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Enshassi, Adnan
Department of Civil engineering, IUG

Elzebdeh, Salam
UNRWA

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Residential Consumers' Attitudes towards Water and Energy Conservation

Adnan Enshassi¹, Salam Elzebedeh²

¹Department of Civil engineering, IUG, Gaza, Palestine, ² UNRWA, Gaza, Palestine
Corresponding author email: aenshassi@gmail.com

Abstract: *The objective of this paper is to explore the residential consumers' attitudes towards water and energy conservation at residential buildings. A self-administered questionnaire was used in this study targeting 123 household's residents who are living at United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA) rehousing project in Rafah. The results revealed that the most important household's residents attitudes towards water and energy conservation are: survey participants believed that Gaza Strip suffering water and energy shortage problem and they convinced by the concept of water and energy conservation and sustainability. Participants believed of the importance of regular maintenance for water and energy appliances, and they believed that turning off the water pump when the roof tanks are full will conserve water and related energy. This result indicated that the residents are aware of water and energy conservation in residential buildings and have a good intention to make an effort to reduce water and energy usage. Reduction of water and energy leakage will lead to a decrease in consumption. Water and energy concerned parties are advised to provide training for engineers and technicians who are responsible about operation, distribution and maintenance of water and electricity networks.*

Keywords: Water; Energy; Conservation; Households; Attitudes

1. INTRODUCTION

The availability of water and energy in sufficient quantities is not only a prerequisite for human health and well-being but also essential for freshwater ecosystems and services that they provide [1]. Residential buildings are considered as major consumers of water and energy and key contributors to carbon-dioxide emissions which become more and more crucial as a focus for water and energy conservation and environmental protection [2]. The misuse of water pumps in Gaza Strip houses is one of the major causes of interfering the water networks design. Therefore, there is an urgent need to improve the efficiency of water consumption and related energy use in Gaza Strip buildings through the application of sustainable design, and operation.

There exists an energy and water crises in Gaza Strip. The people of Gaza over-pump approximately 160 million cubic meters (MCM) of water from the coastal aquifer per year, but the sustainable yield of the Gaza sub-aquifer is about 100 MCM/year. Sustainable yield is the amount of water that can be extracted from the aquifer annually, while still maintaining ground water levels [3]. Gaza power generation plant is producing a power of 80 MW and the Israeli Electrical Company supplies 120 MW and Egypt supplies 17 MW [4]. The number of inhabitants of the Gaza Strip governorates is estimated around 2,125,000 in August 2016. While the population in Gaza Strip increases, the consumption of water will increase and the deficit in energy resources water supply will increase, leading to a severe economic catastrophe that will result in a significant rise in the probability of an outbreak of conflict.

Lipchin [5] stated that generally, the relative scarcity of water (both in terms of quantity and quality) in Jordan and Palestine drives local perceptions and attitudes towards this resource. Lipchin [5] explored the impact of water culture on the public's perceptions and

attitudes toward water use among three water cultures: Israeli, Palestinian and Jordanian. The results showed that most families use more water than they need, most respondents from all three countries admitted that they use more water than required. For all three countries people were relatively divided between confidences in local water supply meeting current needs versus mistrust in local water supplies meeting the communities' needs. In terms of being able to reduce the amount of water people use, over 50% of respondents from all three countries admitted that this would be difficult to do. Approximately 30% of the respondents said that their household water use could be reduced. Given the imperative of water and energy conservation for environmental sustainability, efficient water and energy management, and climate change mitigation, it is critical to understand household's residents attitudes towards water and energy conservation at residential buildings. The objective of this paper is to explore the residential consumers' attitudes towards water and energy conservation in Rafah residential buildings in the Gaza Strip-Palestine.

2. LITERATURE REVIEW

Residential water and energy end-uses are heterogeneous and vary significantly among households with demographic, behavioral, technological, and geographic factors contributing to variations among users [6, 7, 8]. Individual behavior, lifestyle, psychological, cultural and social factors and gender preferences are some other factors that may influence end use energy consumption in a residential sector [9]. Janda [10] and Willis et al. [11] observed that building occupants are the real consumers of energy and not the building itself. Therefore, the behavior of the occupants of a building may be more important than the specific features of a particular building. Plappally and Lienhard [12] and Shimoda et al. [13] stated that the end use

energy intensity is very high relative to most processes and human behavior has a very substantial role in setting water related energy consumption. Aitken et al. [14] found that there was a significant convergence between perceived water conservation and actual water consumption.

Stern [15] reported that the major causes of water conservation behaviors and attitudes are beliefs, habits or routines, personal capabilities and contextual force. Water conservation behaviors can be divided into two major categories as efficiency behaviors, and curtailment behaviors. Russell and Fielding [16] examined five major causes of water conservation behaviors (attitudes, beliefs, habits or routines, personal capabilities and contextual force), they concluded that these are important drivers of water conservation behavior which can be used to inform policy makers about what types of strategies might be most effective to influence these drivers. Gregory and Leo [17] found that lower water users tended to be older, less educated and of lower income than the higher water users. Hassell and Cary [18] concluded that change in water consumption behaviour is mostly occur when external factors such as appropriate water pricing and policy consistency are exist. Miller and Buys [19] in the residential study in Australia's South East Queensland found that most participants reported that feeling was responsible for water conservation, but this attitude is not reflected in their day-to-day water use behaviors. Similar conclusions were drawn by Gregory and Leo [17] and Aitken et al. [14]. Consuming water sustainability should be amongst everyone's priorities: consuming responsibility, even if it means shifting one's consumption habits, and consuming less [20].

Beal et al. [21] stated that there cannot be exclusive reliance on individual household attitudes and beliefs to reduce water consumption. Mandatory measures such as water restrictions or incentives such as rebates are possibly more reliable in reducing residential demand. Abrahamse and Steg [22] explored the linkage between household energy use and householders' intention to reduce their energy use on the one side, and psychological variables and socio-demographic variables on the side. They found that energy use in residential buildings seemed to be most strongly related to socio-demographic variables (income, household size, age), while attitudinal variables and self-transcendence values (tradition/security and power/achievement) were important also.

Aktamis [23] revealed that there is a significant difference among energy saving and awareness of secondary school students in Turkey according to gender and that this difference was in favor of females. Also, in Turkey Kilic and Dervisoglu [24] revealed that female students' average of subjective norm towards water saving is higher compared to male students. Fan et al. [25] concluded that the key drivers for reducing water consumption behavior are awareness, education, gender, elder and residents income and recommended that water price transparency and water bill reform because they enhance the information transparency of residents with their water consumption. Adams [26] stated that understanding people's general attitudes towards the environment can help shed more light on the motivations behind water conservation behavior. Research literature and public institutions recognized the need for adopting personal behaviors that promote

water and energy conservation and improve its uses [27, 28]. Sarabia-Sánchez et al. [29] concluded that a change in citizen behaviour is very important for water conservation.

3. METHODOLOGY

To achieve the objective of this study, a self-administered questionnaire was used to elicit the residential consumers' attitudes towards water and energy conservation at residential buildings. The population of this study is the residential consumers who are living at UNRWA rehousing project in Rafah, phase I. The participants are selected randomly as per house units, where one participant represents each house units is invited to participate in in this study. The UNRWA rehousing project in Rafah, phase I consists of 600 housing units. The following l equation was used to determine the sample size [30].

$$SS = \frac{Z^2 \times P \times (1 - P)}{C^2}$$

Where: SS: The sample size, Z: Z value (e.g. 1.96 for 95% confidence interval), P: Percentage picking a choice, decimal, (0.50 used for sample size needed), C: Maximum error of estimation (0.08)

$$SS = \frac{1.96^2 \times 0.5 \times (1 - 0.5)}{(0.08)^2} = 150$$

Correction for finite population

$$SS_{new} = \frac{SS}{1 + \frac{SS - 1}{pop}}$$

Where: pop is the population; the population is equal to 600 housing units for household residents. So that:

$$SS_{new} = \frac{150}{1 + \frac{150 - 1}{600}} = 120.6 \approx 121$$

The previous calculations showed that the minimum number of the questionnaires needed to be collected is 121. One hundred and thirty questionnaires were distributed randomly among housing units for household residents as targeted group. One hundred and twenty-three questionnaires were received back. The high percentage of received back questionnaires is justified due to the number of UNRWA engineers engaged with the rehousing project and their tight relation with the household's residents who are smoothly interact with the questionnaire survey.

The questionnaire consists of two parts, the first part contains general information about the household residents in terms of age of the head of household, gender, material status, educational level, monthly income of the family, family size, area of the house and finally the floor level and quantities of water and energy (electricity) consumption per month. The second part including 14 statement investigating attitude of the residential consumers toward water and energy consumption, these attitudinal statements are derived from previous literature. A pilot study was conducted by inviting five professionals who have more than 15 years' experience in managing residential buildings to

review and comments on the questionnaire. The resulted comments were carefully considered in modifying the final questionnaire.

Statistical validity is used to evaluate instrument validity, which include criterion-related validity and structure validity [31]. The results indicated that P-values was found less than 0.05 or 0.01, so the correlation coefficients of the attitudes statements are significant at $\alpha = 0.01$ or $\alpha = 0.05$. Therefore, it could be said that the attitudes statements are consistent and valid to measure what it was set for. Cronbach's Alpha Coefficient for reliability was used to measure the reliability of the questionnaire. The Cronbach's coefficient alpha was calculated and found 0.823 which is acceptable and the result ensures the reliability of the questionnaire. Five points Likert scales was used in this questionnaire. The respondents were asked to indicate their agreement or disagreements by circling the appropriate number represent their scale of agreement. Where, 1 represented "strong disagreement" and 5 represented "strong agreement". The Relative Importance Index (RII) was used to determine the ranks of the drivers. The relative importance index was computed as [32, 33, 34]:

$$RII = \frac{\sum W}{A \times N}$$

where: W is the weighting given to each factor by the respondents (ranging from 1 to 5), A = the highest weight (i.e. 5 in this case), N = the total number of respondents. The RII value had a range from 0 to 1 (0 not inclusive), the higher the value of RII, the more impact of the attribute.

4. RESULTS AND DISCUSSION

In this section, the attitudes of the residential occupants' toward water and related energy conservation will be presented and discussed. Table 1 and Figure 1 depict 14 attitudes that have been queried by residential occupants to assess their attitudes toward water and related energy conservation in residential buildings.

The results showed that the attitude (A.1) " I feel that Gaza Strip suffering from water and energy shortage problem" was ranked in the 1st position with RII = 85.83% and Mean = 4.9 according to overall respondents. The value of the test-value=10.27 with positive sign of the test and P-value = 0.000 which is smaller than the level of significance $\alpha = 0.05$. The mean of this attitude is significantly different and greater than the hypothesized value 3. Feeling or perceiving water and energy shortage problem or scarcity creates an attitudinal concern, which might be transmitted into conservative behavior toward these resources. In addition, this result is in line with [5, 35, 36].

The attitude (A.2) 'I am convinced by the concept of water and energy conservation and sustainability at Gaza Strip' with RII=82.31% and Mean=4.12 has got the 2nd rank. Convincing in something is a type of belief which is conceptually independent determinant of attitude. However, it is a challenge to convince others regarding water or energy conservation. Nonetheless, when people are convinced by the concept of water and

energy sustainability and conservation, they will have a positive attitude towards conservation. Attitude (A.3) 'I believe of regular maintenance for water and energy appliances (for example. the roof water tank, water pump...)' was ranked in the 3rd position with RII = 81.98% and Mean = 4.10. Regular maintenance for water and energy households' appliances as house water pumps and roof water tanks to control leakage problems is considered as one of the most important strategies regarding conservation and sustainability. This result revealed that the occupants have a positive attitude towards water and energy conservation. This result is in line with [37, 38] outcomes.

The results revealed that, 'I believe that turning off my water pump when the roof tanks are full will conserve water and related energy' attitude (A.4) with RII = 81.82% and Mean = 4.09 has got the 4th rank. Similarly, attitude (A.7) 'I believe that washing and cleaning the house while water pump is operating is a serious cause of over consumption' was ranked in the 7th position with RII = 72.89% and Mean =3.64.

Both attitudes (A.4 and A.7) assure the validity of water and energy conservation attitude among household residents. The finding is consistent with [18, 24, 25] results.

The findings showed that, 'I believe that more attention for water and energy conservation is needed' attitude (A.5) with RII = 80.67% and Mean = 4.03 has got the 5th rank. An increase in the attention of water and energy consumption most likely will inspire residents for more conservation attitude and behavior.

This result is in line with ([39, 40] outcomes. Attitude (A.6) 'I think that leakage in my home appliances or hoses during operating the water pump is an important cause of over consumption" was ranked in the 6th position with RII = 78.51% and Mean = 3.93. Believing in leakage as a problem will emphasize the necessity for maintenance of consumers' appliances. Reduction of water and energy leakage will lead to a decrease in consumption. This finding is in line with other [6, 41] results.

Furthermore, 'I feel that it is important and visible that water and energy concerning parties make strict laws to support water and energy conservation' attitude (A.8) with RII = 69.92% and Mean = 3.5 has got the rank 8. Regulations as restrictions are measured as one of the most important strategies that have a significant impact on water and energy conservation. This result is in line with the results of [27, 40]. "I believe that I could make more efforts to conserve water and energy" attitude (A.9) was ranked in the 9th position with RII = 66.67% and Mean = 3.33. Efforts are required for all aspects of conserving water and energy. As example, believing in efficiency and conservation emphasizes the efforts exerted to use efficient devices or eliminating the use of inefficient ones. Efforts to inspire residents to reduce water and energy consumption have s good chance degrees of success. This success depends on the integrity of the appeal by household's residents and the message by the providers. This result agrees with [27, 35, 42] findings.

Table 1. RII and Test value of respondents attitudes towards water and energy conservation

No.	Water and energy conservation attitudes	Mean	RII (%)	SD	Test value	P-value (Sig.)	Rank
A.1	I feel that Gaza Strip suffering water and energy shortage problem	4.29	85.83	0.69	10.27	0.000*	1
A.2	I am convinced by the concept of water and energy conservation and sustainability at Gaza Strip.	4.12	82.31	0.63	10.03	0.000*	2
A.3	I believe of regular maintenance for water and energy appliances (ex. the roof water tank, water pump...).	4.10	81.98	0.70	9.88	0.000*	3
A.4	I believe that turning off my water pump when the roof tanks are full will conserve water and related energy.	4.09	81.82	0.85	9.35	0.000*	4
A.5	I believe that more attention for water and energy conservation is needed.	4.03	80.67	1.08	8.28	0.000*	5
A.6	I think that leakage in my home appliances or hoses during operating the water pump is an important cause of over consumption.	3.93	78.51	1.01	8.38	0.000*	6
A.7	I believe that washing and cleaning the house while water pump is operating is a serious cause of over consumption.	3.64	72.89	1.15	6.54	0.000*	7
A.8	I feel that it is important and visible that water and energy concerning parties make strict laws to support water and energy conservation.	3.50	69.92	1.06	5.53	0.000*	8
A.9	I believe that I could make more efforts to conserve water and energy.	3.33	66.67	1.38	4.10	0.000*	9
A.10	I believe that changing attitudes and beliefs affects the water and energy conservation.	3.31	66.22	1.31	3.69	0.000*	10
A.11	I believe that I can play additional positive role toward water energy conservation.	2.94	58.83	1.24	-0.33	0.743	11
A.12	I feel that my neighbors are not aware about water and energy conservation issue.	2.93	58.68	1.14	-0.43	0.668	12
A.13	I think that I am a part of water and energy shortage problem.	2.09	39.83	1.37	-5.29	0.000*	13
A.14	I think that I can dispense of water pumps in my house.	1.79	35.76	1.16	-7.46	0.000*	14
Water and energy personal attitudes		3.44	68.80	0.53	6.22	0.000*	

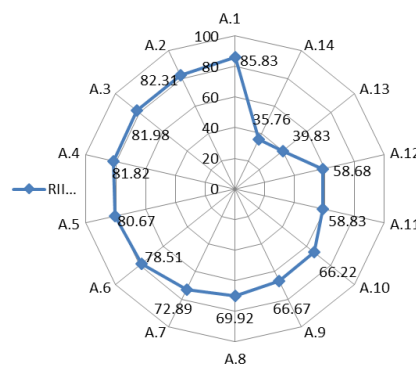


Figure 1. RII for attitudes of occupants toward water and energy conservation

5. CONCLUSION AND RECOMMENDATIONS

The objective of this paper is to explore the residential consumers' attitudes towards water and energy conservation at residential buildings. The results revealed that the most important residential consumers' attitudes towards water and energy conservation at residential buildings are: I feel that Gaza Strip suffering water and energy shortage problem, I am convinced by the concept of water and energy conservation and sustainability at Gaza Strip, I believe of regular maintenance for water and energy appliances, and I believe that turning off my water pump when the roof tanks are full will conserve water and related energy. This result indicated that residents are aware of water and energy conservation in residential buildings and have a good intention to make an effort to reduce water and energy usage. The use of incentives and disincentives mechanism by the government or water and energy concerned utilities, will also stress residents attitudes toward conservation.

Water and energy concerned parties are advised to provide training for engineers and technicians who are responsible about operation, distribution and maintenance of water and electricity networks. The contributed knowledge will establish a good platform for future researchers to identify meaningful ways for providing solution to come over the challenges in terms of water and energy scarcity. To enhance the degree of confidence of the current study results, a qualitative research method and action research study is recommended to collect data repetitively over an extended period, like repetitive interviews with household's residents to follow up their attitude and behavior change toward some action.

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