THE POTENTIAL OF EFFICIENT WATER MANAGEMENT SYSTEM IN HIGH-RISE DESIGN

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ABSTRACT

Water is a natural gift upon all life forms since the early civilization of mankind and Malaysia is one of the nation that is rich with water resources. Since decades ago, the development in the water sector spurs the social economic growth of this country (Mohd. Azhar, 2000). As time goes by with rapid urbanisation across Malaysia, the demand for water especially in buildings, increase to accommodate a growing population and their needs. Roodman et al. (1995) and the United Nations Environment Programme (UNEP) (Al-Tamimi, 2011) highlight that the World watch Institute estimates building consumption to be at least 40% of the world's energy and 16% of the water used annually. However, issues like increasing wastages and mismanagement of water leads to a problem towards this resources. Hence, the first part of the paper assesses the issues faced globally and locally towards water resources and the principles of water quality cascade in relation to sustainable water management in buildings. The next part are collective reviews of two selected case studies that include sustainable water management in the respective building design approach. The significant of this paper is to encourage the mind set of designers to contemplate and develop a more efficient water management system in high-rise buildings design as well as the importance for regulatory authorities and consultants to integrate the principles of sustainable water management onto development governing.

Keywords*: Sustainability, Water Efficiency, High-Rise Building*

INTRODUCTION

Water is not only a fundamental natural resource to each and every living being, but during the course of history has been an essential channel of production for populations, used for trade, defence, transportation, industry and recreation, hence defining the character of urban fabrics. In the post-industrial civilization, the usage of water resources for aesthetic indulging in urban planning and architectural design scheme has increasingly predominated on other purposes since the origin and development of the leisure and tourism industry (Laura Daglio, 2014).

However, the entire world is currently confronting a prominent water crisis over the years and consequently billions of people and surroundings are suffering from scarcities of resources either seasonally or on a permanent basis. The majority of the advancing nations are enduring droughts as they are situated in regions that are dry during part of the year (Falkenmark, 1990). Compounded with the climate change, population growth and advancement in living standards, this circumstance offered a dreadful challenging scenario within the developing region.

Generally, water crisis is an environmental dilemma and nations with plentiful of water resources also facing constraints in supplying clean drinking water as a result of water pollution (Md. Aziul Bari et al, 2015). In this case, Malaysia is one of those nation that is facing this problem although it is rich with water resources as water pollution is looming large in developed areas (Ang Kean Hua et al, 2014).

As a result, water conservation with efficient management system are becoming gradually crucial as the world is facing decreased ground and surface water levels, drought and varying climate patterns (Vinita Chanan et al, 2003). There are abundant schemes in Malaysia targeting water efficiency in development projects, but less effort has been executed to trim down water demand in the commercial district.

Therefore, with the aim to identify the effects of efficient water usage in building design, water usage in commercial high-rise buildings are investigated in order to distinguish its value towards the sustainability and passive design of a building.

ISSUE STATEMENT

1. High Water Demand

Although at first glance, agriculture and industry signify the majority of water demand, the ratio of household usage in total water consumption ranges from 10-30% in developed nations (Katrin Millock et al, 2010). Moreover, water consumption will increase in proportion to per capita Gross Domestic product (GDP) growth (L. Bengtsson et al, 2005). Hence, as economic growth rises in developing nations, water consumption will also increase and the patterns will change drastically.

Water usage can be differentiated according to its final consumption in industrial, commercial, residential, industrial, public and wastage and differ according to the living standards of consumers (Steel et al, 1979).

Activities	*Grater Kuala Lumpur*		*Thailand*		*Korea*		*U.K.*		*U.S. pre-retrofit*		*U.S. post-retrofit*	
	Lpcd	*%*	*Lpcd*	*%*	*Lpcd*	*%*	*Lpcd*	*%*	*Lpcd*	*%*	*Lpcd*	*%*
Bathing/showering	125	47	78	40	27	23	33	26	48	22	43	30
Toilet	63	24	31	16	52	45	44	34	71	33	30	21
Washing cloth	18	7	52	27	13	11	15	12	56	26	35	24
Kitchen	39	15	4	2	23	20	36	28	40	19	35	25
Others	23	9	28	15	-	-	-	-	-	-	-	-
Total	268	100	217	100	115	100	128	100	215	100	143	100

Table 1: Comparison per capita water consumption with other countries

Source: Water Consumption Patterns in Greater Kuala Lumpur: Potential for Reduction (Md. Azizul Bari et al, 2015)

Table 1 shows the litres per capita daily usage towards water resources for Greater Kuala Lumpur with other developing countries and the metropolitan is greater than any stated nations. Consequently, with growing population and alteration of climate patterns, reconsideration towards the availability of fresh water is required by preparing a more sustainable approach when designing a building as it should provide benefits in terms of their water consumption efficiency (Cheng-Li Cheng et al, 2016).

2. Water wastage

Furthermore, the average domestic water consumption in Malaysia is greater than that of advanced nations. As an example, Table 1 suggests that Greater Kuala Lumpur single-handedly consume larger amount of water resources than any stated developed countries. The consumption is more than twice the average of Thailand, Korea, United Kingdom or United States.

Whereas average water consumption in Selangor including residential, commercial, institutional and industrial exceeded 300 litre per day. The international standard for recommended water usage is 165 litre per day (Lam Kim Seong, 2013). Thus, showing how much this country is receding in water resources management. Other than that, more than 4.27 billion litres of treated water are wasted recently due to leaky pipes (The Strait Times, 2014).

SUSTAINABLE WATER MANAGEMENT

Based on Vinita Chanan et al (2003), sustainable water management systems are established on the concept of the water quality cascade. As a result, water resources should be complemented with end uses in terms of the necessitated water quality as shown in Table 2.

Increasing perception of risk ↓

Source	End Use
Scheme water OR Treated and disinfected rainwater	Drinking Kitchen Showers Basins
Treated and disinfected greywater	Cleaning Cooling tower make up Toilet flushing
Treated and disinfected cooling tower blowdown	Cleaning Toilet flushing
Treated and disinfected blackwater and blackwater blowdown	Roof garden irrigation

Increasing quality requirement ↑

Table 2: Water Quality Cascade with End Uses

Sources: Sustainable Water Management in Commercial Office Buildings (Vinita Chanan et al, 2003)

The concept of sustainable water management help categorizes substitute water resources that can be provided to achieve the water demand in ways that does not need potable water property. It also stresses on consuming the most efficient water utilization that is more viable (Vinita Chanan et al, 2003).

EFFICIENT WATER MANAGEMENT DESIGN OPPORTUNITIES

Architects and designers can achieve energy efficiency in buildings by analysing the macro and micro climate of the proposed site and provide a bioclimatic design feature. As an example, the passive design approach such as water bodies for evaporation and cooling can improve thermal and visual comfort inside a building. In addition, it provides a significant amount of reduction in energy consumption from conventional air conditioning (Peter O. Akadiri et al, 2012). The following suggests the opportunities that can be done through architectural design to achieve efficient water management:

1. Rainwater Harvesting

Rainwater harvesting or rainwater utilization system possesses the capability to resolve two water issues in Malaysia, such as scarcity of water supply and excessive water consumption. If applied in a development project, it can trim down water demand as well as easing flood hazards by enablement flows into the storm water managing grid. The government introduced the scheme after the drought in Kuala Lumpur during the year 1998. Rainwater harvesting has been incorporated in the National Urbanization Policy 18 formed by the Town and Country Planning Department. Moreover, the Federal Government declared that rainwater harvesting would become mandatory to large buildings in the country (S.A Rahman, 2009).

2. Roof Gardens

Roof gardens or green roofs in commercial buildings can engage not only in water and wastewater management but also in refining the energy operation of the building. There are two modes of green roofs which are extensive and intensive. Extensive green roofs comprise of thin growing medium, have lesser variety of plants and somewhat inexpensive. Intensive green roofs consist of a deeper soil substrate, have a larger plants diversity and micro-organism habitats, and possibly have better energy efficiency and storm water retention capabilities and a lengthier membrane lifespan.

Roof gardens can lessen the ‘urban heat island effect’, which is the overheating of urban belts due to expansion of concreted areas relatively to ‘green’ areas. Other important gains include extending roof lifespan, purifying of airborne particles, sound insulation, formation of appealingly pleasurable landscapes and storm water retention (Peck et al, 2001). Life cycle estimation calculations carried out by the National University of Singapore on rooftop gardens have learned that extensive green roofs cost less than conventional roofs when energy savings factor is considered (NUS, 2006).

3. Water Bodies Landscaping

Water element has been utilized by landscape architects as a major aesthetic influence. It was generally applied for unravelling the monotony caused by the solid materials used by architect. Its magnitude in visual and non-visual landscapes varies on the experience of the eyewitness. Furthermore, it is a neutral architectural element which cannot be distinguished as natural or built (Anjaly Meera Ibrahim, 2015). Through the design of water landscape, it can utilize many ecological sound schemes to safeguard water quality. The opportunity is there to integrate options such as buffers, minimal-impact development, open space design, rain gardens, retentions, and native plantings in the design progression (Andrea Lora Davis, 2006).

4. Efficient Fixtures

Commercial buildings can utilize the technological innovations produced in the improved water efficiency of fixtures like toilets, urinals, taps and showerheads and additional systems such as cooling towers and rainwater capture and treatment systems. By increasing the efficiency of water fixtures technology, it can steer to major cutbacks in water demand from the end uses and also transforms into significant cost savings (Vinita Chanan, 2013).

CASE STUDIES

1. **Case Study 1: One City @ USJ 25, Malaysia**

Figure 1: One City @ USJ 25, Malaysia

Source: http://www.serviceofficesmalaysia.com/serviced-offices/Selangor/MCT-Tower-One-City

i. Green Building Index: Silver Award

The One City @ USJ 25 building have been awarded the Silver Award by Green Building Index (GBI), in recognition of its eco-friendly design approach practices with application of sustainable building system (Green Building Index, 2016).

ii. Water Resource Management System

PART	CRITERIA		GBI Max. Points	Targeted	Share score points among 3 components : Retail Office, Hotel & Corporate Office Tower	Remarks
5	**WE**	**WATER EFFICIENCY**				
	WE1	Rainwater Harvesting	2	1	YES	Under One System
	WE2	Water Recycling	2	2	YES	Under One System
	WE3	Water Efficient - Irrigation / Landscaping	2	2	YES	Under One System
	WE4	Water Efficient Fittings	2	2	YES	Under One System
	WE5	Metering & Leak Detection System	2	1	YES	Under One System
	Sub Total		**10**	**8**		
6	**IN**	**INNOVATION**				
	IN1	Innovation in Design & Environment Design Initiatives	6			
		- Condensate water recovery		1	YES	Under One System
		- Thermal Energy Storage, TES		1	YES	Under One System
		- Non-Chemical water treatment		1	YES	Under One System
		- Recycling Fire System water during testing		1	YES	Under One System
		- Entire building with LED implementation		1	NO	
		- Waterless Urinal		1	NO	
	IN2	Green Building Index Accredited Facilitator	1	1	NO	
	Sub Total		**7**	**7**		
TOTAL POINTS :			**100**	**68**		

Figure 1: GBI Water Efficiency (WE) & Innovation (IN) Score

Source: Green Building Index

- The placement of water features is parallel to the layout of the building to act as a heat sink in which will aid in cooling the building via evaporation as well as conduction between the stone floors.
- The condensate water collected from air conditioning system will channel to Atrium Boulevard Water Pond.
- Condensate water temperature is relatively lower than domestic water, thus added condensate water into the pond will cool down the ambient temperature.
- The pond overflow pipe will channel the excessive water to Basement Recycle Water Tank.
- Waterless urinal is installed throughout the building toilets.
- The rainwater harvested & grey water recycled is utilized for all Irrigation System and Cooling Tower. The Irrigation System is 100% using recycled water, thus no potable water is use at all.

Source: Green Building Index

2. Case Study 2: Marina Bay Financial Centre (MBFC), Singapore

Figure 2: Marina Bay Financial Centre

Source: http://www.meinhardtgroup.com/projects/marina-bay-financial-centre/

i. BCA Green Mark: Platinum Award

The Marina Bay Financial Centre (MBFC) have been bestowed the Platinum Award by Building & Construction Authority (BCA) Green Mark Platinum, in acknowledgement of its high-quality practices in environmental design approach with implementation of sustainable building technologies. The Platinum Award is the most premier honour in BCA Green Mark scheme (MBFC, 2014).

ii. Water Resource Management System

The Marina Bay Financial Centre is 1 of 16 buildings in Singapore to be given recognition for including efficient water resource management features (Audrey Tan, 2015). The design of the water management system is based on the objective of enabling an organisation to take a systematic approach to achieve continual improvement of water efficient and develop and implement water saving measures. The water resources management system in the Marina Bay Financial Centre buildings, includes:

- The tower features include the water leak detection and monitoring systems which reduces and minimise water wastage.

- The tower features include the water leak detection and monitoring systems which reduces and minimise water wastage.
- The condensate water from the air conditioning system is recycled for use in fountains, irrigation and cleaning, contributing to the saving of about 3,000 cubic metres of water annually.

- They include water-efficient fittings installed in all toilets such as self-closing system to all water taps and auto sensor system for all water closets.
- Signs with contact information displayed in all toilets to enable timely reporting and repair of leaks or faulty fittings.

Source: BCA Greenmark

CONCLUSION

Many architects and urban planners are conscious of the negative impacts of urbanization and the necessity to integrate water management in spatial planning to achieve sustainability (Anna Januchta-Szostak, 2014). For the reason that a sustainable building is regarded as a strategy for the built environment industry to move towards safeguarding the surrounding environment. The campaign of sustainable building practices is to go for a balance in economic, social, and environmental performance in executing construction projects (Peter O. Akadiri et al, 2012).

Architects and designers can achieve energy efficiency in buildings by providing a bioclimatic design features based on the macro and micro climate analysis of the proposed site (Peter O. Akadiri et al, 2012).

In terms of the selected case studies, both developments steered to be an example of green commercial buildings by integrating the concepts of environmental sustainability in all attributes of its design, operation and maintenance. The developments are managed by the following principles:

- Commercial Viability
- Integration of water saving systems with minimum resource consumption
- Minimum water usage and maximum use of recycled and treated wastewater

In order to realise this philosophy, it will need regulatory authorities to implement the above principles into development controls and regulations to increase and guarantee the take up of the technologies and practices for new commercial buildings in the future.

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