

# Identifying and Analyzing the Demand and Consumption Patterns of Water Use in Hotel Sector

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**Abstract**—Without water, we are unable to visualise a single organism, since water is the main requirement for every arrangement of the world. “Freshwater accessibility in the world is 2% of the overall stock of water in the hydrosphere”. So, we must manage the available fresh water. Some investigations are contributed to the causes and significances of water use by the industries. From those outcomes, the tourist hotel sector uses far more water than the other industries. This research mainly focused on tourist hotels around the coastal belt of the Colombo district. Water management there will be helpful to improve future designs criteria of the NWS&DB. The main aim of the research is to help effectively manage the demand for water NWS &DB and for the future forecast of industrial water demand. Data were collected from the NWS&DB and from onsite surveys. Mainly seasonal variations can be found from the tourist hotel sector. The water use efficiency of hotels was also clarified as a function of ‘influential variables’; The number of rooms, average room rate and number of employees, somewhat correlated with the water consumption and obtained the linear relationship among them. Finally, an equation for both season and off-season consumption was built up. If the expected increment of tourist sector occurs, the pressure on the fresh water will correspondingly increase. Tourism of that area will become unstable and it will badly affect for all the sectors. Therefore, a precautionary water management approach is built up.

**Keywords**— tourist hotels, water management, seasonal variations, influential variables

## I. INTRODUCTION

Water is a primary requirement for all forms of life on earth. The accessibility of freshwater in the earth is 2% of the overall water stock in the hydrosphere. The quality and availability of water resources have received a lot of international attention in recent years, as many countries

are facing serious water problems with groundwater and depleted and heavily contaminated groundwater. Water for manufacturing usage can be provided by a public or self-supplied supplier. Few hotels moderately encounter their water requirements by desalting seawater. In some cases, local residents, most rooms and hotels charge a tax on the water. These taxes are separate of the quantity of water engaged (Gossling, 2001). Most industries and families depend on fresh water in and cultivation. Freshwater is no longer just for drinking.

In the world, water is being used more than once in the process of production of different products mainly in cleaning, dilution, cooling, washing procedures. At least one of the above processes are included when producing a product. Producing basic stuff such as food and paper also complex stuff like chemicals, metals and petroleum refinery take large amounts of water for the more advanced processes than cooling and cleaning. The water demand by the industries can be served by public supply, dedicated suppliers while some companies keeping their own water supply handled and maintained by a separate unit of the company. In the agricultural field, water supply is the key element even to initiate steps. That means no agriculture could be done with no water. The domestic usage cannot be forgotten. Remember a day with an interrupted water supply, and how distressed that day was. Water usage figures are differing from season to season. Also, according to the type of industry mainly in the hotel industry.

This research will help to effectively manage the demand for water for NWS and DS and for the future forecast of water demand. The main objectives of the research are to establish a relationship among consumption and influence variables (which affect the water consumption) to obtain the rate of water consumption in the hotel tourism industry and, to analyze the patterns of water use if it is composed as a seasonal variety.

## II. METHODOLOGY

### A. Primary Data Collection

As one objective is to establish a relationship between daily consumption and influencing variables is developed in this research. Consumption rate is changed according to the no. of rooms, rate of occupancy, no. of employees. There are 305 hotel industries situated around the Colombo District. In the research, only considered the tourist hotel at the coastal belt. So, in this study, 120 tourist hotel samples were collected. That number is more than enough because coastal belt's hotels are less than 250 hotels.

To select the sample size following parameters were used.

- Population size- 240
- Confidence level- 95%
- Confidence Interval- 5%

Site surveys were done to collect the relevant information from the hotels and the following data were collected from hotels/ tourism sector.

- Account no. of the water bill.
- Number of rooms.
- Occupancy rate.
- Number of employees.
- Gardening area.

### B. Secondary Data Collection

Secondary data collected were the water consumption values of the last 3 years of NWS and DB relating to each hotel separately. These data were collected from NWS and DB.

To identify the relationship between that average consumption values and above mention variables of hotels, graphs were plotted. After calculating the average monthly water consumption values, graphs were plotted between the average consumption values versus the above variables.

Then multiple linear regression was done to analyse and find out the relationship between the variables. After that to develop models, monthly consumption of water of each hotel was taken as the dependent variable. During the model development, several factors were considered as independent variables such as number of rooms, number of employees and occupancy rate. After that, an equation was built up for that relationship separately for both season and off-season periods. All analysis was carried out using SPSS software. The following equation type was derived in the analysis, equation 01.

Equation 01

$$Y = M_1X_1 + M_2X_2 + M_3X_3 + C$$

Here,  $Y$  = Average Consumption per month

$X_1$  = Number of rooms

$X_2$  = Number of employees

$X_3$  = Occupancy rate

Finally compared that prediction values and actual values.

## III. RESULTS AND DISCUSSIONS

### A. Survey results

The on-site survey was done to collect the data sample from 120 hotels of the coastal belt of Colombo. Gardening areas of hotels are limited in most cases. They do not use water board line to their gardening purposes which have considerable gardening areas. Sample of the data sheet is shown below.

Table 1. Surveying data of hotel/ tourism sector

No.	A/C No.	No. of rooms	No. of employees	Gardening area	Occupancy rate/ Seasons
1	21/03/096/044/13	20	20	-	7 per day
2	21/03/096/159/14	25	13	-	12 per day
3	21/03/351/073/16	32	24	-	20 per day
4	21/03/058/194/11	6	3	-	2 per day
5	21/03/526/676/11	5	2	-	2 per day
6	21/03/526/780/14	15	4	-	Nov-April(full)/ 10 per day
7	21/03/150/146/12	2	1	-	1 per day
8	21/03/118/104/19	20	12	-	Nov-April(full)/ 10 per day
9	21/03/042/001/15	30	18	-	Nov-April(full)/ 8 per day
10	21/03/132/165/16	6	2	-	2 per day
11	21/03/796/265/13	8	3	-	Nov-April(full)/ 2 per day
12	21/06/132/095/11	9	7	-	5 per day
13	21/06/132/398/15	2	2	-	1 per day
14	21/06/132/001/14	10	8	-	Nov-April(full)/6 per day
15	21/06/115/120/15	9	12	-	Nov-April(full)/4 per day
16	21/06/115/100/19	14	4	-	Nov-April(full)/7 per day
17	21/06/333/008/11	90	155	-	Nov-April(full)/50 per day
18	21/06/115/026/10	25	16	-	Nov-April(full)/15 per day

From the data obtained, the two seasonal variations were identified as from April- November and November- April.

- May- October: Off-season
- November- April: Season

In the season period, the occupancy rate is 100%

Three-year consumption values got from the NWS & DB and its consumption graphs are shown below. The average consumption values were calculated from this data.

Table 2: Customer Billing summary

Customer Billing Summary								
Account No.: 21/03/036/325/12					Category: Tourist/ Guest			
NIC No.: N/A					Name: The Manager			
VAT No. / SVAT No. - 114299049 7000								
Bill ref	Billing type	Reading type	Comp. code	Current reading	Current date	Con sum	Amt BF	Curr Chg water
2017-8	N	N		6185	10/8/17	162	-240.08	12,150.00
2017-7	N	N		6023	10/7/17	143	69.00	10,725.00
2017-6	N	N		5880	9/6/17	86	-362.25	6450.00
2017-5	N	N		5794	15/5/17	146	-532.43	10,950.00
2017-4	N	N		5648	17/4/17	284	-537.90	21,300.00
2017-3	N	N		5364	10/3/17	283	-551.48	21,225.00
2017-2	N	N		5081	9/2/17	234	1,206.00	22,050.00
2017-1	N	N		4787	10/1/17	236	30,060.32	22,000.00
2016-12	N	N		4491	3/12/16	221	-1553.18	16,575.00
2016-11	N	N		4270	10/11/16	201	-340.95	15,075.00
2016-10	N	N		4063	10/10/16	182	-327.83	13,650.00
2016-9	N	N		3887	12/9/16	181	-291.53	13,575.00
2016-8	N	N		3706	9/8/16	161	20,006.77	12,075.00

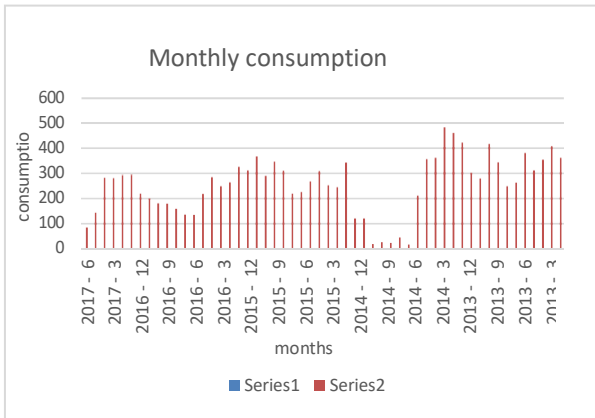


Figure 1. Consumption values variation with months

B. Correlation between consumption and variables

Three graphs which show the variation of consumption with the available rooms of the hotel, consumption with the number of employees and, consumption with the number of occupant rooms of the hotel were drawn for both season period and off-season periods. From the graphs, identified a linear relationship, so multiple linear regression was done. Following graphs shows mainly how the variables correlate with the average monthly consumption. Following graphs shows mainly how the variables correlate with the average monthly consumption of water.

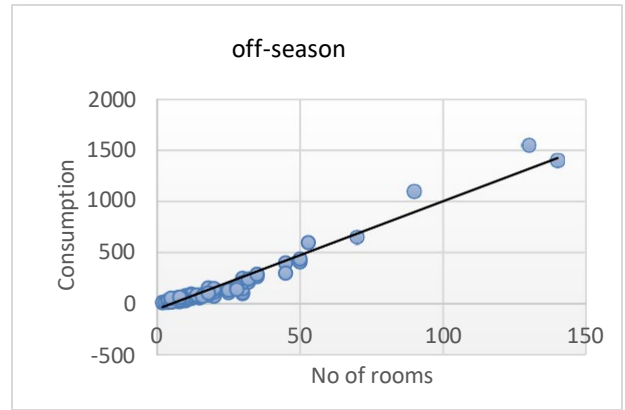


Figure 2. Consumption versus no. of rooms(off-season)

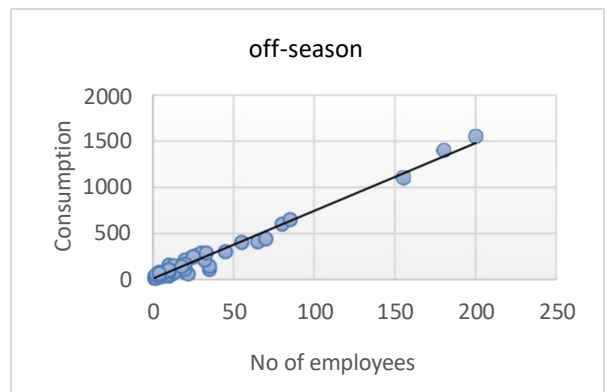


Figure 3. Consumption versus no. of employees

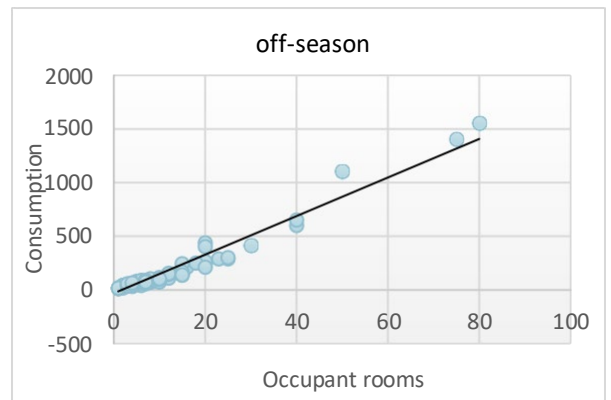


Figure 4. Consumption versus occupant rooms

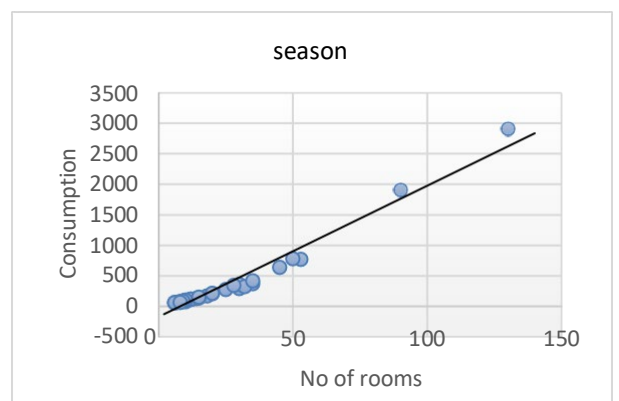


Figure 5. Consumption versus no. of rooms

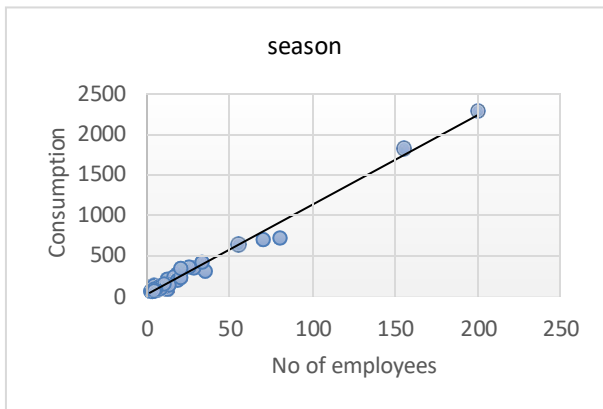


Figure 6. Consumption versus no. of employees

### C. Analysis

SPSS analysis was conducted to obtain the equations for seasonal and off-seasonal periods and the following results were obtained from the analysis.

#### For the seasonal variation

Dependent variable - Average consumption  
Independent variables - No of rooms  
- No of employees

(Occupancy rate is 100% in season. So no of rooms is equal to the number of occupant rooms.)

Table 3. Coefficient table -seasonal variation

model	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std. Error	Beta		
1 {constant}	-5.565	18.293		-0.304	0.763
No. of rooms	4.158	1.794	0.226	2.317	0.027
No. of employees	8.566	1.080	0.772	7.931	0.000

So, the obtained equation is,

#### Equation 02

$$Y = 4.158X_1 + 8.566X_2 - 5.565$$

Where,  $Y$  = Average Consumption per month  
 $X_1$  = Number of rooms  
 $X_2$  = Number of employees

#### For the off-seasonal variation

As in the off-season, the occupancy rate is not 100%, the number of occupant rooms are not equal to the number of rooms of the hotel. So, two parameters were considered for number of rooms and occupancy rate. The following variables were considered in the derivation of equation for seasonal variations.

Dependent variable - Average consumption  
Independent variables - No of rooms  
- No of employees  
- No of occupant rooms

So, the equation was obtained from the analysis as equation 03, from the results of table 4.

Table 4. Coefficient table- off- seasonal variation

model	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std. Error	Beta		
1 {constant}	0.507	4.767		0.106	0.916
No. of rooms	-1.783	0.859	-0.164	-2.076	0.040
No. of employees	5.269	0.387	0.707	13.628	0.000
Occupancy rate	8.409	1.266	0.455	6.645	0.000

#### Equation 03

$$Y = -1.783X_1 + 5.269X_2 + 8.409X_3 + 0.507$$

Where,  $Y$  = Average Consumption per month

$X_1$  = Number of rooms

$X_2$  = Number of employees

$X_3$  = Occupancy rate

Then the predicted values which is related to equations and actual consumption values were compared. The following datasheet (table 5) shows the values of actual consumption values and predicted values.

By referring the table 5, can get the idea about actual values and predicted values. Both the actual and predicted consumption values are approximately equal.

Table 5. Actual values vs predicted values

A/C No.	Avg consumption (season)	Avg consumption (off-season)	Predicted values (season)	Predicted values (off-season)
21/03/096/044/13		75		129.09
21/03/096/159/14		110		125.337
21/03/351/073/16		240		238.087
21/03/058/194/11		37		22.434
21/03/525/676/11		33		18.948
21/03/526/780/14	140	80	91.069	78.928
21/03/150/145/12		10		10.619
21/03/118/104/19	210	75	180.387	112.165
21/03/042/001/15	280	100	273.363	109.131
21/03/132/165/16		30		17.165
21/03/796/265/13	80	20	53.397	18.868
21/06/132/095/11		61		63.388
21/06/132/398/15		14		15.888
21/06/132/001/14	98	40	104.543	75.283
21/06/115/120/15	86	58	134.649	81.324
21/06/115/100/19	131	65	86.911	55.484
21/06/333/008/11	1820	1100	1696.385	1077.182
21/06/115/026/10	240	135	235.441	166.371

## IV. CONCLUSION

Fresh water demand management aims at achieving desirable uses and desirable demand. Water demand is in high value in the tourist sector. Among those, tourist hotels take a special place. It consumes more water than other tourist industries.

This research mainly focused on tourist hotels in the coastal belt at Colombo District. Seasonal and Off-seasonal monthly consumption and its influencing variables were discussed and found the correlation between them. By referring that graphs can identify each variable has a linear relationship with water consumption.

Finally got the two equation separately for the season and off-season. By that equation, can predict the average monthly consumption values when giving the number of rooms, number of employees, occupancy rate. Both predicted values and actual values are approximately equal. So, this equation can be used for predicting the values.

The season period is from November to April and the Off-season is from May to October. Colombo area can name as tourist attraction area. So, in this area, a 100% occupancy rate occur on seasonal days. So, the average water consumption values higher than the off-seasonal days. The water consumption of seasonal days varies with the number of rooms and the number of employees. The water consumption of off-seasonal days varies with the "number of rooms", "number of employees" and the rate of occupancy. Those are the main differences between those two equations. NWS&DB can predict consumption values earlier and it will help to do their design criteria in future. From that water management can handle very easily for all the parties.

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