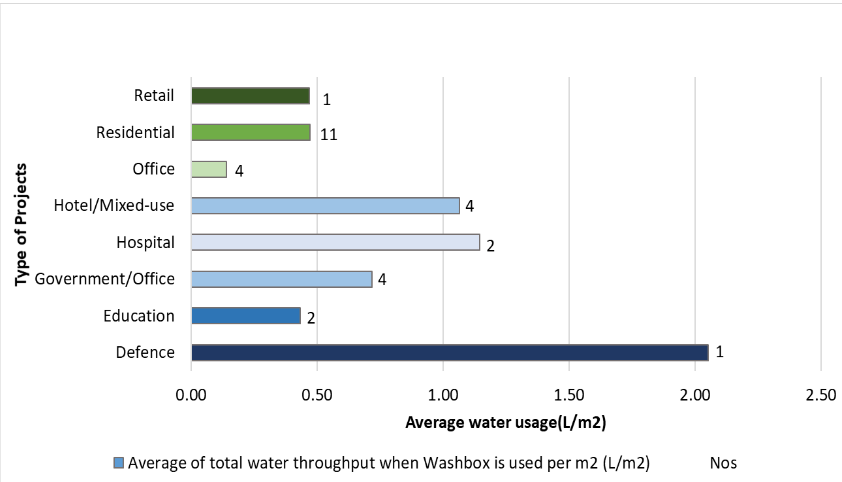

Figure 2: Average water usage per m^2 of gross floor area by project type (when Washbox system was utilised)

Source: Perera, et al. (2021)

4.2.2 Comparison of Water-saving by Project Type

Figure 3 indicates the average water saving for different types of building projects analysed per m^2 of building gross floor area. Data collected from Defence projects can be disregarded as it is based on one data point, which may represent an outlier. However, its inclusion is justified because evidently in this particular project, the Washbox system was the sole LWM system used. On the other hand, the water savings per square meter of buildings for residential type projects represented over 10 datasets, which is much more indicative of true savings. The average across all types of projects indicates a saving of 2.1 litres per m^2 and this is significant and would potentially have a significant impact on water usage in projects across the construction sector.

The water saving that can be achieved for Class 2 type of buildings (multi-storey residential type) is around 2 litres per m^2. When this figure is extrapolated to the 53,000 apartments constructed in the 2017-18 period in Australia, it is estimated that there will be around 10 million litres of water saved in a year. This is considerable and it is only just the saving from the Class 2 type of construction in NSW.

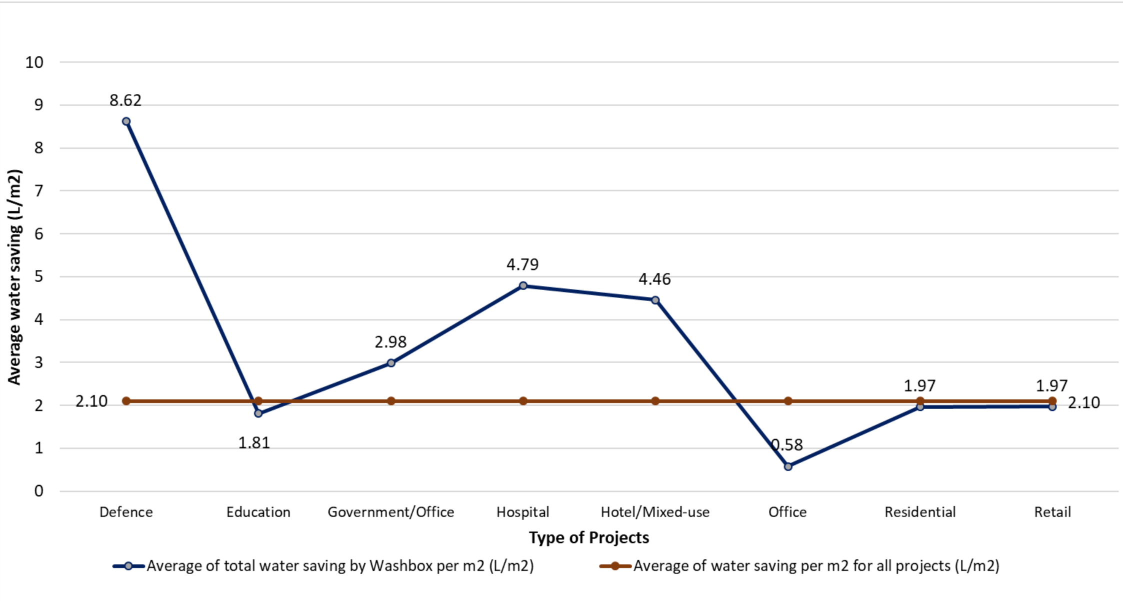

Figure 3: Comparison of average water saving by Washbox per m^2 of gross floor area by project type

Source: Perera, et al. (2021)

4.2.3 Comparison of Water Usage and Water Saving by Project Type

Here again, it is prudent to compare data for types of buildings where there are many data points. Figure 4 clearly indicates the amount of water saving that can be achieved across many building types. In all cases, it indicated over 95% water saving except for Education buildings (85%). The savings varied from 85% to 99% indicating a significant benefit due to water savings. Further, the use of such technologies means that wastewater from tool washing, site cleaning and related activities are not reaching the main sewer system or waterways, which, in turn, keeps the environment away from contamination.

Moreover, a greater level of water efficiency is indicated in the Hotel/Mixed-use category compared to the residential category may also indicate that there is greater scope for improvement of water efficiency in residential projects. However, this may have been a product of Residential buildings involving a greater number of wet trades related to finishes compared to Hotel/Mixed-use that adversely affect efficiency.

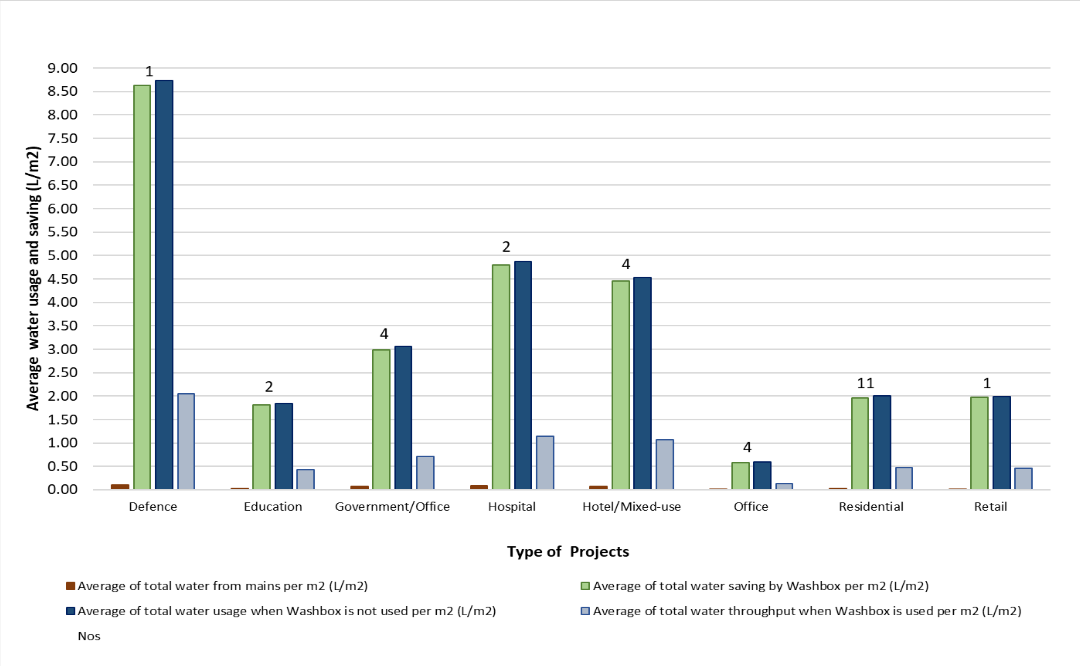

Figure 4: Comparison of average water usage saving per m² of gross floor area by project type

Source: Perera, et al. (2021)

4.2.4 Comparison of Water Usage and Water Saving by the System User (Size of the Organisation

Alternatively, the average water usage and water saving were compared against the size of the system users, which are categorised as large and medium-sized organisations. As revealed in Figure 5, there is not much difference shown in water usage when Washbox is used by both users. However, there is slightly greater water usage in projects delivered by large builders compared to medium-sized builders across all types of projects when Washbox is not used.

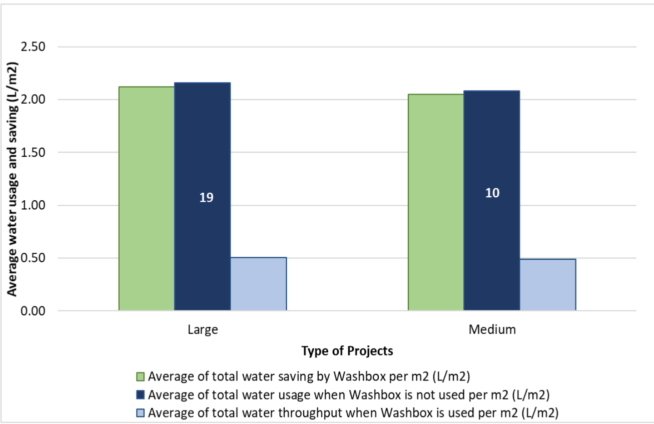

Figure 5: Average water usage and saving per m² of gross floor area by the system users

Source: Perera, et al. (2021)

In terms of water saving, greater water saving by large builders has been observed. This is an interesting outcome that could be resulted from the employment of Washbox systems as a sole LWM system and the use of appropriate LWM procedures. However, it needs further investigation to identify whether the systems and procedures adopted in these two situations are different for this result to manifest. In smaller projects, it is often difficult to have alternative methods and a smaller number of wet trades involved on-site provide greater control.

5. CONCLUSIONS AND RECOMMENDATIONS

This research investigated the current practice of LWM in construction projects, followed by a data analysis using the data collected from 29 different types of building projects. It was estimated that Residential buildings use 0.03 L/m^2 of water for tool washing when Washbox system is used. This is indicative of a 1.97 L/m^2 saving which is a comparatively significant amount. The average water saving for all projects stands around 2.1 L/m^2. When the water savings are extrapolated for multi-storey residential projects (Class 2) across NSW, the total annual saving is estimated at 10 million litres. Large builders seem to be slightly more efficient in water saving than small to medium-sized builders. Since the Washbox system is a closed-loop system that recycles the wastewater within the system, 98% of the water is saved through the Washbox system, proving its efficiency in water saving. Water reclamation, recycling and reuse are being recognised as key components of water and wastewater management (Po, et al., 2004). As such, commissioning an LWM system like Washbox at the construction sites not only enables the construction organisations to comply with the environmental requirements but also helps to achieve economic benefits and enhance the organisation's commercial reputation by reducing the wastewater footprint, conserving water and thus contributing to environmental safety and sustainability.

It is recommended that the efficiency of washout facilities employed on-site should be continuously measured and data of that type should be utilised to create acceptable efficiency benchmarks for construction sites. Water-saving measures used and the amount of waste saved in construction projects are not reported to local authorities (e.g., council) and therefore not acknowledged. There will be no management required if the LW is not measured, reported and inspected. Therefore, reporting of LW managed on-site and off-site needs to be mandated. It is desirable to incorporate the LWM process as a recognised component in Green Star evaluations and introduce rewards such as Green Star credit points for projects which save water through the development and implementation of water-saving plans. Because rating tools such as green star can be considered as a valuable reference to implement water-saving measures in construction projects (Wu, et al., 2020). In terms of legal compliance, there should be a step-change with revisions in working towards full legal compliance related to LWM in construction projects. Legislation governing LWM should specifically state the requirements for and impact of discharging partially or untreated LW from construction sites. The inclusion of an LWM plan that could form a part of either WMP, EMP or CEMP should be mandated for all construction projects. Further research needs to be carried out to evaluate in detail the state of legislation with respect to LWM in construction projects and the environmental consequences of LW generated from construction projects.

6. ACKNOWLEDGEMENTS

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