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Adoption of Rainwater Harvesting: a Dual-factor Approach by Integrating Theory of Planned Behaviour and Norm Activation Model

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Abstract
The objective of the study is to identify the factors that lead to the adoption of rainwater harvesting in enabling sustainable ground water. The Theory of Planned Behavior and Norm Activation Model has been adopted. The sample consists of 400 participants who were either constructing and likely to construct houses have been considered for the study. Structural Equation Modelling was used to analyze the data. The study results exhibited the adoption of rainwater harvesting, and the moderation effect of intention to acquire rainwater harvesting knowledge on the relationship between environmental concern; environmental responsibility and rainwater harvesting. Based on the results, significant theoretical and practical implications have been made.

Keywords Environmental concern · Environmental responsibility · Personal norm · Subjective norm · Theory of planned behavior · Norm activation model · Rainwater harvesting

1 Introduction

Water is a nonrenewable resource (Alley et al. 1999) that plays a significant role in the nations' economic development (Jha et al. 2007). Because of the domestic, agricultural and industrial demand for water the global water use is expected to increase by 85% in 2050 (International Energy Agency 2012) and is also predicted that more than 57% of the global population will encounter water scarcity at least for one month in a year by 2050 (World Metrological Organization 2021). Combating water scarcity therefore remains a crucial task and requires strategic water resource management policies and plans (Mirchi et al. 2012). Therefore, prior researchers have suggested to invest for improved water management (e.g. Koop

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and van Leeuwen 2015; Yousefi et al. 2016). To address the issues of water pollution several artificial remediation techniques can be adopted (Afshar et al. 2015; Yousefi et al. 2021a, b) however to topple water scarcity ground water recharge remains the omnipresent technique (Busico et al. 2021; Zhou et al. 2021). Though several researchers reiterated the significance of adopting rainwater harvesting, the contribution of Individual's behavioral aspects towards RWH were less explored. Individual's behavioral variables significantly impacts the decisions on renewable energy (Masini and Menichetti 2012). Therefore, the current research attempts to augment ground water through rain water harvesting (RWH) as the relationship between these two has been established by Glendenning and Vervoort (2010). At the same time as, limited research was carried out, Pandey et al. (2003) suggested to undertake research to identify the reasons behind the limited interest of individuals towards RWH.

In addition, the current research proposes that individuals should have concern towards environment and feel responsible for the depletion of groundwater resources. Based on this premise the current research employs the Theory of Planned Behavior (TPB) and Norm Activation Model (NAM) with constructs like intention to acquire knowledge to investigate the adoption of rainwater harvesting system. The constructs namely subjective norm, personal norm, environmental responsibility and environmental concern have been adopted to study the adoption of rain water harvesting as these constructs were adopted to investigate the pro-environmental behavior. In addition, to the best of our knowledge concerned based on the extensive reviews no studies have explored these constructs to investigate the behavior aspects of individuals towards the adoption of rainwater harvesting (ARWH).

RWH system withers the adversities of climate change (Pandey et al. 2003); improves irrigation (Boers and Ben-Asher 1982); augments indoor use, food production and groundwater recharge (Stout et al. 2017) whereby, it remains a significant strategy in the current context. In the meantime, several strategies and efforts have been fostered by the government to implement rainwater harvesting. Based on this discussion, the current study intends to investigate and understand the reasons for the less intention of individuals to adopt RWH.

2 Theoretical Basis and Hypotheses

2.1 Rainwater Harvesting (RWH)

Rainwater harvesting is the method of collecting and storing rainwater for various purposes (Boers and Ben-Asher 1982). While India is a tropical monsoon country with the potential to harvest rains, despite the growing awareness about rainwater harvesting (Kumar et al. 2006), there is low adoption in India. Hence, to comprehensively explore the reasons for the low adoption of rainwater harvesting, this empirical study adopts constructs including personal norm from Norm Activation Model, intention to acquire rainwater harvesting knowledge (IARWH), environmental responsibility, environmental concern, along with the subjective norms of the Theory of Planned Behavior.

2.2 Personal Norms (PN)

Personal norms are implied as the humanistic values, manifests as obligations and compassion that are with oneself gets transpired when encountered with social tribulations. Researchers like Lindenberg and Steg (2007) argued that individuals are steered to elicit

pro-environmental behaviors based on the inner motivation as guided by the conscience or morality. Accordingly, Schwartz (1977) defined personal norms as the internalized core values that are presumed as moral obligations which play a key role in decision making.

In the meantime, several researchers have addressed the active engagement of personal norms on the pro-environmental behavior. The study conducted by Wynveen and Sutton (2015) signified that; individuals embracing personal norms plant trees, and use products that consume less energy to mitigate the adversities of climate change. Similarly, Shanmugavel and Solayan (2021) signified a positive relationship between personal norms and green products purchase intention among the centennials in India. This shows that personal norm could be an intrinsic motivation that usher individuals to adopt rainwater harvesting in their premises. Accordingly, the following hypotheses are proposed:

H1a. Personal norms positively influences the intention to acquire RWH knowledge.
H1b. Personal norms positively influences individuals' responsibility towards the environment.
H1c. Personal norms positively influences environmental concern of the individuals.
H1d. Personal norms positively influences the adoption of rainwater harvesting.

2.3 Subjective Norms (SN)

Subjective norms are the guidance that oneself derives or inherits from others to perform an action (Lam 1999), therefore empirical evidence signifies its role on individual's behavioral intentions and actions. Fishbein and Ajzen (2011) defined subjective norms as the reference to individuals from known and important persons' actions and behaviors to perform a task.

Marcos et al. (2021) investigated the influence of subjective norms on water conservation and found that it holds a strong binding with the individuals' intention to conserve water. However, a study conducted by Kim and Seock (2019) discovered that social norm significantly influenced pro-environmental purchasing behavior. López-Mosquera et al. (2014) argued the significance of social norms by stating that individuals would intend to spend for environmental conservation. Hence, this study assumes that subjective norms will be a strong predictor to adopt rainwater harvesting. Therefore, the following hypotheses are proposed:

H2a. Subjective norms positively influences the intention to acquire RWH knowledge.
H2b. Subjective norms positively influences individuals' responsibility towards the environment.
H2c. Subjective norms positively influences environmental concern possessed by the individuals.
H2d. Subjective norms positively influences the adoption of rainwater harvesting.

2.4 Acquisition of Rainwater Harvesting Knowledge (ARWHK)

Knowledge is a supreme power which enables the cognitive skill of individuals (Zagzebski 2017), and motivates intellectualism (Fantl 2012). Knowledge is acquirable as the acquisition of knowledge includes knowledge of others, things and own self. Therefore, knowledge is an understanding about a subject matter. The acceptance behavior of individuals is influenced by the attitude towards knowledge adoption (Davis 1989). In addition, MacRae (1990) has urged the need to

design programs to create awareness about the sources that deteriorates the ecological status and remediate the environment.

Prior researchers have stated the linkage between knowledge and attitude (Bagheri et al. 2019). Individuals who acquire knowledge through sustainable development education programs necessarily shapes a sustainable future (Hadjichambis et al. 2015). A study conducted by Fielding and Head (2012) affirmed that knowledge predicts more pro-environmental behavior. Accordingly, this study presumes that intention to acquire knowledge play a significant role in the adoption of rainwater harvesting. Further, this study construes that intention to acquire RWH knowledge mediates the relationship between personal norms and subjective norms with the adoption of RWH. In view of the above discussion, the following hypotheses are framed:

H3a. Intention to acquire RWHK positively influences the adoption of RWH.
H3b. Intention to acquire RWHK mediates the relationship between personal norms and adoption of RWH.
H3c. Intention to acquire RWHK mediates the relationship between subjective norms and adoption of RWH.
H3d. Intention to acquire RWHK positively influences the environmental responsibility.
H3e. Intention to acquire RWHK positively influences the environmental concern.

2.5 Environmental Responsibility (ER)

Environmental responsibility is attributed as an inherent behavior of individual's environmental interest manifested from their concern towards environmental security and welfare (Wong et al. 2018). Studies have also shown that environmental responsibility could be influenced through environmental education (Slavoljub et al. 2015). Environmental responsibility could be manifested by keeping the environment clean; consuming less and optimal use of energy; involves in raising hands against environmental evils.

Yue et al. (2020) demonstrated the significant effect of environmental responsibility on green consumption behavior and environmental concern. Kaiser and Scheuthle (2003) discovered the influence of environmental responsibility on the eco-friendly behavior. Attaran and Celik (2015) confirmed the relationship between environmental responsibility and purchase intention of green buildings. In view of the above discussions, following hypotheses are proposed:

H4a. Environmental responsibility positively influences the adoption of RWH.
H4b. Environmental responsibility positively influences environmental concern.
H4c. Environmental responsibility mediates the relationship between personal norms and adoption of RWH.
H4d. Environmental responsibility mediates the relationship between subjective norms and adoption of RWH.

2.6 Environmental Concern (EC)

Environmental concern is categorized as individual's attitude (Minton and Rose 1997) that might be developed through the perceived personal threats duly caused by environmental deterioration (Baldassare and Katz 1992). Prior researchers have construed environmental concern as a strong positive predictor to pro-environmental behavior (e.g. McDonald

et al. 2015; Felix et al. 2018). Hence, this study assumes that greater the environmental concern is a consequence of high level of environmental information acquired.

Individuals possessing greater degree of environmental concern instantaneously take actions against environmental problems and involves empathetically to protect the environment (McDonald et al. 2015). Empirical studies have elicited the impact of environmental concern on environmentally responsible behavior (Fransson and Gärling 1999). Similarly, environmental concern influences the willingness to pay for eco-friendly products (Xu et al. 2020). In view of the discussions, this study proposes the following hypotheses.

H5a. Environmental concern positively influences the adoption of RWH.
H5b. Environmental concern mediates the relationship between personal norms and adoption of RWH.
H5c. Environmental concern mediates the relationship between subjective norms and adoption of RWH.

2.7 Moderating Variable: Intention to Acquire Rainwater Harvesting Knowledge (IARWHK)

Another interesting aspect in the contemporary information era is the influence of information and the intention to acquire knowledge. Hilgert et al. (2003) are of the opinion that individual's knowledge about a specific subject would influence their attitude toward behavior. Prior studies also proved the significant effect of environmental knowledge on pro-environmental behavior (Onel and Mukherjee 2016). Masud et al. (2015) argued that knowledge about the adversities of climate change favors actions to mitigate climate change. Therefore, this study assumes the moderating influence of IARWHK on the individual's intention to adopt rainwater harvesting. Similarly, based on the discussions, this study surmises that environmental responsibility and environmental concern influences the adoption intention of rainwater harvesting.

H6a. The impact of environmental responsibility on the adoption intention of rainwater harvesting is positively moderated by the intention to acquire rainwater harvesting knowledge.
H6b. The impact of environmental concern on the adoption intention of rainwater harvesting is positively moderated by the intention to acquire rainwater harvesting knowledge.

2.8 Proposed Research Model

To predict the individual's pro-environmental behavior, several researchers have used and validated the TPB (e.g., Ru et al. 2019). Though TPB intends to investigate the behavioral intent, subjective norms play a crucial role (Aliabadi et al. 2020). Several researchers including Ajzen (1991) have suggested to add variables that holistically explain the intended behavior (e.g., Tommasetti et al. 2018). At the same time, several researchers also have claimed that Norm Activation Model (NAM) is one of the best theoretical models to study the pro-environmental behavior in view of its predictive power (e.g., Onwezen et al. 2013). Though the NAM proposed by Schwart (1977) was scantly used to investigate the altruistic behavior, it has been extended to study pro-environmental behaviors in its extended forms (Stern et al. 1999). Few researchers also argued that moral norm enhances

the predictive power of TPB (e.g., Whitmarsh and O'Neill 2010). Based on the discussion the personal norm has been added (Kim and Seock 2019). Similarly, the environmental responsibility and environmental concern as signified by Yue et al. (2020) and derived from NAM has also been added. In addition, the intention to acquire knowledge about rainwater harvesting is also added, as this study assumes that intentions are scuttled by personal and subjective norms. Accordingly, the proposed research model is shown in Fig. 1.

3 Research Methodology

3.1 Research Design and Sample

The study adopted a cross-sectional design. Data was collected during a five-day construction equipment event in India during December 2019. 420 respondents were identified through convenience sampling procedure who were constructing or likely to construct individual houses were introduced about the purpose of the study, and requested to respond to the survey questionnaire. We received 403 responses and used only 400 which was quite adequate for the study. Table 1 shows the demographic characteristics of the sample.

3.2 Measurement

In order to identify the adoption of rainwater harvesting, the research adopted six constructs that are measured with 22 items. The personal norm scale was adopted from Van der Werff et al. (2013); 4 items measuring subjective norm was adopted from Dean et al. (2012); the Intention to acquire RWH knowledge has been derived from Liao and Chou (2012); 4 items explaining environmental responsibility was adopted from Stern et al. (2010); scale

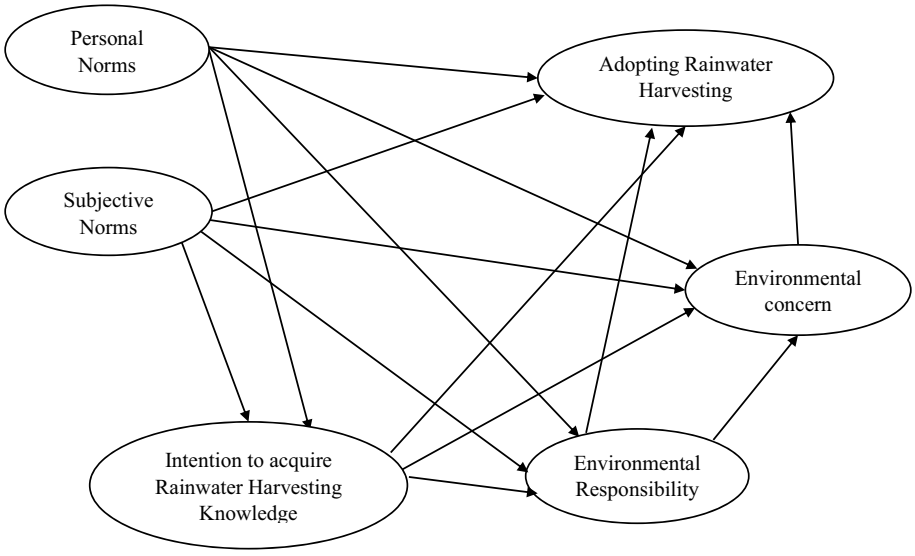


Fig. 1 The Proposed hypothetical model to study adoption of rainwater harvesting

Table 1 Socio-demographic characteristics of the sample

Characteristics		Frequency (N = 400)	Percentage (%)
Gender	Male	284	73.5
	Female	106	26.5
Age	20–25	2	0.5
	26–30	3	0.8
	31–35	68	17
	36–40	113	28.2
	41–45	104	26
	46–50	58	14.5
	51–55	43	10.7
	> 56	9	2.3
Educational Background	Under-graduate like B.A., B.Sc., B.Com., BCA., etc	57	14.2
	Post-graduate degrees like M.A., M.Sc., M.Com., MCA., etc	88	22
	Professional Degrees like B.E., B. Tech., M.E., M. Tech., M.B.A., etc	253	63.3
	Others	2	0.5
Income	< Rs. 20,000	10	2.5
	Rs. 20,001, – Rs. 30,000	29	7.2
	Rs. 30,001- Rs. 40,000	49	12.3
	Rs. 40,001-Rs. 50,000	139	34.8
	Rs. 50,001 – Rs. 60,000	75	18.7
	Rs. 60,001 – Rs. 70,000	51	12.7
	> Rs. 70,000		11.8
Place of residence	Urban	306	76.5
	Rural	94	23.5
Construction area	< 1000 Square feet	261	65.3
	> 1000 Square feet	139	34.7

to measure environmental concern has been adopted from Hamzah and Tanwir (2021) and 4 items that measure adoption intention of RWH has been derived from Sheng et al. (2019). Though prior validated scales were adopted small changes were made to suit to the current context without semantic differences.

Likert's seven-point scale ranging between 1 (strongly disagree) and 7 (strongly agree) were used for all the items. The questionnaire also included 4 demographic questions and 1 question relating to the construction of house.

3.3 Data Analysis

Data was analyzed with the use of Microsoft Excel, SPSS 23.0, and AMOS. Further, to study the proposed research, the two-stage structural equation modelling was used as suggested by Anderson and Gerbing (1988). Confirmatory Factor Analysis (CFA) was performed to check the validity and reliability of the constructs, and then the structural model was analyzed. Based on the suggestions of Leong et al. (2019), the co-variance-based

structural equation modelling (SEM) was adopted. Similarly, as suggested by Hair et al. (2017) based on the factor loadings SEM was employed. Further, the skewness-kurtosis values were lesser than 2 and not exceeding 4 confirmed the data free from univariate normality issues, which further suggests the use of SEM (Kline 2005). The mediating role of intention to acquire rainwater harvesting knowledge between personal norms and adoption intention of rainwater harvesting, and subjective norms and adoption intention of rainwater harvesting as signified in H3b, H3c, H4c and H4d is presented as model 2 and given in Fig. 1. Further, the moderating role of intention to acquire rainwater harvesting knowledge on the relationship between environmental responsibility, and environmental concern on the adoption intention of rainwater harvesting was studied through H6a and H6b, and presented as model 3 as given in Appendix B.

4 Results

4.1 Respondents' Profile and Characteristics

Socio-demographic details of the study units is presented in Table 1. The study consists of 73.5% male and 26.5% female. Over 28.3% of the respondents are between 31–35 years of age. In addition, 63.5% of the respondents possess professional degrees like B.E., B. Tech., M.E., M. Tech., M.B.A., etc. It is also significant to note that 34.8% of the respondents' income ranges between Rs. 40,001–50,000 and 76.5% of the respondents' hail from urban areas. Over 65.3% of the respondents were constructing or likely to construct houses below 1000 square feet.

4.2 Assessment of Measurement Model

Initially the Cronbach's alpha value was tested (shown in Table 3) to ensure the sufficiency of internal consistency, and the individual constructs scored more than 0.77 and confirmed to the suggestions of Nunnally and Bernstein (1994). Subsequently, the convergent and discriminant validity were examined. Table 2 shows the item loadings for all the constructs above 0.65 and the Average Variance Extracted (AVE) above 0.56 indicates an excellent content and convergent validity (Hew and Kadir 2016). Further a good discriminant validity is assured, as the values of AVE were greater than the MSV (Maximum Shared Variance) and ASV (Average Shared Variance) (Hew and Kadir 2016). Similarly, the values of composite reliability as greater than 0.8 determines an excellent fit (Shanmugavel and Micheal 2022). Further, the discriminant validity could be checked from Table 3 through the correlation matrix as diagonal values are similar to the square root of AVEs and greater than the corresponding inter-correlations. Further based on the recommendations of Leong et al. (2012) we measured the fit indices like; $\chi^2/df = = 2.461$ (Ideal < 3.0), Goodness of Fit Index (GFI) = 0.941 (Ideal > 0.900), Adjusted Goodness of Fit Index (AGFI) = 0.918 (Ideal > 0.900), Comparative Fit Index (CFI) = 0.973 (Ideal > 0.900) and Root Mean Square Approximation (RMSEA) = 0.054 (Ideal < 0.08) to measure uni-dimensionality and to minimize measuring bias. The corresponding values satisfy the threshold limit recommended by Leong et al. (2019) and Hair et al. (2010).

Table 2 Results of the Measurement Model

Construct	Items	Mean (SD)	Loadings	AVE, MSV & ASV	Composite Reliability
Personal norm	PN1	3.14 (1.10)	0.916***	0.616,	0.826
	PN2	3.01 (1.23)	0.692***	0.285 & 0.223	
	PN3	3.21 (1.17)	0.728***		
Subjective norm	SN1	3.23 (1.17)	0.683***	0.600,	0.856
	SN2	3.24 (1.11)	0.792***	0.373 & 0.270	
	SN3	2.96 (1.06)	0.740***		
	SN4	2.83 (1.04)	0.872***		
Intention to acquire rainwater harvesting knowledge	IARWH1	3.85 (1.75)	0.651***	0.561,	0.810
	IARWH 2	3.02 (1.57)	0.851***	0.294 & 0.214	
	IARWH 3	2.89 (1.49)	0.731***		
Environmental responsibility	ER1	3.01 (1.30)	0.944***	0.794,	0.939
	ER2	3.06 (1.22)	0.952***	0.397 & 0.253	
	ER3	2.89 (1.09)	0.843***		
	ER4	2.78 (1.02)	0.818***		
Environmental concern	EC1	3.12 (1.03)	0.889***	0.820,	0.948
	EC2	3.30 (1.11)	0.959***	0.373 & 0.319	
	EC3	3.24 (1.01)	0.928***		
	EC4	3.01 (1.12)	0.841***		
Adoption intention of rainwater harvesting	AIRWH1	2.87 (1.15)	0.755***	0.605,	0.859
	AIRWH2	2.90 (1.23)	0.713***	0.397 & 0.325	
	AIRWH3	2.75 (1.03)	0.734***		
	AIRWH4	3.01 (1.29)	0.897***		

AVE denotes Average Variance Extracted, *MSV denotes* Maximum Shared Variance, *ASV denotes* Average Shared Variance

*** significant at 99% confidence level; *** Denotes values significant at 99% confidence level

4.3 Common Method Bias Analysis

The current study relies on data that are self-reported, hence there is a need to assure that the data is free from Common Method Bias (CMB) issues (Podsakoff et al. 2003). Similarly, Shanmugavel et al. (2022) suggested to check CMB issues when common tools were used to measure all variables. Therefore, we used Harman's single factor analysis (Harman 1976) which has been extensively used by several researchers (e.g., Podsakoff

Table 3 Inter-correlation and $\sqrt{\text{AVE}}$ values

Constructs	Cronbach's α	EC	PN	SN	IARWH	ER	AIRWH
EC	0.945	*0.905*					
PN	0.809	0.534	*0.785*				
SN	0.852	0.611	0.473	*0.775*			
IARWH	0.773	0.534	0.380	0.456	*0.749*		
ER	0.937	0.542	0.457	0.469	0.372	*0.891*	
AIRWH	0.852	0.598	0.503	0.570	0.542	0.630	*0.778*

The diagonal values represent the $\sqrt{\text{AVE}}$

EC environmental concern, *PN* personal norm, *SN* subjective norm, *IARWH* intention to acquire rainwater harvesting knowledge, *ER* environmental responsibility, *AIRWH* adoption intention of rainwater harvesting

et al. 2003; Wong et al. 2015). With the use of SPSS 23 exploratory factor analysis was performed considering all the 22 items using unrotated factor solution. In summary, the first factor explained 39.87 per cent of the variance which is lesser than 50 percent, and hence satisfies Podsakoff et al. (2003)'recommendation and confirms the data free from CMB issues (Hew and Kadir 2016; Lin et al. 2014).

4.4 Structural Model Evaluation

The second stage of the SEM shows the results of hypothesis testing of model 1 as exhibited in Table 4. This has been done by drawing the path diagram with the use of Analysis of Moment Structures (AMOS) after the results of measurement model are within the acceptable level. The relationship between personal norm and intention to acquire rainwater harvesting knowledge was found to be statistically significant ($\beta = 0.229$; $p < 0.001$), thereby H1a was accepted. Similarly, the relationship between personal norm and environmental responsibility was also found to be significant ($\beta = 0.288$; $p < 0.001$), thereby H1b was accepted. In addition, the relationship between personal norm and environmental concern was found significant ($\beta = 0.227$; $p < 0.001$), whereby H1c was accepted. Further, a significant relationship exists between personal norm and adoption intention of rainwater harvesting ($\beta = 0.123$; $p < 0.05$) and H1d was also accepted. Next, the subjective norm was tested with the intention to acquire rainwater harvesting knowledge ($\beta = 0.375$; $p < 0.001$); environmental responsibility ($\beta = 0.298$; $p < 0.001$); environmental concern ($\beta = 0.327$; $p < 0.001$) and adoption intention of rainwater harvesting ($\beta = 0.189$; $p < 0.001$); thus H2a, H2b, H2c and H2d were accepted. Similarly, statistical relationship was examined between the intention to acquire rainwater harvesting knowledge with adoption intention of rainwater harvesting knowledge ($\beta = 0.231$; $p < 0.001$), environmental responsibility ($\beta = 0.148$; $p < 0.05$) and environmental concern ($\beta = 0.247$; $p < 0.05$), whereby H3a, H3b and H3c were accepted. A positive relationship exists between the environmental responsibility and adoption intention of rainwater harvesting ($\beta = 0.352$; $p < 0.001$); and environmental concern ($\beta = 0.226$; $p < 0.001$), therefore H4a and H4b were accepted. Finally, a statistical significance exists between environmental concern and adoption intention of rainwater harvesting ($\beta = 0.124$; $p < 0.05$) and H5 was accepted. Further, through linear regression analysis the variance inflation factors were estimated, and it proved the absence of multicollinearity issues between the independent and dependent factors. Additionally, Table 4 shows the estimated values of VIF are lesser than 10 and confirmed the study free from multicollinearity issues based on the results as signified by Brace et al. (2000). Further, the study holds an excellent fit. X^2 /df = 2.871 (Ideal < 3.0); GFI = 0.928 (Ideal > 0.900); AGFI = 0.910 (Ideal > 0.900); CFI = 0.938 (Ideal > 0.900); RMSEA = 0.068 (Ideal < 0.08). Finally, a good predictive validity was also derived as the variance calculated were 0.231, 0.34, 0.47 and 0.52 for intention to acquire rainwater harvesting knowledge, environmental responsibility, environmental concern and adoption intention of rainwater harvesting respectively.

4.5 Analyzing the Direct and Indirect Effect (Model 2)

The total, direct and indirect effects notified in model 2 were analyzed using 3000 bootstrap sample at 95% significance level (Preacher and Hayes 2008) as shown in Table 5. The study shows the indirect relationship between both personal norm and adoption intention of rainwater harvesting; and subjective norm and adoption intention of rainwater harvesting,

Table 4 Results of hypotheses testing

Endogenous constructs	Exogenous constructs	Standardised Estimates	VIF
Intention to acquire rainwater harvesting knowledge	Personal norm	0.229***	2.641
Environmental Responsibility	Personal norm	0.288***	2.312
Environmental concern	Personal norm	0.227***	1.486
Adoption intention of rainwater harvesting	Personal Norm	0.123**	1.931
Intention to acquire rainwater harvesting knowledge	Subjective norm	0.375***	1.671
Environmental Responsibility	Subjective norm	0.298***	2.327
Environmental concern	Subjective norm	0.327***	1.647
Adoption intention of rainwater harvesting	Subjective norm	0.189***	2.138
Adoption intention of rainwater harvesting	Intention to acquire rainwater harvesting knowledge	0.231***	2.383
Environmental responsibility	Intention to acquire rainwater harvesting knowledge	0.148**	2.431
Environmental concern	Intention to acquire rainwater harvesting knowledge	0.247***	2.657
Adoption intention of rainwater harvesting	Environmental responsibility	0.352***	2.521
Environmental concern	Environmental responsibility	0.226***	1.786
Adoption intention of rainwater harvesting	Environmental concern	0.124**	2.641

VIF variance inflation factor

** denotes $p < 0.05$; *** denotes $p < 0.001$

and signifies the presence of partial complementary mediation. The study further shows the existence of positive direct relationship between personal norm and adoption intention of rainwater harvesting and; subjective norm and adoption intention of rainwater and similarly indirect relationships through environmental responsibility. This further proves the existence of partial complementary mediation. Finally, the direct and indirect relationships of personal norm; and subjective norm with adoption intention of rainwater harvesting was checked and confirmed the indirect effect of environmental concern on the relationships between personal norm; and subjective norm with adoption intention of rainwater harvesting. As both the direct and indirect effects are positive, this study proves the existence of partial complementary mediation and accepts H3b, H3c, H4c, H4d, H5b and H5c.

4.6 Analyzing the Moderating Influence of Intention to Acquire Rainwater Harvesting Knowledge (Model 3)

Intention to acquire rainwater harvesting knowledge (IARWHK) significantly moderated the relationship between environmental responsibility and adoption intention of rainwater harvesting ($\beta = 0.518$; $p < 0.001$) and; environmental concern and adoption intention of rainwater harvesting ($\beta = 0.656$; $p < 0.001$), thereby, H6a and H6b got accepted. Further, it could be inferred that greater the intention to acquire rainwater harvesting knowledge, it augments the effect of environmental responsibility and environmental concern on the adoption intention of rainwater harvesting. The results of the moderation are well depicted through interaction graphs in Appendix A.

Table 5 Results of Mediation Analysis

	Effects	Effect of IARWHK on AIRWH	Effect of ER on AIRWH	Effect of EC on AIRWH
PN	Total Effects (std. error, lower bound, upper bound)	0.321*** (0.058, 0.429,0.203)	0.333*** (0.072, 0.480,0.202)	0.323*** (0.073, 0.466,0.190)
	Direct effect (std. error, lower bound, upper bound)	0.248*** (0.057, 0.362,0.139)	0.198*** (0.058, 0.462,0.182)	0.209*** (0.077, 0.370,0.072)
	Indirect effect (std. error, lower bound, upper bound)	0.073*** (0.026, 0.134, 0.031)	0.135*** (0.033, 0.212,0.079)	0.114*** (0.037, 0.200, 0.055)
SN	Total Effects (std. error, lower bound, upper bound)	0.461*** (0.051, 0.557,0.355)	0.461*** (0.059, 0.579,0.346)	0.463*** (0.059, 0.579,0.348)
	Direct effect (std. error, lower bound, upper bound)	0.340*** (0.057, 0.453,0.226)	0.312*** (0.072, 0.469, 0.241)	0.301*** (0.071, 0.447,0.166)
	Indirect effect (std. error, lower bound, upper bound)	0.121*** (0.030, 0.188, 0.070)	0.149*** (0.031, 0.222,0.100)	0.161*** (0.048, 0.276,0.083)

PN personal norm, *SN* subjective norm, *IARWH* intention to acquire rainwater harvesting knowledge, *ER* environmental responsibility, *EC* environmental concern, *AIRWH* adoption intention of rainwater harvesting

*** denotes significant at 99% confidence level; n = 400; bootstrap iterations = 3000

5 Discussions

This study has employed the intention to acquire rainwater harvesting knowledge to predict the adoption intention of rainwater harvesting. Therefore, this study fills this gap and the results show that intention to acquire rainwater harvesting knowledge is kindled by personal norm and subjective norm, which further moderates environmental responsibility and environmental concern. In line with the findings of Aliabadi et al. (2020), personal norm was found to be one of the influential drivers to predict the adoption intention of rainwater harvesting. It is further found that personal norm influences environmental responsibility and concern. Consequently, environmental responsibility and concern were determined as the strong predictors of adoption intention of rainwater harvesting, and also mediates the relationship of personal norm and subjective norm on the adoption intention of rainwater harvesting. Subsequently, subjective norm enables the adoption intention of rainwater harvesting and supports the findings of Lam (2006). Similarly, subjective norms influence the intention to acquire rainwater harvesting knowledge, environmental responsibility, and concern, and finally helps in the adoption intention of rainwater harvesting.

5.1 Theoretical Contributions

The outcome of this study adds new knowledge in view of the behavioral perspective of rainwater harvesting literature, by signifying the drivers of environmental responsibility and concern, and further reveals their impact on the adoption intention of rainwater harvesting. Personal and subjective norms are noted to be the significant contributors to environmental responsibility and concern, and are strong predictors to the adoption intention to rainwater harvesting. It is an interesting and novel finding that intention to acquire rainwater harvesting is activated by personal and subjective norms which further leads to the adoption intention of rainwater harvesting. Another notable contribution of this work is the moderating effect of intention to acquire rainwater harvesting knowledge on environmental responsibility and concern. Further the mediating aspect of intention to acquire rainwater harvesting, environmental responsibility and environmental concern on the relationships between personal norm; subjective norm and adoption intention of rainwater harvesting are also the significant contributions of this study.

5.2 Practical Implications

Developing environmental responsibility is presumed as a challenge though it results in environmental and ecological concern (DesJardins 1998). However, this study finds different way to develop environmental responsibility and concern, and draws few significant implications that will be useful to the policy makers and the society at large in promoting sustainable ground water. First, the study considered the factors such as; environmental concern, personal norm, subjective norms, intention to acquire rainwater harvesting knowledge, environmental responsibility to predict the intention to adopt rainwater harvesting. All these factors significantly contributed to adopt rainwater harvesting. Along with Kumar et al. (2006) this study affirms the imperativeness of rainwater harvesting for sustainable ground water. Hence, the role of government and non-government organizations in this regard is significant to transform the public opinion towards the sustainable ground water. This study indicates that policy makers need to provide relevant information about rainwater harvesting to make the public internalize

the adoption of rainwater harvesting as personal norm, and environmental concern and environmental responsibility play significant role in the intention to adopt rainwater harvesting. Similarly, the individual households who adopted rainwater harvesting should be appreciated to induce the subjective norm, because subjective norm plays a key role in the transformation of people towards the adoption of rainwater harvesting. In addition, incentives should be provided to the households through reduction in property tax and others. Further, the government can install rainwater harvesting system to individual households in a subsidized rate. The government needs to do advertisements through television channels, print media and social media, as the intention to acquire rainwater harvesting knowledge induces environmental responsibility and environmental concern. The reach of all these platforms in disseminating social messages is phenomenal.

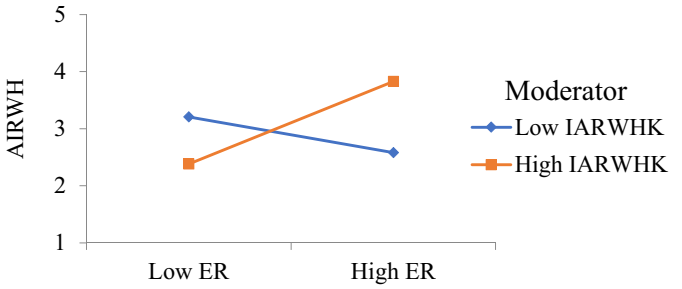
5.3 Limitations and Future Research Directions

Finally, we signify the limitations of our study. First, our sample represents the participants in a five-day construction equipment event in India. Though it represents people across the country, the study does not fully represent samples across India. Therefore, the findings may attach some residence bias. In future extensive research covering all cities, major towns and villages can be undertaken to investigate people across different segments. In addition, our study identifies the factors such as personal norm, subjective norm, intention to acquire rainwater harvesting knowledge, environmental responsibility and environmental concern however, there are other factors like cost to install rainwater harvesting system, incentives to install, need for rainwater harvesting, and others that can be adopted to explain the adoption intention of rainwater harvesting. Future research can focus on the link between the influence of technological knowhow of rainwater harvesting and environmental knowledge.

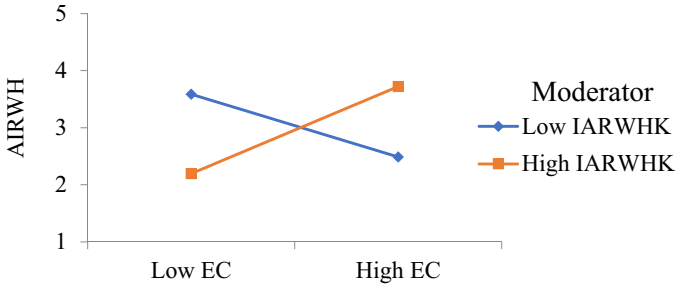
6 Conclusions

Triggered by the exploitation of ground water and the deprivation of water for drinking, farming and industrial purposes, this study intends to gain a better understanding of sustainable ground water by implementing rainwater harvesting. To fulfill the objectives of the study Theory of Planned Behaviour and Norm Activation Model have been adopted. Based on the data the hypothetical model adopted has been validated to predict the adoption of rainwater harvesting. The moderation effect of intention to acquire rainwater harvesting knowledge on environmental responsibility and environmental concern and the mediating effect of intention to acquire rainwater harvesting knowledge, environmental responsibility, and environmental concern on the paths between personal norm; and subjective norm and adoption of rainwater harvesting are the significant results of the study. Further, the results of the current study suggest to have a behavioral modification among the individuals to successfully adopt RWN to augment sustainable ground water. In view of the rich findings and the discussions, both the government and individuals would be benefitted in adopting rain water harvesting.

Appendix A

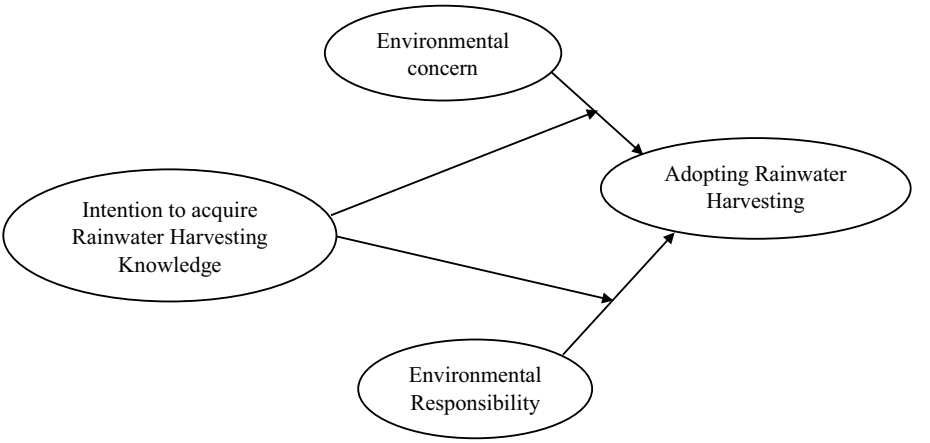


Graph. B1. Interaction effect of IARWHK & ER on adoption intention of rainwater harvesting.



Graph. B2. Interaction effect of IARWHK & EC on adoption intention of rainwater harvesting.

Appendix B



Hypothetical model with IARWHK as moderator (model 3)

Author Contribution **Nagarajan Shanmugavel**: Conceptualization, Methodology, Validation, Resources, Data curation, Writing–original draft, Visualization, Supervision, Project administration, Funding acquisition. **Rema Rajendran**: Conceptualization, Software, Formal analysis, Investigation, Writing–review & editing, Funding acquisition.

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Declarations

Ethics Approval The authors confirm that this article is original research and has not been published else wholly and in part thereof in any journal or conference proceedings.

Consent to Participate Not applicable.

Consent to Publish The researchers discharge their consent to publish this research paper in the Journal of Water Resources Management.

Competing Interest The authors declare no conflict of interest.

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