



Performance evaluation on water consumption of the general support staff of Mahidol University, Thailand

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Abstract

Water is very important both in the present as well as in the future world because water is the basic necessities which are used in all operations of life. This is particularly true in the case of Thailand because water is very important to Thai's life style and business due to increasing consumption of water in the recent decades along with the experience of frequent droughts and flooding due to deforestation. The water resources development budget has been increasing and represents a large portion of the budget for national development. This research is performed with aims to 1) analyze the consumption of water of the General Support Staff of Mahidol University, Thailand based on criteria of Eco - Index for fiscal years 2012–2014; 2) compare the statistical analysis of the average water consumption and average water used in each year; 3) compare the statistical analysis of the average water consumption per area and average water used in each year; 4) comparative statistical analysis of the average water consumption per head and average water used in each year. The result of the study concludes that the consumption of the amount of water varies according to the size of the space and the context in which the work operates, such as policies, management and measures for implementation of each assigned task. The study is important as it helps to find the detail comparative analysis of water consumption and activity of each department or faculties for the comparative analysis of water consumption and efficiency in management.

Keywords: performance, evaluation, water consumption, Mahidol University

1. Introduction

"Water" is a crucial resource for living in Thailand. Due to the increase in population, there is an increase in consumption of water which leads to the shortage of water [1]. This includes spending a lot of money on water management for development [2]. At the same time, some people are not aware of the scarcity of water and do not save water. There is also an increasing deterioration of the quality of water such as contamination with waste water discharge, garbage and various chemicals. Human beings are responsible to affect water resources such as deforestation, soil erosion, which causes shallow water and flood in the lower catchment area [3, 4, 5].

The problem of water is not limited to a specific period of one year or two years but for a long time. The water problem is not due to physical problem or inadequacy in supply of water. The problem is associated with the factor of inefficiency in water sharing. Appropriate management in water allocation is important to solve the problem. Inadequacy in water management causes lack of performance economically along with increasing disparity in supply and utilization. This may increase prevalence of social conflicts [6, 7]. Therefore, water study or management should be integrated in academic research in order to protect from flood, drought, famine and other calamities and

for bringing a sustainable development of the country [8].

At present, the development of a large water reservoir in Thailand with a capacity of more than 100 million cubic meters has limited supplies in many areas, comprising of both terrain and plain environment. In Thailand, development of a large water project, that has the potential to develop a water capacity of a total of 31m³, is essential. However, creating such kind of large water tank to solve water problems is difficult. The presence of drought due to lack of water causes shortages of water supply. The current water shortage is in some years when there is scarcity of rainfall. These causes famine and serious shortages of water, thereby causing damage to agricultural areas and lack of drinking water or water for consumption. In addition, water is basic need of all living beings and is fundamental to the daily needs and contributes to revenue escalation. It can reduce poverty through its contribution from revenue and therefore can be an important economic contributor for developing countries and for its development [9, 10].

Mahidol University is a leading University in Thailand. This study evaluates the consumption of water within Mahidol University during the fiscal year 2012-2014 by comparing the water consumption of each segment or department per year and

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comparison of water consumption by area. The study aims to find out whether the use of water power operates reasonably well. Therefore, we ought to note the use and activity of each department or faculties, the comparative analysis of water use and efficiency in management.

2 Methods

This research is carried out so as to find out the amount of water consumption in Mahidol University by collecting data and other relevant information from 10 faculties about water consumption, based on the eco index criteria of Mahidol University from 3 previous years (Year 2012–14) between October–September in a year, as given under: [2]

- 1) Year 2012: from October 2011 – September 2012
- 2) Year 2013: from October 2012 – September 2013
- 3) Year 2014: from October 2013 – September 2014

Secondary general information were also collected consisting of the scope of the area, quantity of water consumption by each faculties. These information were

obtained from the financial department, consisting of the number of people (staff and students) and service, information, researching strategy and plan of Mahidol University. The collected data was analyzed by using SPSS version 18 for quantitative analysis and statistical results. The findings were categorized into different group information such as in terms of size, area, number of students, staff and service users.

In this study a total of 10 faculties were included in the study as:

- 1) NakhonSawan Campus, Mahidol University
- 2) Amnatcharoen Campus, Mahidol University
- 3) Faculty of Graduate Studies, Mahidol University
- 4) Kanchanaburi Campus, Mahidol University
- 5) Library and Knowledge Center, Mahidol University
- 6) Office of the President, Mahidol University
- 7) Division of Physical Systems and Environment, Mahidol University
- 8) Mahidol Learning Center (MLC)
- 9) MU Condo (Residential Apartment)
- 10) MU Home (Residential Dormitories)

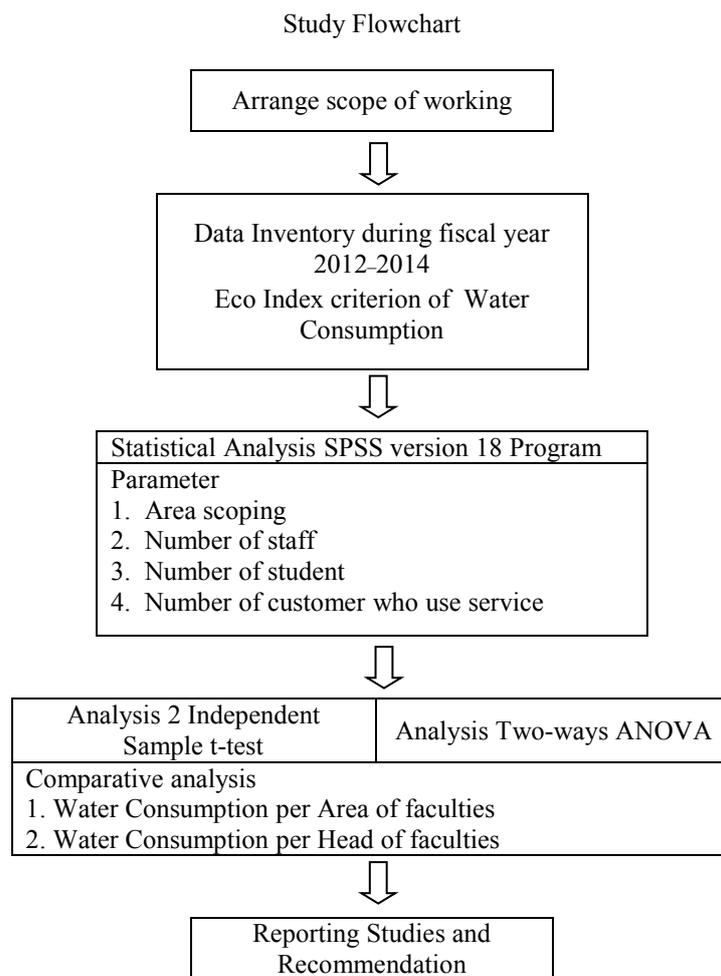


Figure 1 Flow Chart of the Research

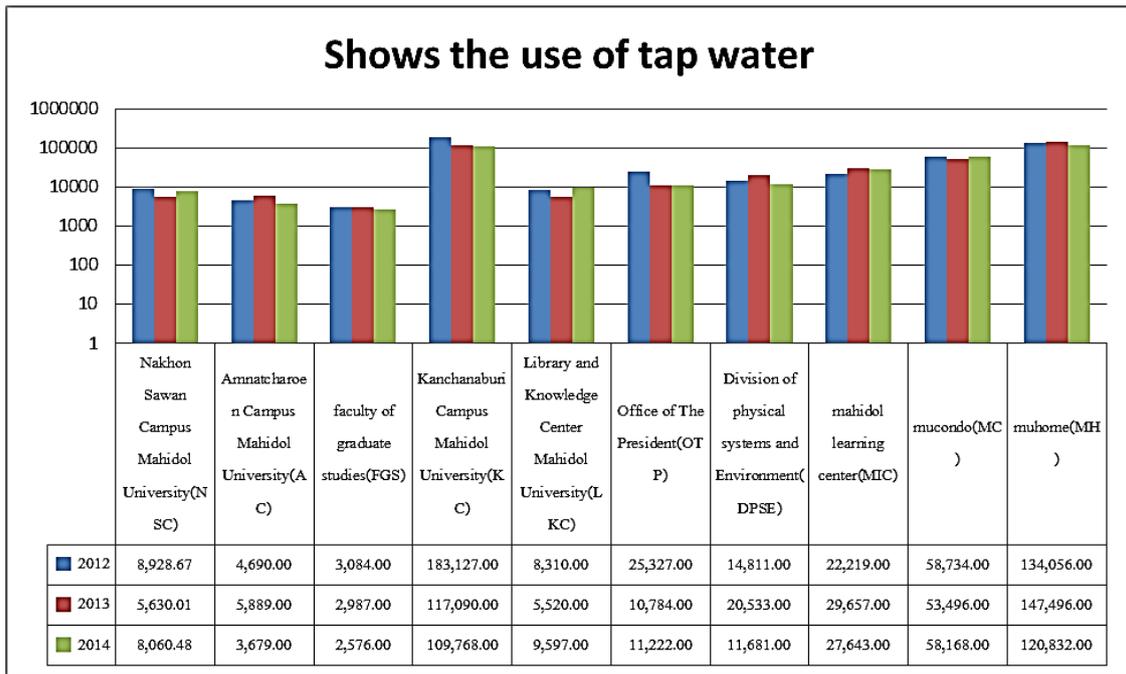


Figure 2 Water consumption of 10 faculties under the eco-index during fiscal year 2012–2014

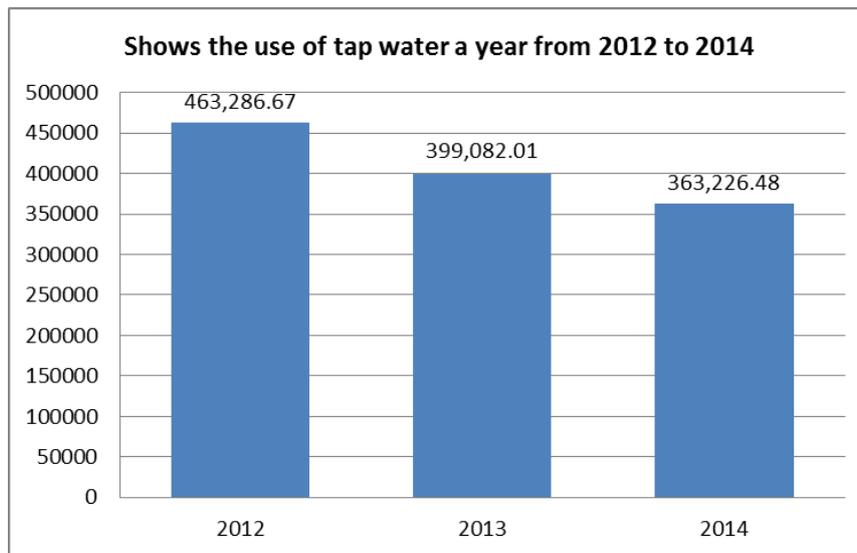


Figure 3 Water consumption during the fiscal year 2012–2014

3 Results and discussions

The study indicated that the group has a primary mission of serving the public. Each segment has an average water consumption, analyzed from 10 faculties of the University during the fiscal year 2012–2014.

From figure 2, it can be seen that during the fiscal year 2012–2014, the total water consumption in the MU Condo (MC.) has the maximum usage of water, 79,519 cubic meters, while Faculty of Graduate Studies (FGS.) is the Faculty with the least usage of water, 8,647 cubic meters. It is important to note that some

other faculties have continuous stable tendency in water usage due to good management system.

Figure 3 shows the total water consumption during the fiscal year 2012–2014 of the 10 faculties of Mahidol University. From the above figure, it can be seen that in 2012, the total water consumption reached 463,268.67 cubic meters in 2013, the total consumption was 399,082.01 cubic meters and in 2014, the total water consumption was 363,226.48 cubic meters. The average use of water during these three years is 408,531.72 cubic meters. However, the general support staff in Mahidol

Table 1 Water Consumption by the public by each year [11]

Faculties	Water consumption (cu.m)			
	year 2012	year 2013	year 2014	Total
NakhonSawan Campus Mahidol University(NSC)	14,811.00	20,533.00	11,681.00	47,025.00
Amnatcharoen Campus Mahidol University(AC)	8,928.67	5,630.01	8,060.48	22,619.16
Faculty of Graduate studies(FGS)	4,690.00	5,889.00	3,679.00	14,258.00
Kanchanaburi Campus Mahidol University(KC)	3,084.00	2,987.00	2,576.00	8,647.00
Library and Knowledge Center Mahidol University(LKC)	183,127.00	117,090.00	109,768.00	409,985.00
Office of The President(OTP)	25,327.00	10,784.00	11,222.00	47,333.00
Division of Physical systems and Environment(DPSE)	134,056.00	147,496.00	120,832.00	402,384.00
Mahidol Learning center(MIC)	8,310.00	5,520.00	9,597.00	23,427.00
MU Condo(MC)	58,734.00	53,496.00	58,168.00	170,398.00
MU Home(MH)	22,219.00	29,657.00	27,643.00	79,519.00
TOTAL	463,286.67	399,082.01	363,226.48	1,225,595.16

Table 2 Results of analysis of variance of the global consumption of water

Data source	Degrees of freedom	Mean Square	F	P-value
Department	9	8,183,009,601.465	44.004	< 0.0009
year	2	256,998,317.002	1.382	0.276
Dislocation	18	185,959,881.853		
TOTAL	29			

University have continuous tendency to reduce the consumption of water.

3.1 Water consumption

Below gives the Statistical Analysis of water used by each faculty of Mahidol University.

The table above showed that $F_1 = 44.004$ which conclude that the public consumption of each faculty were with an average consumption of water during the years 2012 to 2014 with different P-value < 0.0009 on the basis of the pair being tested individually.

The mean difference of Kanchanaburi campus and dormitories have an average value, of more than eight from the rest.

Regarding the mean difference of Residential buildings and Mahidol Learning Center, were with an average of more than six from the rest.

From the Building of Learning Center, University Office of the President, Physical and Environmental Division, Library and Knowledge, and college graduates, the mean difference were $F_2 = 1.382$, which conclude that the public average consumption of water per year were No different at P-value = 0.276.

3.2 Water consumption per area

The area analysis of water consumption of faculties is grouped during the academic years; the results is shown as follows 1.NSC has 1,767,029 square meters 2.AC has 18,528 square meters 3.FGS has 11,300 square meters 4.KC has 54,492.88 square meters 5.LKC has 14,000 square meters 6.OTP has 21,034

square meters 7.DPSE has 384,000 square meters 8.MIC has 24,512.13square meters 9.MC has 35,721 square meters 10.MH has 63,298 square meters

The water consumption per area can be seen from the table given below.

The water consumption per area = water usage/ area size

The table below showed that $F_1 = 30.869$, which conclude that the public consumption when tested individually from residential dormitories of Kanchanaburi campus and residential condominiums, the mean difference of Kanchanaburi campus was with an average of more than seven from the rest dorm of Residential building and Learning Center, Mahidol University. The mean difference of water consumption in dormitory was with an average of more than six from the rest of Residential Building and Learning Center, University Office of the President, University Library and Knowledge Center. The mean difference of Residential was with an average of four which is more than the rest such as University Learning Center, Office of the President, University Library and Knowledge Center etc.

The mean difference with $F_2 = 1.536$ conclude that the public average consumption of water per hectare per year is different, the P-value = 0.242.

3.3 Water consumption per head

The results of water consumption by faculty personnel, student and users, which is grouped during

Table 3 Water consumption per area of water used by each faculty of Mahidol University [11]

Faculty	Water consumption per unit area (cu.m. / m2)			
	2012	2013	2014	SUM
Nakhon Sawan Campus Mahidol University(NSC)	0.0386	0.0535	0.0304	0.1225
Amnatcharoen Campus Mahidol University(AC)	0.0051	0.0032	0.0046	0.0128
faculty of graduate studies(FGS)	0.2531	0.3178	0.1986	0.7695
Kanchanaburi Campus Mahidol University(KC)	0.2729	0.2643	0.2280	0.7652
Library and Knowledge Center Mahidol University(LKC)	3.3606	2.1487	2.0144	7.5236
Office of The President(OTP)	1.2041	0.5127	0.5335	2.2503
Division of physical systems and Environment(DPSE)	2.1179	2.3302	1.9089	6.3570
mahidol learning center(MIC)	0.5936	0.3943	0.6855	1.6734
mucondo(MC)	1.6442	1.4976	1.6284	4.7702
muhome(MH)	0.9064	1.2099	1.1277	3.2441
SUM	10.3965	8.7322	8.3599	27.4886

Table 4: Analysis of variance, the amount of water supply to the area of public

Data source	The sum was twice	Degrees of reedom	MeanSquare	F	P-value
Faculty	21.263	9	2.363	30.869	< 0.0009
year	0.235	2	0.118	1.536	0.242
Dislocation	1.378	18	0.077		
SUM	22.876	29			

Table 5 Water consumption per person of the public by each year. [11]

Faculty	Water consumption per person (cu.m/person)			
	2012	2013	2014	SUM
NakhonSawan Campus Mahidol University(NSC)	107.32	142.59	87.17	337.08
Amnatcharoen Campus Mahidol University(AC)	87.53	39.37	39.51	166.41
Faculty of Graduate studies(FGS)	260.55	56.08	15.52	332.16
Kanchanaburi Campus Mahidol University(KC)	18.46	17.57	15.33	51.37
Library and Knowledge Center Mahidol University(LKC)	167.08	101.72	97.57	366.38
Office of The President(OTP)	18.15	7.13	6.89	32.18
Division of Physical systems and Environment(DPSE)	44.27	41.87	29.97	116.12
Mahidol Learning center(MLC)	69.83	46.00	14.11	129.94
MU Condo(MC)	-	-	149.14	149.14
MU Home(MH)	-	-	119.1509	119.1509
TOTAL	773.2310	452.36	574.39	1,799.99

Table 6 Analysis of variance Water consumption per person of public

Data source	The sum was twice	Degrees of reedom	MeanSquare	F	P-value
Faculty	42,227.658	7	6,032.523	3.000	0.038
year	14,273.466	2	7,136.733	3.549	0.057
Dislocation	28,149.029	14	2,010.645		
SUM	84,650.153	23			

the academic years is given as follows: 1) NSC in year 2012 has 138 persons, year 2013 has 144 persons and year 2014 has 134 persons 2) AC in year 2012 has 102 persons, year 2013 has 143 persons and year 2014 has 204 persons 3) IHRP in year 2012 has 18 persons, year 2013 has 105 persons and year 2014 has 237 persons 4) KC in year 2012 has 167 persons, year

2013 has 170 persons and year 2014 has 168 persons 5) LKC in year 2012 has 1,096 persons, year 2013 has 1,151 persons and year 2014 has 1,125 persons 6) OTP in year 2012 has 1,395 persons, year 2013 has 1,512 persons and year 2014 has 1,628 persons 7) DPSE in year 2012 has 3,028 persons, year 2013 has 3,522 persons and year 2014 has 4,031 persons 8)

MLC in year 2012 has 119 persons, year 2013 has 120 persons and year 2014 has 680 persons 9) MC in year 2012 has - persons, year 2013 has - persons and year 2014 has 390 persons 10) and MH in year 2012 has - persons, year 2013 has - persons and year 2014 has 232 persons The water consumption per head can be seen from the table given under:

The water consumption per head = water usage / head

The table showed that $F1 = 3.000$, which conclude that the public consumption per year was medium. The mean difference of Kanchanaburi Mahidol campus was with an average of four, which is more than the rest such as Faculty of Physical and Environmental Division, Establishment campus, Nakhon Sawan Campus, University Library and Knowledge Center and Residential dormitories. The mean difference of Physical and Environmental Division Establishment campus have an average which is more from the College and the Office of the President.

Establishment campus, Nakhon Sawan Library and University Knowledge Center, Residential Dormitory and the Office of the President were with the mean difference of $F2 = 3.549$, which, thus, conclude that the public average consumption of water per person per year is different, the P -value = 0.057.

4. Conclusions

This research studies evaluates the **water consumption performance of the general support staff in Mahidol University, Thailand**. The general support staff in Mahidol University should have continuous evaluation of water consumption every year so that the data can be compared and also changes in water consumption. In addition, there should be evaluation covering all activities of water consumption with regard to other factors such as the use of water from natural sources in order to estimate the real value of water consumption. The consumption of the amount of water varies according to the size of the space and the context in which the work operates, such as policies and measures for implementation of each assigned task. This influences the consumption of water. From the study, it can be seen that there is no significant difference in the consumption of water from the previous year with regard to the operations associated with the usage of water However, the university management plan aims to stabilize the water supply to the areas within the university. But it requires the participation of all segments so as to make a continuous care on water resource utilization management for the all - round development of the university. [12]

So, if we have a good management system, such as utilizing water management system standards, it will help to assist in the implementation of the work regarding the usage of water and the system will be more efficient. In addition, there is no need to reduce water resources related jobs if there is the use of equipment and technologies that enable to save water

and energy systems, such as mounted sensor faucet sinks and also bringing water from the canal to reduce water plants etc. Thus, it can be finally concluded that water usage amount depends on the type of management system and the most important point in this regard is to create public awareness with campaign to save energy and water resources with due consideration of cost-effectiveness as much as possible.

References

- [1] The international conference on water and the environment. **Proceedings of ICWE: Development issues for the 21st century**; 1992 Jan 26-31; Dublin, Ireland.
- [2] Sethaputra S, Thanopanuwat S, Kumpa L, Pattanee, S. **Thailand's water vision: A case study [Internet]**. Regional Office for Asia and the Pacific. [cited 2016 Dec 21]. Available from: <http://www.fao.org/docrep/004/AB776E/ab776e04.htm>
- [3] FAO: Economic and social development department. **Water resource issues and agriculture [Internet]**. [cited 2016 Oct 10]. Available from <http://www.fao.org/docrep/003/t0800e/t0800e0a.htm#b1-Introduction%20and%20overview>
- [4] Homer-Dixon TF, Boutwell JH, Rathjens GW. **Environmental change and violent conflict**. *Sci. Am* 1993; Feb:38-45.
- [5] The Dublin statement and report of the conference. *Proceedings of ICWE*; 1992; Dublin, Ireland.
- [6] Bigas H, editor. **The global water crisis: Addressing an urgent security issue [Internet]**. Papers for the InterAction Council, 2011-2012. Hamilton, Canada: UNU-INWEH. 2012. [cited 2016 Sep 5]. Available from: <http://inweh.unu.edu/wp-content/uploads/2015/06/Water-Security-Global-Crisis.pdf>
- [7] Rogers P. **Comprehensive water resources management: A concept paper**. Policy research working paper. Washington, DC: World Bank; 1992.
- [8] UN. **Protection of the quality and supply of freshwater resources: Application of integrated approaches to the development, management and use of water resources**; 1992 Chapter 18 Agenda 21. Report of the United Nations conference on environment and development.
- [9] Organisation for Economic Co-operation and Development. **Sustainable management of water resources in agriculture [Internet]**. 2010 [cited 2015 May 20]. Available from: <http://www.oecd.org/tad/sustainable-agriculture/49040929.pdf>
- [10] Provincial waterworks authority. **Analysis of water resources development division of water resources development [Internet]**. 2012 [cited 2015 May 20]. Available from: <http://tele-wrd.pwa.co.th/web/>

- [11] Department of Environmental Quality Promotion with Faculty of Environment and Resource Studies, Mahidol University. **Evaluation guideline green office [Internet]**. 2015 [cited 2015 September 1]. Available from: <http://www.op.mahidol.ac.th/orpl/assets/information-2558new.pdf>
- [12] **An input–output model of water consumption: Analysing intersectoral water relationships in Andalusia** Esther Vela´zquez. *Ecological Economics* 2006; 56: 226 – 240.