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Predicting greywater reuse for potable and nonpotable purposes in a developing country – a theory of planned behaviour approach

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ABSTRACT

This study was aimed at predicting greywater reuse in a municipality of a developing country using the theory of planned behaviour (TPB). It sought to identify the beliefs that influence people's intentions to reuse greywater for potable and nonpotable purposes. Residents within the municipality completed a questionnaire designed with the TPB constructs and other demographic data. Results revealed an excellent fit for potable reuse intention and a mediocre fit for nonpotable reuse intentions. Attitudes and behavioural control were the constructs that significantly influenced intentions to reuse greywater for both potable and nonpotable purposes. Location of the source of water to the respondents and level of education were introduced as background factors. Location of the source of water had no significant direct or indirect influence on intentions to reuse greywater for potable or nonpotable purposes. Level of education had a nonsignificant indirect and direct effect on intentions to reuse greywater for potable purpose but is mediated through attitudes and perceived behavioural control for nonpotable reuse intentions. Strategies aimed at promoting greywater reuse should be targeted at a specific reuse option and not a wholesale intervention that is expected to address all reuse interventions.

Keywords: Greywater; Reuse; Theory of planned behaviour; Potable; Nonpotability

1. Introduction

Water use and demand around the globe have increased rapidly, even at a higher rate than population growth [1]. Due to industrialization and urbanization, most developing countries are using more water than they previously used in order to sustain both standard of living and economic growth. However, these developing countries have to deal with limited access to clean and potable water. Water resource professionals believe reclaiming water after use is an important and underutilized element of sustainable water resources management. Lack of access to clean water has been shown to be directly linked to poor sanitation and hygiene and a decline in economic growth [2]. Wastewater generated from human activities is not regarded as a byproduct that can be reused but should be discarded. However, greywater which forms part of wastewater can be easily treated for reuse. Greywater is characterized as a high-volume low-strength stream that constitutes about 50%–80% of domestic wastewater [3–5]. It is considered a very useful

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resource, which can address the emerging water crisis that the world is expected to face and further reduce the over-reliance in treating freshwater for nonpotable uses. Water reuse can help improve water conditions in areas with a lot of strain on their water resources. Many states in the United States support the general concept of greywater reuse for nonpotable purposes EPA [6]. Direct potable reuse (DPR) has also been used in some arid and semiarid countries. DPR involves the introduction of treated wastewater into the raw water supply system of a drinking water treatment facility or direct injection of this treated water into a potable water supply distribution system [7]. There are many technologies that exist today which can treat greywater into drinking water quality standards. However, despite the proof and certainty that the water meets the required standards for consumption, it has seen more resistance and less interest in the population. Currently, the only city that has adopted DPR on a large scale is Windhoek, the capital city of Namibia where highly treated waste water is recycled into a drinking water system that serves close to 250,000 people [7,8]. Other agencies and municipalities in the United States have also begun looking at DPR as a viable option.

In the implementation of any project, public perception has been recognized as one of the integral factors in determining the success of the project. Several studies have been conducted to assess public perception towards greywater reuse in different parts of the world using different strategies. These strategies include interviews, questionnaires, focus group discussions, informal discussions, and other equally good social surveys [9–15]. It is, however, clear that most of these surveys identified clear support for the concept of greywater reuse as an environmentally sustainable method of protecting freshwater resources and pollution prevention. However, Gifford and Nilsson [16] identified that simply transmitting knowledge is not enough to change lifestyles and behaviour patterns. It is obvious that communities support the concept of water reuse as a means of responsible water resources management to mitigate scarcity and abate pollution. However, internationally, many technically sound schemes have failed because communities have rejected them. Ajzen et al. [17] have suggested that there is a need to identify the beliefs people hold towards an issue and how these beliefs affect their intentions and behaviour rather than making sure people have accurate information. Although some researchers have studied the behaviours of recycled water reuse [18,19], little has been known of how people in developing countries make their decisions to accept or reject greywater reuse schemes.

This research is therefore aimed at providing a deeper understanding of the factors that will influence the perception of individuals in developing countries to accept greywater as an alternative source of water by using a social cognitive model known as the Theory of planned behaviour (TPB). This study holistically investigates the reasons why people will want to reuse greywater from the cultural, religious, location of current water supply, regulatory, and environmental points of view. Developing this kind of knowledge is crucial for creating interventions that aim to promote greywater reuse and further develop a theoretical decision model for policymakers in developing countries.

2. Analysis of the framework

According to the theory, human behaviour is guided by three kinds of considerations: beliefs about the likely consequences of the behaviour (behavioural beliefs), beliefs about the normative expectations of others (normative beliefs), and beliefs about the presence of factors that may facilitate or impede performance of the behaviour (control beliefs) [20,21]. In their respective aggregates, behavioural beliefs produce a favourable or unfavourable attitude towards the behaviour; normative beliefs result in perceived social pressure or subjective norms, and control beliefs give rise to perceived behavioural control. In combination, attitude towards the behaviour, subjective norm, and perception of behavioural control lead to the formation of a behavioural intention which may then be converted into action. The direct path between perceived behavioural control and behaviour models the actual behavioural control. This refers to the extent to which a person has the skills, resources, and other prerequisites needed to perform a given behaviour. Therefore, the successful performance of the behaviour depends not only on favourable intention but also on a sufficient level of behavioural control [20]. According to the model, people's attitudes towards behaviour are determined by their accessible beliefs about the behaviour, where a belief is defined as the subjective probability that the behaviour will produce a certain outcome. The outcome probability is weighed with the subjective evaluation of the outcome [22]. In the TPB, the expectancy values of attitude, subjective norm, and perceived behavioural control are obtained by the product of behavioural belief and outcome evaluations, normative belief and motivation to comply, and control belief and perceived power to control, respectively. The conceptual framework supporting this theory is presented in Fig. 1.

The defining behaviour of interest in the design of the questionnaire is the individual perception towards greywater reuse thus the flexibility within which an individual is willing to accept greywater as an alternative source of water. Following the definition of the three main determinants, as described in the TPB, the individual determinants of greywater reuse consider the various reuse options that are available for greywater reuse and these are nonpotable and potable uses. An individual's societal norms refer to the pressure or level of acceptance for the option of greywater reuse, and

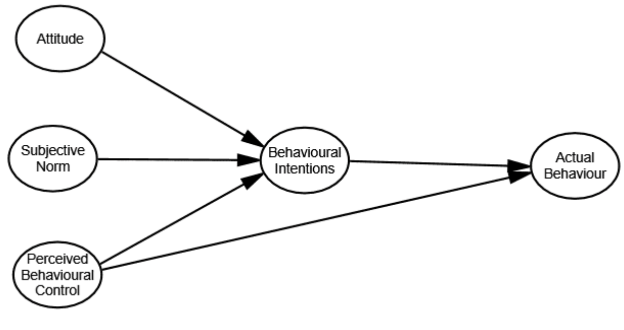

Fig. 1. Conceptual framework.

these include family, neighbours, and the regulatory body. The individual's perceived behavioural control refers to the ability of an individual to reuse greywater.

The predictive strength of these factors is analyzed using structural equation modelling (SEM) to examine the relationship between factors and individual perceptions of greywater as an alternative source of water. Fundamentally, SEM is a term for a large set of techniques based on general linear models. It is often used to access hidden factors that contribute significantly to a phenomenon or condition. SEM multivariate technique combines aspects of multiple regression and factor analysis to assess a series of dependent relationships simultaneously which is not possible using other multivariate techniques [23].

3. Methodology

This was a cross-sectional study carried out among local residents of a peri-urban municipality within the central region of Ghana. The central region of Ghana is chosen for this study because it has a blend of rural, peri-urban, and urban settlements. It also has people from different cultures and ethnicities. The study adopted a random sampling approach to collect data. The study used the TPB to assess the predictive power of the Theory's constructs on the intention to reuse greywater for potable and nonpotable reuse options.

3.1. Pilot study

Fishebein and Ajzen [21] suggest elicitation of accessible beliefs from a sample of respondents prior to designing the TPB questionnaire. A pilot study was conducted among 50 local residents within the study area. An open-ended questionnaire was administered to them to determine their readily accessible beliefs about greywater reuse. They were asked to write their opinion about greywater reuse with specific emphasis on the advantages and disadvantages of reusing greywater for domestic potable and other non-potable uses such as irrigation, toilet flushing, car washing, etc. They were also to state the persons or groups of people who would approve or disapprove of their actions in greywater reuse and finally factors that could either facilitate or prevent them from reusing greywater for the above-listed functions. A content analysis of the responses was conducted to determine frequencies of each of these responses, and the most frequent responses were included in the model set.

Prior to conducting the main study, 60 local residents were selected for a pretest of the questionnaire. This was conducted to test the coherence, understandability, clarity, and psychometric properties of the questionnaire. Modifications were then made to questions that were not clearly worded or sounded ambiguous. Because the study is interested in identifying the determinants of greywater reuse for two specific reuse options, the questionnaire was a two-in-one type that had constructs of the TPB model with each section capturing specific reuse option. An overall Cronbach alpha for potability and nonpotability reuse were 0.670 and 0.839, respectively, indicating that the scales were all adequate.

3.2. Main study

Residents within the study area were approached by the investigator, and after declaring their willingness to participate in the study, they were asked to sign a consent form and received information regarding the aim of the study. The questionnaire was in two parts: one part included items on demographics while the second part included the TPB constructs. All the items on the TPB section were scored using a 7-point Likert scale. Three research assistants were present to support respondents who had difficulty in responding to the questionnaires.

3.3. Questionnaires

3.3.1. Attitude

The attitude was measured using behavioural beliefs and their outcome evaluation. The questionnaire had a total of 4 questions that were used to assess the participants' beliefs and 4 outcome evaluations about the consequences of reusing greywater for various reuse options. The questionnaire assessed the individual's advantages and disadvantages of reusing greywater. From the elicitation, the relevant beliefs that were identified are water conservation, environmental protection, reduction in water bills, and health concerns.

3.3.2. Subjective norms

Subjective norm was measured using normative beliefs and motivation to comply. The questionnaire had a total of 3 questions that were related to normative beliefs and 3 questions on accompanying motivation to comply. Participants were asked to rate how specific important people either agreed or disagreed to them reusing greywater and whether this has any influence on their decision to either reuse or not reuse greywater for the various reuse options.

3.3.3. Perceived behavioural control

Perceived behavioural control was measured using control beliefs and power of control factors. The questionnaire had a total of 5 questions that were related to control beliefs and 5 questions that were related to the matching perceived power to control factor. The questionnaire assessed the ability of the individual to reuse greywater without any hinderances.

3.3.4. Behavioural intentions

A total of 3 questions were used to assess the intentions of greywater reuse.

3.3.5. Demographics

The questionnaire assessed demographic information about the respondents. In total, 5 demographic items were assessed in the questionnaire.

3.4. Statistical analyses

A total of 853 respondents were approached, and responses were received from 526 indicating a response rate of 61%.

The researchers cancelled questionnaires that had any item vacant. In all, 462 respondents completed all items from the survey. The model constructs are analyzed using factor analysis with SEM using SPSS Amos 23 with maximum likelihood estimation. The analyses were performed in two steps. First, the original TPB model was tested for both reuse options. Second, in order to better understand the role of education and proximity to the source of water played in intentions, these distal variables (proximity to source and level of education) were introduced into the model.

3.5. Descriptive analysis of variables

The research framework consists of three exogenous and one endogenous variables for each of the reuse options. Each construct shows an acceptable Cronbach alpha value of above 0.60 as recommended by Field [24]. A composite variable of each belief was derived by multiplying each belief statement by its corresponding belief evaluation. The model is assessed by using sample size-independent fit indices such as root mean square error of approximation (RMSEA), normed fit index (NFI), Tucker-Lewis index (TLI), and comparative fit index (CFI). According to Cangur [25], the acceptable values of TLI and CFI are 0.90 while values above 0.95 are classified as excellent, and RMSEA values smaller than 0.08 classified as acceptable while values less than 0.06 classified as excellent. The NFI ranges from 0–1 with 1 being a perfect fit.

4. Results

4.1. Demographic profile of respondents

The demographics and other distal factors are presented in Table 1. The mean age of the respondents was 40 (12.8) years. From the descriptive statistics of the profile of respondents, it can be observed that a majority of the respondents had tertiary education implying their comprehension of the questionnaire administered to them. The majority of these respondents were Christians which also reflects the religious dynamics within the study area. With reference to the source of water, the majority of the respondents relied on potable pipe-borne water supplied by the water company with just a minority still relying on unsafe drinking water sources such as streams. Though a majority indicated they relied on a piped network, not all of them have the resource in their house. As can be seen in Table 1, about 31.6% will have to walk or move out of their dwelling to have access to water. A majority of the respondents are Akans, which is the largest tribe in Ghana.

Table 1
Socio-demographic distribution of respondents

Demographics	Frequency	Percentage
Sex		
Female	229	50.7
Male	223	49.3
Educational level		
No formal education	44	9.7
Basic	75	16.6
Secondary	123	27.2
Vocational	32	7.1
Tertiary	178	39.4
Religion		
Christianity	331	73.2
Islam	101	22.3
Traditional	10	2.2
Hinduism	10	2.2
Source of water		
Pipe-borne	387	86.6
Stream	6	1.3
Well	59	13.1
Location of source of water		
In-house	309	68.4
Outside	143	31.6
Tribe		
Akan	297	65.7
Ewe	56	12.4
Ga	45	10.0
Northerner	54	11.9

4.2. Descriptive statistics

Participants reported weak intentions (M = 2.04, standard deviation (SD) = 0.10), negative attitude (M = –4.26, SD = 13.04), low social pressure (M = 2.32, SD = 1.28), and negative controllability (M = –3.81, SD = 0.73) to reuse greywater for potable purposes. However, for nonpotable uses, participants reported strong intentions (M = 5.15, SD = 0.24), positive attitude (M = 9.37, SD = 5.81), moderately high social pressure (M = 4.54, SD = 3.59), and high controllability (M = 12.43, SD = 0.64). The correlation matrix presented in Table 2 indicates that almost all the variables in the TPB are significantly associated with behavioural intentions. The results showed that the significant predictors of greywater reuse intentions were attitudes and perceived behavioural control while social pressure has no significant influence on intentions to reuse greywater.

4.3. Testing the TPB model

The structural models representing potable reuses and nonpotable reuses are presented in Figs. 2 and 3, respectively. The test indicates that this model accounted for 16% and 18% of the total variance in respondent's intentions to reuse greywater for potable and nonpotable purposes, respectively. Based on the Cohen [26] classification, it can be seen that attitude (β = 0.11, SE = 0.008, p = 0.039) had a small but significant effect on intentions for potable reuse, whereas there was a moderate and significant effect of attitude (β = 0.28, SE = 0.017, p < 0.01) on intentions towards nonpotable reuse. Both subjective norms had small size effect and were insignificant on intentions for potable reuses (β = 0.00, SE = 0.014, p = 0.996) and nonpotable reuses (β = 0.10, SE = 0.019, p = 0.056). Perceived behavioural control (β = 0.37, SE = 0.027, p < 0.01) had a moderate but significant effect on intentions towards potable reuses, whereas the effect was weak but significant (β = 0.37, SE = 009, $p < 0.001$) towards nonpotable reuses.

The direct links between composite beliefs and the TPB latent variables were all between β = 0.40–0.98, $p < 0.01$ indicating very high effects on the individual latent variables on both potable and nonpotable uses. However, there is an insignificant small effect between attitude and health concerns belief-composite (β = 0.03, $p = 0.281$). Effects between latent variables indicate significant paths for both categories with the strongest effect being between perceived behavioural control and attitude on nonpotable reuse (β = 0.68, SE = 0.062, $p < 0.001$) and between attitude and subjective norm (β = –0.19, SE = 0.011, $p < 0.001$) for potable reuse. The remaining paths show small and insignificant effects (β = 0.02–0.17, $p > 0.05$).

The fit indices indicate that the standard TPB model provided an excellent fit to the data on potable reuses (CFI = 0.963, NFI = 0.929, TLI = 0.954, RMSEA = 0.047) and a mediocre fit for nonpotable reuses (CFI = 0.939, NFI = 0.925, TLI = 0.924, RMSEA = 0.092).

4.4. Effects of beliefs

The four behavioural beliefs explained 80.4% of the variance in attitude towards greywater reuse towards both potable and nonpotable purposes. These beliefs were '*reusing greywater for potable/nonpotable purposes will help me save water at home*', '*reusing greywater for potable/nonpotable purposes will help me protect the environment*', '*reusing treated greywater at home for potable/nonpotable purposes will help me reduce my water bills*', and '*reusing treated greywater at home for potable/nonpotable purposes will be dangerous to my health*'. The effect of these beliefs on potable reuses is water conservation (β = 0.83, $p < 0.001$), environmental protection (β = 0.76, $p < 0.001$), reduction in water bill (β = 0.83, $p < 0.001$), and health concerns (β = 0.40, $p < 0.001$). Whereas the effects on nonpotable reuses are water conservation (β = 0.86, $p < 0.001$), environmental protection (β = 0.87, $p < 0.001$), reduction in water bill (β = 0.88, $p < 0.001$), and health concerns (β = 0.03, $p = 0.281$).

Five composite control beliefs explained 79.7% of the variance in perceived behavioural control towards potable reuse and 92% towards nonpotable reuses. These beliefs were '*an appropriate technology for treating greywater will encourage me to reuse it for potable/nonpotable purposes*', '*water scarcity will force me to reuse treated greywater for potable/nonpotable purposes*', '*my religious practices does not prevent me from reusing treated greywater for potable/nonpotable purposes*', '*incentives for reusing treated greywater for potable/nonpotable purposes will encourage me to adopt it*', '*my cultural practices does not prevent me from reusing treated greywater for potable/nonpotable purposes*'. The effects of these beliefs on potable reuses are technology (β = 0.78, $p < 0.001$), water scarcity (β = 0.61, $p < 0.001$), religion (β = 0.66, $p < 0.001$), incentives (β = 0.64, $p < 0.001$), and cultural practices (β = 0.62, $p < 0.001$). Whereas the effects on nonpotable reuses are technology (β = 0.62, $p = 0.001$), water scarcity (β = 0.81, $p < 0.001$), religion (β = 0.97, $p < 0.001$), incentives (β = 0.72, $p < 0.001$), and cultural practices (β = 0.99, $p < 0.001$). Subjective norm was not significant in the model hence the effects of individual beliefs on this latent variable were not examined.

4.5. Effects of level of education and proximity to the water source

Level of education and proximity to a source of water were introduced as distal factors into the TPB model as shown in Fig. 4. To avoid overloading the figure, only significant paths have been displayed in the figure. The model provided an excellent fit for potable reuses (RMSEA = 0.050, NFI = 0.922, TLI = 0.933, CFI = 0.956) and a mediocre fit for nonpotable reuses (RMSEA = 0.091, NFI = 0.923, TLI = 0.904, CFI = 0.937). Level of education and proximity to a source of water had neither direct nor indirect significant effects on intentions to reuse greywater for potable purposes. For nonpotable purposes, there was no significant direct effect of level of education and proximity to source on intentions; however, level of education had a significant direct effect on all five factors of perceived behavioural control: technology (β = –0.158, SE = 0.244, $p < 0.01$), water scarcity (β = –0.125, SE = 0.219, $p < 0.01$), religion (β = –0.154, SE = 0.231, $p < 0.01$), incentives (β = –0.106, SE = 0.213, $p = 0.026$), and culture (β = –0.155, SE = 0.228, $p < 0.01$) and all four factors of attitude: water conservation (β = –0.118, SE = 0.261, $p = 0.012$), environmental protection (β = –0.203, SE = 0.247, $p < 0.001$), reduction in water bill (β = –0.165, SE = 0.255, $p < 0.001$), and health concerns (β = 0.095, SE = 0.258, $p = 0.047$).

5. Discussion

The results of this study confirm to a large extent that the TPB as a framework can be used to understand greywater reuse in developing countries. Attitudes and behavioural controls accounted for the proportion of variance in intentions to reuse greywater for both potable and nonpotable purposes. The use of SEM revealed an excellent fit for potable reuses and a mediocre fit for nonpotable reuses between the standard TPB model and the data. A scrutiny of the specific behavioural and control beliefs that affected the overall reuse options among the respondents revealed four behavioural beliefs (water conservation, environmental protection, reduction in water bill, and health concerns) and five control beliefs (technology, water scarcity, religion, incentives, and culture).

With reference to the behavioural beliefs, it was realized that water conservation, environmental protection, reduction in water bill, and health concerns were all significantly affecting intentions to reuse greywater and this is also supported in another study [18]. However, health concerns were not significantly related to the intention to nonpotable reuses. With respect to potable reuses, it was realized that participants had a very negative attitude towards this reuse application and this is also supported in a similar study [27]. The application of potable water is mostly for consumptive purposes; therefore, use of recycled water can be seen as a health risk, and this is supported by the study which identified a very high positive evaluation of good health; thus, substituting piped water for recycled water may be seen as a potential health risk. Even though substituting piped water with recycled water can lead to some water reduction, the perceived health risk associated with reusing treated greywater for potable purposes far outweighs its environmental, economic, and water conservation benefits. On the other hand, participants had a very positive attitude towards nonpotable applications,

Table 2
Correlation, Cronbach alpha, grand means, and factor means table for model. Lower triangular matrix represents nonpotability and upper triangular matrix represents potability reuses

Latent	Cronbach alpha		Mean (SD)			Mean				
	Potable	Nonpotable	Potable	Nonpotable		Potable	Nonpotable	1	2	3
Attitude	0.60	0.70	–4.26[b] (13.04)	9.37[b] (5.81)	1. Water conservation	–10.73[b]	11.73[b]	1	0.636**	0.694**
					2. Environmental protection	–10.74[b]	12.28[b]	0.744**	1	0.619**
					3. Reduction in water bill	–10.88[b]	12.78[b]	0.754**	0.772**	1
					4. Health concerns	15.32[b]	0.68[b]	0.001	–0.030	–0.044
Subjective norms	0.611	0.60	2.32[b] (1.28)	4.54[b] (3.59)	5. Family	2.64[b]	1.41[b]	0.343**	0.310**	0.353**
					6. Neighbours	0.91[b]	3.77[b]	–0.013	–0.057	–0.019
					7. Authority	3.42[b]	11.50[b]	0.054	0.051	0.128**
Perceived behavioural control	0.791	0.92	–3.81[b] (0.73)	12.43[b] (0.64)	8. Technology	–3.42[b]	12.70[b]	0.664**	0.596**	0.599**
					9. Water scarcity	–3.76[b]	12.39[b]	0.578**	0.576**	0.565**
					10. Religion	–3.30[b]	13.27[b]	0.570**	0.540**	0.573**
					11. Incentives	–3.49[b]	12.29[b]	0.416**	0.426**	0.432**
					12. Culture	–5.08[b]	16.51[b]	0.573**	0.565**	0.572**
Intentions	0.878	0.95	2.04[a] (0.10)	5.15[a] (0.24)	13. Make and effort	1.91[a]	5.36[a]	0.349**	0.395**	0.340**
					14. Have plans	2.10[a]	5.21[a]	0.323**	0.356**	0.307**
					15. Will reuse	2.09[a]	4.89[a]	0.273**	0.294**	0.272**
Background factors	–	–	–	–	16. Education	–	–	–0.095*	–0.181**	–0.157**
	–	–	–	–	17. Proximity	–	–	–0.078	–0.048	–0.026

* = $p < 0.05$, ** = $p < 0.01$ level; [a]Theoretical range = 1–7; [b]Theoretical range = –21 to 21.

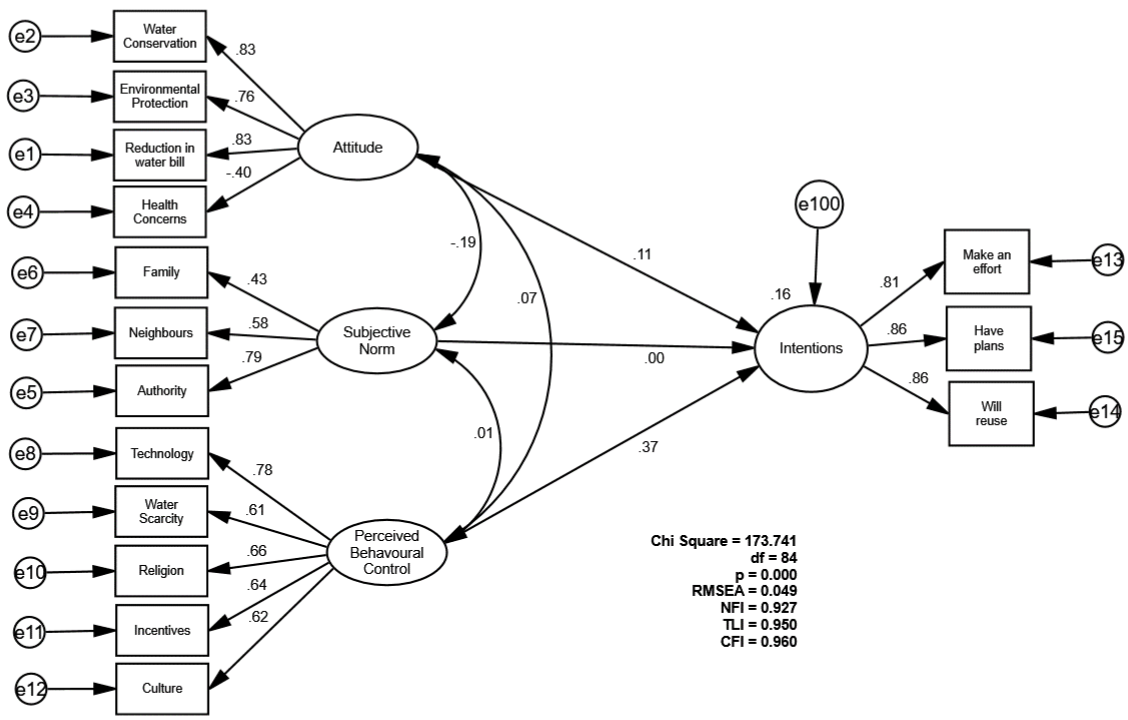

Fig. 2. Potability.

Correlation matrix													
4	5	6	7	8	9	10	11	12	13	14	15	16	17
–0.316**	–0.165**	–0.035	–0.107*	0.031	0.021	0.048	0.127**	–0.096*	0.158**	0.038	0.059	0.098*	0.033
–0.292**	–0.137**	–0.042	–0.118*	0.082	0.017	0.075	0.108*	–0.067	0.237**	0.140**	0.152**	0.174**	–0.013
–0.365**	–0.190**	–0.063	–0.126**	0.060	0.028	0.056	0.127**	–0.033	0.121**	0.039	0.035	0.222**	–0.036
1	0.080	–0.015	0.085	–0.018	0.085	–0.017	–0.047	–0.990*	–0.114*	–0.109*	–0.006	–0.093*	0.025
–0.068	1	0.240**	0.330**	–0.010	0.010	0.030	–0.026	0.009	–0.002	0.040	0.024	–0.068	–0.081
–0.109*	0.226**	1	0.466**	–0.014	0.019	0.007	–0.045	0.056	–0.043	–0.051	–0.011	–0.075	0.008
–0.134**	0.298**	0.508**	1	0.004	0.011	0.042	–0.031	0.016	–0.019	–0.011	0.002	–0.088	0.040
0.038	0.334**	0.002	0.076	1	0.449**	0.520**	0.467**	0.544**	0.259**	0.201**	0.206**	–0.042	–0.010
–0.050	0.252**	–0.036	0.056	0.690**	1	0.403**	0.382**	0.442**	0.198**	0.209**	0.190**	–0.043	–0.039
–0.014	0.262**	–0.013	0.094*	0.610**	0.746**	1	0.480**	0.316**	0.275**	0.192**	00.215**	–0.105*	–0.006
–0.017	0.188**	–0.038	0.008	0.514**	0.604**	0.718**	1	0.352**	0.387**	0.277**	0.286**	–0.001	0.076
–0.023	0.258**	–0.035	0.078	0.641**	0.807**	0.959**	0.710**	1	0.182**	0.110*	0.142**	–0.078	–0.024
–0.118*	0.220**	0.084	0.099*	0.356**	0.316**	0.326**	0.246**	0.349**	1	0.687**	0.689**	0.047	0.013
–0.122**	0.200**	0.081	0.094*	0.330**	0.290**	0.312**	0.204**	0.337**	0.920**	1	0.748**	0.027	–0.020
–0.045	0.203**	0.050	0.077	0.305**	0.241**	0.278**	0.171**	0.291**	0.807**	0.849**	1	0.021	0.013
–0.085	–0.148**	0.007	–0.089	–0.140**	–0.105**	–0.145**	–0.096*	–0.142**	0.006	0.027	0.001	1	–0.205**
0.002	–0.064	0.023	0.068	–0.073	–0.038	0.022	–0.012	0.003	–0.122*	0.101*	0.104*	0.205**	1

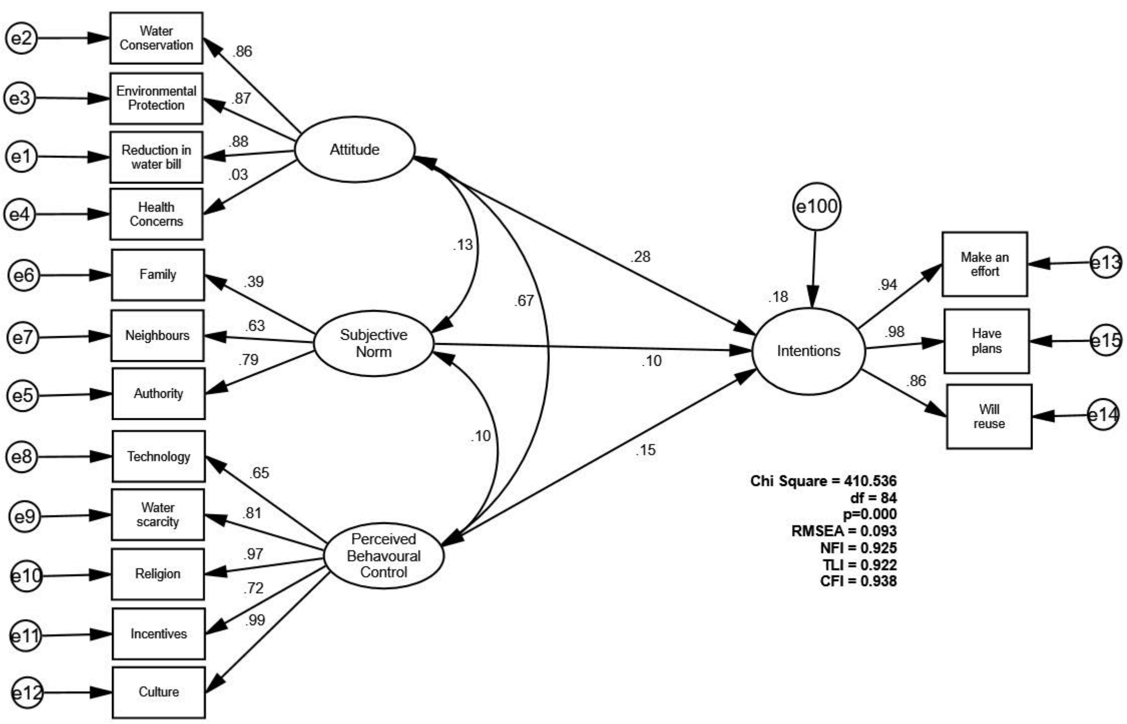

Fig. 3. Nonpotability.

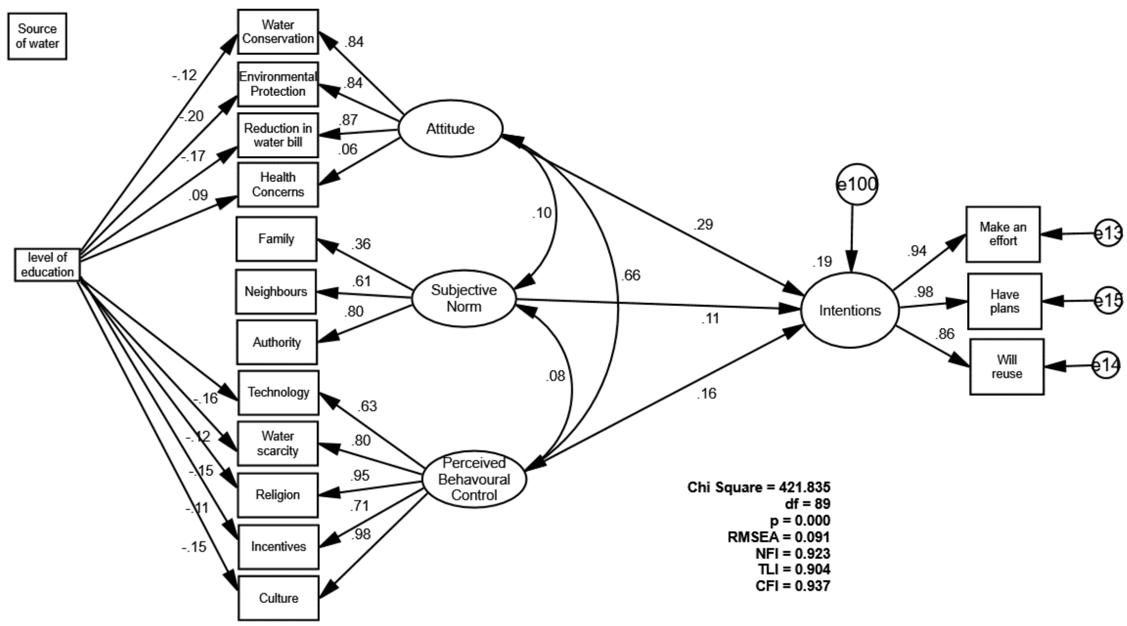

Fig. 4. Effect of education on nonpotable uses.

and this could also be due to the volume and uses of water for nonpotable applications. Large volumes of water are needed for nonpotable applications such as watering of lawns and scrubbing among many others. Since most of these water uses are not for consumptive purposes, there is a clear support for accepting a substitute as seen in this study. The study also showed only a very weak perceived health risk associated with this type of use. This suggests that interventions aimed at promoting greywater reuse should consider different approaches since a single approach might not yield positive outcomes for both reuse options. Interventions emphasizing the positive outcomes of greywater reuse are less likely to be effective in potable reuse applications but may rather be effective in nonpotable reuse applications. However, interventions that emphasize the perceived health risk are more likely to be effective in potable reuse applications.

The study found out that subjective norms did not significantly influence greywater reuse intentions. This suggests that the judgement of significant others do not matter much in this domain.

For control beliefs, it was realized that all five factors, appropriate technology, water scarcity, religious practices, incentives, and cultural practices, had a significant effect on intentions to reuse greywater for both potable and nonportable purposes. The study further revealed that participants showed a strong positive ability towards nonpotable reuses but moderately negative control over potable reuses. This suggests that providing the necessary skills or technology may only facilitate nonpotable uses but will not influence potable reuses.

Our findings have some limitations that should be mentioned. This is a cross-sectional study, and this type of study prevents us from making causal inferences. The second limitation is its reliance on self-reports of greywater reuse intentions. It is possible that participants may have misreported, be elusive, or biased with some of the questionnaire items in their responses. Finally, the representativeness of participants may be limited given the sampling strategy employed which may have introduced selection bias.

6. Conclusions

The study sought to find the determinants of greywater reuse in a developing country by considering the two major reuse applications: potable and nonpotable reuses. The study identified attitude and behavioural control as the two main constructs that affect intentions to reuse greywater for both reuse applications. However, one intervention method for both reuse options is not likely to lead to effective outcomes. Interventions are supposed to target a specific reuse option by using the factors outlined in the study. It further concludes that level of education does not have a direct effect on intentions to reuse greywater for nonpotable purposes but effects are rather mediated through attitude and behavioural control, also supporting the need for a diverse approach to shaping public opinion. From the discussions above, it is evident that nonpotable reuse approaches might be easier to implement and monitor as compared with potable reuses. To achieve potable reuse behaviour, it is imperative to approach it from the perceived health risk point of view and further enhance trust in the ability of the individual. It will also be prudent to assess the determinants of willingness to adopt a technology for greywater treatment at the household levels to achieve household-level participation of greywater reuse schemes.

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