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Bedouins choice behavior toward the desalinated water in Halaib, Egypt

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Abstract. Insufficiency of water is a growing global problem challenging sustainable development due to its limited water resources. This research aimed to 1) know about Bedouins' sources and uses of water in the Halaib study's area, 2) explore Bedouins' choice behavior towards desalinated water using consumption value theory, 3) determine factors related to Bedouins' choice behavior, and 4) determine the reasons for water contamination and propose solutions. Data were collected from a sample of 153 Bedouins through personal interviews using a questionnaire form in November 2021. Data were analyzed and presented using frequency, mean, and step-wise regression analysis. The reliability of the questionnaire (0.864) was estimated by Cronbach's alpha. The results showed that desalinated water was the most popular clean water source in the examined area and that it was crucial for providing people with safe water. All Bedouins (100%) prefer using desalinated water for cleaning, animal watering, and irrigation. The mean score of respondents' perception of function value price is 5.78 (96.3% of the total score); the social value is 4.78 (79.67%); the function value quality is 4.57 (76.17%); and the emotional value is 4.49 (74.83%). The quality of the function value explains about 59.1% of the variance in Bedouins' choice behavior towards desalinated water, while the social value accounts for about 12.1% and the emotional value accounts for about 3.6%. There was sufficient evidence to disprove H4, H6, and H7. The results were used to provide suggestions for further research.

Keywords: *Bedouins, consumption value theory, choice behavior, desalination, and Egypt*

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1. Introduction

Water is the most important substance for human beings and living organisms. Insufficiency of water is a growing global problem, challenging sustainable development and the expansion of cultivated areas to meet increasing food requirements. In the past 100 years, human demands on the world's water supply have grown by a factor of roughly eight due to rising economies, intensive population growth, and the pursuit of higher standards of living (Veldkamp et al., 2017). Water supplies have rapidly reduced due to growing water pollution, generating a terrible supply-demand mismatch that threatens the long-term development of dry regions despite the high increase in demand (Li et al., 2017). To ensure the availability and sustainable management of water and sanitation for all, the United Nations General Assembly created Sustainable Development Goal 6 (SDG6) in 2015 (Hoekstra et al., 2017). It is worth mentioning that water is one of the primary limiting factors in socioeconomic growth, and water scarcity has refocused attention on the necessity of developing strategies and taking steps to manage water resources (Liu et al., 2017; World Economic Forum, 2019; Tzanakakis et al., 2020).

Egypt's need for water is growing quickly, but the country only has a small amount of fresh water, which is not enough to meet the high demand. Water is no longer considered a natural resource; it is a self-renewing, low-cost resource that is freely available to all. Many areas have undergone extended droughts, resulting in desertification and a population shift toward this valuable resource. As a result, various viewpoints on the economic and societal consequences have emerged (Batisha, 2007).

Egypt is suffering from a severe lack of water because of its rapidly growing population, expanding industrial sector, and rising demand for water from the agricultural sector. Since the Nile Valley is already quite inhabited, the ideal places to go would be the Red Sea and Sinai. The Sinai and Red Sea areas are experiencing a severe water shortage. Geographically, the two regions are virtually identical. Not being in close proximity to the Nile means that their underground water supplies are also limited (Abou Rayan et al., 2003). Around the world, more than a billion people have daily challenges obtaining safe drinking water. The Egyptian Red Sea coast stretches for around 2025 km, of which 1080 km are on the Red Sea and 945 km are on the gulfs of Suez and Aqaba (Abd El Wahab & Hamoda, 2012).

Map 1. Red Sea Governorate (Abou Rayan et al., 2003)

As shown in Map 1, the Red Sea region is favorable for Egypt's economic development, with water being the primary obstacle. For the future water scarcity situation in the southern area of Halaib, desalination is the clear choice (Abou Rayan et al., 2003). Desalinated saltwater is used for both industrial and human activities in the Red Sea Governorate. The governorate's cities use eleven desalination plants to produce 43,240 m^3 of water per year and use 33870 m^3 of seawater per year. The city of Halayeb and the villages around it get their water from a desalination plant in the nearby village of Abu Ramad. Each year, the plant makes 525 m3, but only 446 m3 are used. About 8,156 people, or 2039 households, benefit from this desalination facility. About two-thirds of the population has access to the public water system, while the other one-third lives in valley villages that rely on water delivery vehicles to provide desalinated water to their homes.

People's feelings about the environment, especially about water resources, are complicated and involve many different fields, like psychology, economics, and marketing. Scholars have investigated the public's views of alternative water sources as well as the factors that influence behavior from a range of viewpoints and ideas (Hurlimann & McKay, 2004; Dolnicar & Schafer, 2006; Dolnicar & Schafer, 2009; Dolnicar & Hurlimann, 2010; Dolnicar et al., 2011; Hurlimann & Dolnicar, 2016; Fu et al., 2020; Chfadi et al., 2021; Gao et al., 2021). The Theory of Consumption Values (TCV) is composed of five components, according to Gao et al. (2021): function value quality, function value price, social value, emotional value, and choice behavior. Details are provided below:

1. Function value quality (FVQ) is a perceived utility based on functional and physical properties and can be derived from features or attributes such as reliability and durability.
2. The function value price (FVP) of a product is its utility, which is recognized based on the valuation of the price (reasonable and affordable).
3. Social value (SV) refers to the perceived utilities that result from an association with one or more specific social groups. SVs are similar to subjective norms that reflect external social pressure.
4. Emotional value (EV) refers to the perceived benefits of a product that consumers experience based on their feelings and emotional states.
5. Choice behavior (CB) is often associated with emotional responses, and consumer likes and dislikes of a particular product influence their final choices.

This study explores the factors that influence choice behavior (CB) in the use of desalinated water. It investigates the influence of various values on CB based on the TCV to identify the factors influencing desalinated water choice behavior, with the following golden goals:

1. Know about the Bedouins' sources and uses of water in the study area.
2. Explore Bedouins' choice behavior toward desalinated water using consumption value theory.
3. Identify variables influencing Bedouins' behavior toward desalinated water. Identify clean water problems and propose solutions to solve them.

2. Materials and Methods

The Red Sea Governorate (Map 1) is one of Egypt's provinces. It is located in the southeastern part of the country, between the Nile and the Red Sea. It borders the Suez Governorate in the north, part of the Egyptian-Sudan border in the south, the Red Sea in the east, and Aswan, Qena, Sohag, Assiut, Menia, and Bani Swif in the west. It consists of six cities, including the capital city of Hurghada: Ras Gareb, Safaga, Al-Quseir, Marsa Alam, Shalateen, and Halaib.

The consumption value theory was used in this study to investigate Bedouins' acceptance of desalinated water in Halaib, Egypt. The scale included 15 questions divided into five categories: function value quality, function value price, social value, emotional value, and choice behavior (Khan & Mohsin, 2017; Zailani et al., 2019; Gao et al., 2021). The scale asks individuals to react on a 3-point Likert-type scale ranging from 1 (disagree) to 3 (agree).

Halaib was chosen to perform the empirical investigation since it includes three villages (Abu Ramad, Raas Hederba, and Adaldib, with 1285, 186, and 153 Bedouin families, respectively). These three communities have a total population of 1,541 people. A sample of 153 Bedouin households was picked at random from three villages (128, 18, and 7 from each village, representing 10% of the population). In November 2021, data were collected using a questionnaire form. The software package SPSS (version 21) was used to analyze the data. Frequency, mean, and step-wise regression analyses were used to present the data, and Cronbach's alpha (0.864) was used to determine the questionnaire's reliability.

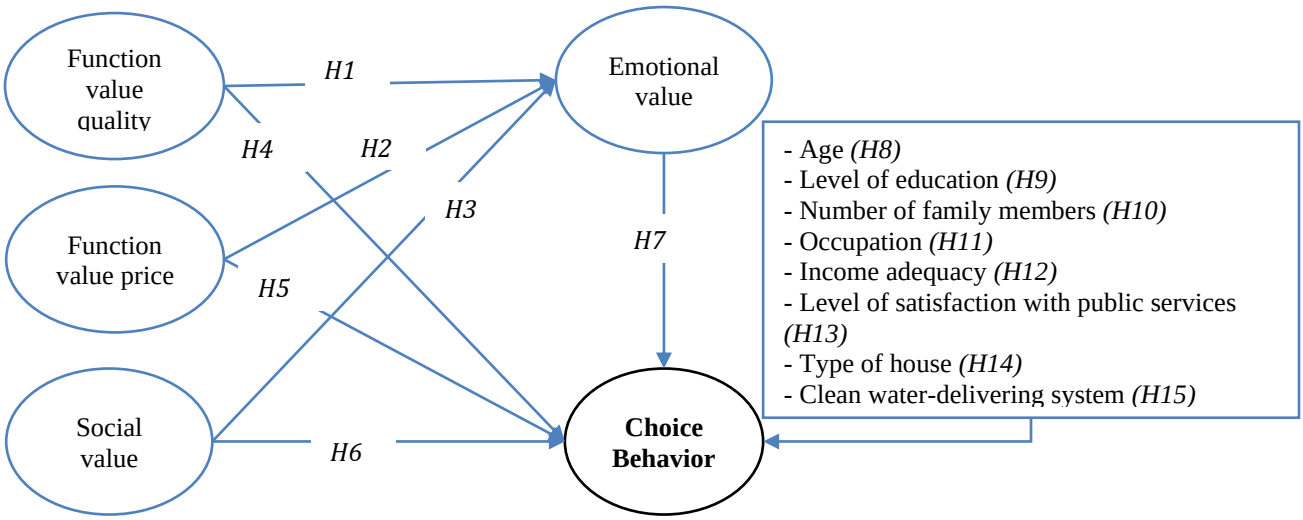

Figure 1. Theoretical model of the study

To fulfill the study's final goal, this study contends that the influence of product quality, price, and social values on decision-making should be included while investigating consumer emotional value and choice behavior. Consequently, the following hypotheses are proposed in this study:

H1: Emotional value of desalinated water is favorably influenced by its function and quality.
H2: Function value pricing has a favorable impact on the emotional worth of desalinated water.

H3: Social value impacts the emotional value of desalinated water.
H4: Quality parameters favorably impact customer decision-making in desalinated water.
H5: Price factors impact customer decision-making in the desalinated water industry.
H6: Social value positively influences the decision-making behavior of consumers of desalinated water.
H7: Emotional value positively influences the decision-making behavior of consumers of desalinated water.
H8–H15: Respondent characteristics (age, education level, number of family members, occupation, income sufficiency, degree of satisfaction with public services, type of house, and clean water delivery system) significantly impact consumer decision behavior in desalinated water.

3. Results and Discussion

3.1. Characteristics of the study's sample

According to the data presented in Table 1, more than half of the respondents fall into the age range of 44–74 years old, and almost half of them (49.7%) live in houses that were built by the Construction Authority in the Red Sea Governorate. At the land port that is located on the Sudanese border, there are nearly a quarter of the respondents who do not have any educational qualifications working as freelancers; this number is 24.8%. More than two-thirds of the respondents get their clean water from the tanks connected to their homes (68.6%), and just below one-third of them (31.4%) get their clean water from the public water network. More than half of respondents (52.9%) had an income that is considered to be middle-class. Last but not least, 61% of those who took the survey were extremely pleased with the community services.

Table 1. Characteristics of respondents

Items		Frequency	Percentage
Age	23 – 30 years old	37	24.18
	31 – 43 years old	39	25.49
	44 – 74 years old	77	50.33
Level of education	Illiterate	38	24.84
	Primary school	42	27.45
	Preparatory school	37	24.18
	Secondary/technical school	32	20.92
	University	4	2.61
Number of family members	1 – 2 members	55	35.95
	3 – 5 members	78	50.98
	6 – 7 members	20	13.07
Occupation	Governmental employee	27	17.65
	Grazers	22	14.38
	Hunters	26	16.99
	Self-employed / freelancing	55	35.95
	Without job	23	15.03
Income adequacy	Insufficient	49	32.03
	Somehow	81	52.94
	Adequate	23	15.03
Level of satisfaction with public services	Low satisfaction	22	14.38
	Moderate satisfaction	39	25.49
	High satisfaction	92	60.13
Type of house	Bedouin	77	50.33
	Governmental	76	49.67
Clean water delivery system	Portable delivery system (Tanks)	105	68.63
	Government water network	48	31.37

Source: this study result

3.2. Bedouins' sources of water

The data presented in Table 2 shows the major sources of clean water that respondents utilize in their daily lives. According to the findings, "desalinated water" was the most often mentioned source of clean water among those who were recorded. Only a small percentage of respondents mentioned that they get their fresh water from the Nile or subterranean sources (20.3% and 16.3%, respectively). The long distance to the Nile and the lack of underground water wells were the main

factors in respondents' lesser usage of those sources of water, but the proximity to the Red Sea and the presence of desalination plants led to desalinated water being the primary source of water in the investigated region. The source of groundwater wells came in third place. There are only two wells in the region under investigation, and those are the Jahiliya and the Asira wells. Both the community as a whole and the grazers in particular depend on these wells for their water supply.

Table 2. Clean water sources as indicated by respondents

No.	Sources of clean water	Frequency	Percentage
1.	River Nile	31	20.3
2.	Underground water wells	25	16.3
3.	Desalinated water	153	100

Source: this study result

3.3. Bedouins' uses of water

Figure 2 displays the percentage of respondents who stated they would utilize each alternate water source for each of the five reasons. In terms of water consumption associated with cleaning, watering animals, and irrigation, the results show that desalinated water has the largest proportion of users (100%), followed by subterranean water (95%), and to a lesser extent, River Nile water (93%). While the majority of respondents (86.9% and 77.8%, respectively) report using desalinated water for personal purposes (cooking and drinking), roughly 27% and 10% of respondents, respectively, report using Nile water for drinking and cooking in addition to the desalinated water. In addition to desalinized water, the findings showed that 15% of respondents utilized water from an underground source for domestic purposes. Some residents travel to Aswan, which is roughly 200 kilometers away, to collect Nile water in order to resell it to others who are interested in purchasing it. The cost of one barrel, which contains 200 liters, is approximately 60 Egyptian pounds (approximately 3.5 US dollars). The purchasers of Nile water preferred to use it for drinking and making hot beverages like tea and coffee (a practice known as "Gabana") since, in their opinion, the taste of desalinated water made these beverages taste unpleasant. Because of the exorbitant cost of Nile water, its use is restricted to people from high-income households, such as the sheikhs of various tribes. This is because providing Nile water to visitors is considered an act of hospitality and kindness. According to the findings of this study, desalinated water should be prioritized above water from the Nile or from subterranean sources for a variety of applications involving the usage of water. Previous studies that compared consumer preferences for desalinated and recycled water (Dolnicar & Schafer, 2009; Dolnicar & Hurlimann, 2010; Hurlimann & Dolnicar, 2016) found that recycled water was preferred over desalinated water. The results that were reported here are largely in agreement with those studies.

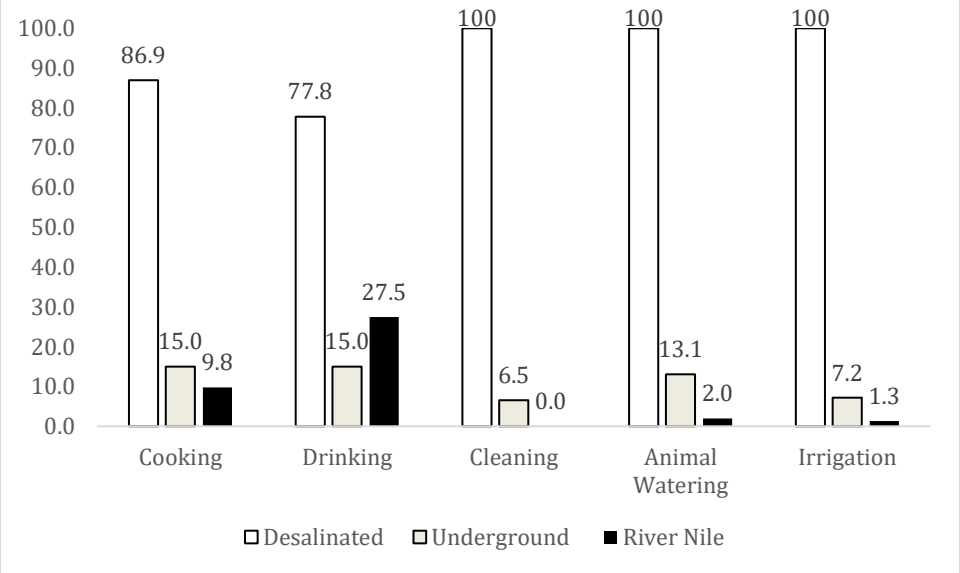

Figure 2. Water use purposes from different water sources. **Source**: this study result

3.4. Bedouins' profile of desalinated water based on consumption value theory

Table 3 displays numerical and percentage results for Bedouin perceptions of the consumption value theory of desalinated water variables. It is clear that the mean score of respondents' perceptions of function value price reached 5.78 (representing 96.3% of the total score). This implies that respondents perceive an adequate pricing system for desalinated water; this may be due to the Egyptian government's decision to provide free desalinated water to all citizens in all residential communities, whether by connecting to the main water network or by vehicles transporting water to water tanks in Bedouin homes.

The social value of desalinated water perceived by Bedouins ranked second after function value price with a mean score of 4.78 (79.67% of the maximum score), implying that respondents perceived the utility of desalinated water towards the community as well as subjective norms and external socioeconomic pressure to use desalinated water. The mean score of respondents' evaluations of function value quality was 4.57, accounting for 76.17% of the maximum possible score. This demonstrated that respondents evaluated the value of desalinated water because of the water treatment and purification activities carried out by non-governmental organizations (NGOs) to serve such populations. That perception is based on the functional and physical qualities of water that they perceive. The average score for the emotional value of the perceived utility of the desalinated water that customers experience based on their feelings or emotional state is 4.49 (representing 74.83% of the possible maximum score). The obtained results revealed that 82.83% of Bedouins prefer to utilize desalinated water in their daily lives, as confirmed by the prior finding, which was discussed in the section on water applications. Since emotional values play a major role in shaping consumer behavior, Bedouins who have positive views about the future of their community may be more likely to support the use of desalinized water.

Table 3. Bedouins' profile of desalinated water based on consumption value theory

Factors	Rang		Mean		SD	Low		Medium		High	
	Min	Max	Value	%		Freq.	%	Freq.	%	Freq.	%
Function value quality	0	6	4.57	76.17	1.60	5	3.27	62	40.52	86	56.21
Function value price	2	6	5.78	96.33	0.80	0	0.00	9	5.88	144	94.12
Social value	0	6	4.78	79.67	1.59	5	3.27	50	32.68	98	64.05
Emotional value	0	6	4.49	74.83	1.63	7	4.58	63	41.18	83	54.25
Choice behavior	0	6	4.97	82.83	1.56	5	3.27	34	22.22	114	74.51

Source: this study result. *Note.* Min- Minimum, Max- Maximum, %- Percentage, SD- Standard deviation, and Freq- Frequency

3.5. Factors related to Bedouins' acceptance of desalinated water based on consumption value theory

The findings of the statistical analysis of the relationship between the studied characteristics of the respondents (age, level of education, number of family members, occupation, income sufficiently, level of satisfaction with public services, type of house, and clean water delivery system) and the choice behavior revealed that there were no significant correlation coefficients (Table 4). The model provides information on the extent of the link that exists between the model and the dependent variable, which is the Bedouins' emotional value in regard to desalinated water. The value of R is the correlation between the observed and anticipated values for the dependent variable. A higher value of R implies not only that the model is a good fit for the data but also that there is a strong correlation between the variables. The proportion of variance in the dependent variable that can be explained by the regression model is referred to as the R square. It may be deduced from the relatively high value of R^2 (0.724) that the model has an adequate capacity for prediction.

Table 4 displays the findings of a regression analysis based on two independent variables of consumption value theory (the quality of desalinated water's functional value and the social value of desalinated water), which indicate a positive relationship ($R = 0.742$) and a statistically significant relationship ($P < 0.01$) with the dependent variable Bedouins' emotional value toward desalinated water. The variation in the dependent variable was explained by the independent factors to an extent of 54.5% (the modified R^2 value was 0.545). The analysis of variance (ANOVA) determines whether or not the model can be trusted from a statistical standpoint; the significant value of the F-statistic is < 0.01, which indicates that the variation that is described by the model is not the result of a random chance. The obtained results revealed that the function value quality of desalinated water is the most significant factor affecting Bedouins' emotional value towards desalinated water, with the largest percent of explained variance (50.5%). This was followed by the social value of desalinated water, which explains about 4% of the variance in

Bedouins' emotional value towards desalinated water. In addition, both of the observed "t" values of the model's factors are significant at the 0.01 and 0.05 levels, respectively. Two of the research's alternative hypotheses (H1 and H3) had a chance of being accepted; however, the research's null hypothesis had no chance.

Table 4. The accumulative effect of studied consumption values in Bedouins' emotional value for the desalinated water

Model	Variables	R	R^2	Adjusted R^2	% of explained variance	F	t
1st	Function value quality	0.713	0.509	0.505	50.5	156.38**	4.20**
2nd	Social value	0.742	0.552	0.545	4.0	92.269**	2.132*

Source: this study result

Table 5 shows the findings of a regression analysis that was conducted using three independent variables from the consumption value theory. These variables are function value quality, social value, and Bedouins' emotional value for the desalinated water. The results of this analysis indicate a positive relationship (R = 0.867) and a statistically significant relationship ($p < 0.01$) with the dependent variable, Bedouins' choice behavior for the desalinated water. The variation in the dependent variable was explained by the independent factors to the extent of 74.8% (the modified R^2 value was 0.748). The significant value of the F-statistic is < 0.01, which indicates that the variation that is described by the model is not the result of a random chance. According to the findings shown in Table 5, function value quality was the most influential factor in Bedouins' choice behavior toward desalinated water. This component accounted for the highest percentage of the variance that could be explained (59.1%). The social value of desalinated water (which explains approximately 12.1% of the variance in Bedouins' choice behavior toward desalinated water) and the emotional value that Bedouins attach to desalinated water (which explains approximately 3.6% of the variance in Bedouins' choice behavior) come in second and third ranks, respectively. The observed values of "t" for those components in the model are significant at the 0.01 and 0.05 levels, respectively. When compared to the research null hypotheses, it was possible to accept three of the research alternative hypotheses (H4, H6, and H7).

Table 5. The accumulative effect of studied consumption values in Bedouins' choice behavior for the desalinated water

Model	Variables	R	R^2	Adjusted R^2	% of explained variance	F	t
1st	Function value quality	0.771	0.594	0.591	59.1	220.96**	6.22**
2nd	Social value	0.846	0.716	0.712	12.1	189.23**	2.86**
3rd	Emotional value	0.867	0.753	0.748	3.6	151.01**	2.20*

Source: this study result

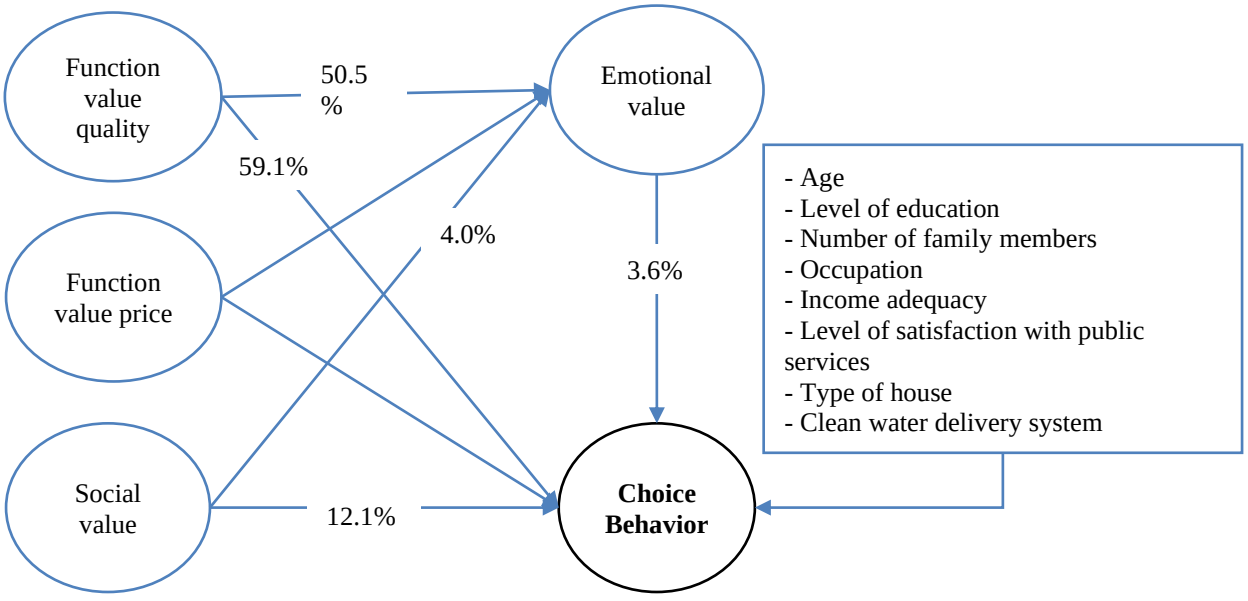

Figure 3. Factors affecting Bedouins' choice behavior for the desalinated water. **Source:** this study result

3.6. Clean water problems and Bedouins' suggestions to solve them

According to the findings presented in Table 6, the respondents are dealing with a total of six issues related to their drinking water. The problem of "not connecting drinking water networks to all houses in the study's area" came in first, as reported by 48.4% of the total respondents. This was followed by the problem of "poor condition of water delivery networks," with an average value of 42.5%, and then the problem of "insufficient water treatment and purification units," as indicated by 21.6% of surveyed respondents. In total, 48.4% of the respondents indicated that this was the most significant problem. The proposal to expand and extend water delivery networks came in first with a percentage of 52.9%, and in second place, the disinfection and periodic maintenance of the water network were present with an average value of 46.4%. The expansion of water purification units came in third place, as reported by 26.8% of respondents, and in fourth place was the construction of water collection systems. In conclusion, in terms of the suggestions that respondents made to address drinking water problems in the study villages, the proposal to expand and extend water delivery networks came in first place with a high percentage.

Table 6. Problems facing drinking water and suggested solutions as mentioned by the respondents

No.		Frequency	Percentage
	Problems facing drinking water		
1.	Not connecting drinking water delivering networks to all residential units	74	48.4
2.	Poor conditions of water delivery networks	65	42.5
3.	Inadequate water treatment and purification units	33	21.6
4.	Lack of a permanent water source in the Bedouin communities in the valleys	30	19.6
5.	Water transport vehicles do not reach residential communities in valleys	27	17.6
6.	Delays in maintenance and operation of water purification units	26	17.0
	Suggested solutions		
1.	Expansion and extension of governmental water delivering networks	81	52.9
2.	Disinfection and periodic maintenance of the water network	71	46.4
3.	Expansion of water purification units	41	26.8
4.	Training local youth to operate and maintain water purification units	35	22.9
5.	Construction of water collection tanks in Bedouin communities	35	22.9
6.	Increase water transport vehicles	30	19.6
7.	Providing a technician to repair pumps for pumping water wells	16	10.5

Source: this study result

4. Conclusion and Recommendations

There is a growing awareness that traditional centralized water systems need to be adapted to meet existing and future challenges, including climate change. One approach to addressing this challenge is to diversify water sources to include the use of alternative, non-traditional sources such as desalinated seawater, recycled wastewater, and rainwater. However, there is no certainty that stakeholders will accept any changes. As a result, further studies are required to better understand the public's perception of these alternate water sources. The long distance of Halaib from the Nile and the lack of underground water wells were the main reasons for respondents' lower use of those sources of water, whereas the close proximity to the Red Sea and the presence of desalination stations led to desalinated water being the primary source of water in the studied area. More research and development efforts should be made in the area of alternate water sources (recycled or rainy water) for human and agricultural applications. Water desalination is regarded as one of the most effective solutions to water scarcity. On the other hand, the public's approval of desalinated water is the most important factor influencing its use and marketing. This study investigates choice behaviors (CB) regarding desalinated water using the theory of consumption values (TCV). The findings indicate that the functions value quality (FVQ) and social value (SV) have a favorable influence on emotional value (EV) and CB; EV acts as an intermediate between the FVQ, SV, and CB. Through the use of the TCV, this study investigated the role of various values in the behavior of water resource users. However, the causes of influence that have an effect on each value are not completely understood. Additional research is necessary to investigate the variables that influence the values that make up TCV. As a result of the delays that have occurred in the operation and maintenance of water purification units in the distant valleys, training courses in the operation, maintenance, and repair of such units ought to be made available to young people living in the studied villages.

Conflicts of interest. The authors mentioned that none of them have a conflict of interest when it comes to this article.

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