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Quality of life and sustainability

Development of an Instrument Based on the EGCI Model to Measure Sustainable Water Use Practices among Citizens

Construcción de un instrumento basado en el modelo EGCI para medir prácticas sostenibles de uso del agua en la ciudadanía

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Abstract

At present, residential water conservation behaviors are essential to prevent the growing global scarcity of water resources. This study aims to analyze the factors that influence citizens' intention to adopt sustainable water care practices, integrating the variables of the EGCI model under a responsible consumption perspective. To this end, an online survey was conducted with 450 participants in Mexico, one of the countries facing a severe water crisis. The instrument was specifically designed for this study, taking into account relevant variables associated with the EGCI acronym (Economic consumption, Sustainable water management, Moral commitment, and Intention to adopt sustainable practices). Data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The results show that moral commitment has a direct and positive influence on both sustainable water management and the intention to implement responsible practices. Likewise, it was confirmed that the perception of reduced costs associated with water consumption has a direct and positive impact on more efficient water management. These findings highlight the importance of continuing to educate citizens not only about responsible water savings but also about offering alternatives for the sustainable management of this resource. Furthermore, they support the design of targeted campaigns aimed at different sectors of society to modify consumption patterns, as well as the use of technological tools to reduce waste and improve water-use efficiency.

Keywords: Consumer economics, sustainable water management, moral commitment, intention to adopt sustainable practices.

Resumen

En la actualidad, las conductas de conservación del agua en el ámbito residencial son esenciales para prevenir la creciente escasez global del recurso hídrico. Este estudio tiene como objetivo analizar los factores que influyen en la intención de la ciudadanía de adoptar prácticas sostenibles de cuidado del agua, integrando las variables del modelo EGCI bajo una perspectiva de consumo responsable. Para ello, se aplicó una encuesta en línea a 450 personas en México, uno de los países que enfrenta una crisis hídrica severa. El instrumento fue diseñado específicamente para este estudio, considerando variables relevantes asociadas al acrónimo EGCI (Economía del consumo, Gestión sostenible del agua, Compromiso moral, Intención de prácticas sostenibles). Los datos fueron analizados mediante modelos de ecuaciones estructurales con mínimos cuadrados parciales (PLS-SEM). Los resultados evidencian que el compromiso moral influye de manera directa y positiva tanto en la gestión sostenible del agua como en la intención de implementar prácticas responsables. Asimismo, se comprobó que la percepción de reducción de costos asociados al consumo hídrico incide positivamente en una gestión más eficiente. Estos hallazgos subrayan la necesidad de continuar promoviendo la educación ciudadana en torno al ahorro responsable y la gestión sostenible del agua, además de diseñar campañas segmentadas que transformen patrones de consumo y fomenten el uso de tecnologías orientadas a minimizar el desperdicio y mejorar la eficiencia en el uso del recurso.

Palabras clave: Economía del consumo, gestión sostenible del agua, compromiso moral, intención de prácticas sostenibles.

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1 Introduction

It is well known that "Day Zero" is associated with a future in which water scarcity will be irreversible; however, the reality is that this scenario is already affecting several regions of the Mexican Republic (Coparmex, 2024). This is due to a series of factors, among which climate change, poor metropolitan planning (Gómez, 2024), and the inadequate use of resources by the population (Gaspar-Santos et al., 2024) can be mentioned.

For this reason, the present research focuses on Sustainable Development Goal (SDG) 6, "Clean Water and Sanitation," which guarantees access to safe drinking water and its sustainable management; since it is estimated that by 2030 billions of people will not have access to this resource unless the population is educated on the efficient use of this valuable water resource, as well as through increased investment in water and sanitation infrastructure and facilities (Organización de las Naciones Unidas, 2020).

Furthermore, the problem of water scarcity is not only of national but also of international concern, because access to this vital resource represents a challenge, as water is sometimes contaminated by high levels of salinity, nitrate, and chloride (AlHaddid et al., 2024; Salem and Ertz, 2023). Indeed, in 2023 water scarcity affected more than 2 billion people worldwide, and this number is expected to increase in the coming years, causing food insecurity, the extinction of some species, droughts that threaten human life, and conflicts between governments over water resources (Nasiri et al., 2024).

According to the National Water Commission (CONAGUA), the state of Puebla ranked second nationwide with the highest level of drought in 2024, due to insufficient rainfall to supply the territory (Milenio, 2024). As a result, the population was advised to recycle water to irrigate plants, wash vehicles, or flush toilets; in addition, citizens were encouraged to avoid littering the streets in order to prevent the clogging of drainage systems and storm drains.

It is important to note that, due to the increasing scarcity of water, there has been a push to seek innovative and sustainable solutions for water management in Puebla; for example, the use of greywater in households has been proposed as a strategy to reduce water consumption, along with modifications to existing plumbing and the installation of an underground storage tank (Reynoso Castro and Díaz Barrientos, 2024). In addition, the right to water is indispensable, even though climate change has caused extreme alterations in climatic conditions that have directly affected the availability of freshwater; for example, rising temperatures lead to intense droughts in some regions by evaporating water from surface water bodies. Therefore, the participation of both citizens and governments is necessary to prevent the scarcity of this vital resource (Rodriguez Garcia, 2024).

According to Gaspar-Santos et al. (2024), proper sustainable water management is crucial to protect the environment and ensure the provision of water resources for future generations. Therefore, the objective of the present study is to analyze the factors that influence citizens' intention to adopt sustainable water-care practices, integrating the variables of the EGCI model from a responsible consumption perspective. The results of the study identify opportunities to improve water-use efficiency, as well as to serve as a reference for predictive models of population behavior regarding the sustainable use of natural resources.

2 Theoretical framework

Previous literature has indicated that behavior aimed at predicting water consumption by the population does not depend solely on external factors, such as price or distribution, availability of information on water-saving measures, among others; but also on personal conditions and the motivational forces of the decision-maker (Cary, 2008; Pino et al., 2017). Therefore, for the purposes of the present research, variables studied in the context of water conservation, such as consumption economics and sustainable water management (Chenoweth et al., 2016; Lowe et al., 2015; Salem and Ertz, 2023), are considered, as well as variables related to environmental awareness and moral commitment, which have been addressed in studies on environmental protection (Imani et al., 2021; Keles et al., 2023; Rusyani et al., 2021), and finally, the variable of intention to adopt sustainable practices in water conser-

vation (Fatoki, 2022; Lowe et al., 2015; Mitev et al., 2024; Salem and Ertz, 2023).

2.1 Sustainable water management for Social Responsibility

According to Chenoweth et al. (2016), the proper use of water is essential to reduce pressure on water sources and the environment. Indeed, the effective management of this vital resource is a priority for many countries worldwide due to industrialization and urbanization processes, which lead to excessive and unplanned water consumption (Pino et al., 2017). For their part, Mitev et al. (2024) state that reducing household water demand is an essential component of reducing overall water consumption in large cities. Indeed, governments, investors, the public, and market forces such as consumers are the driving forces that promote water conservation (Zhang et al., 2025). For example, water supply companies provide users with information on how to improve water consumption and savings through various media channels (Tian and Chen, 2022).

However, Beal et al. (2013) and Tian and Chen (2022) argue that even when households are aware of how to manage water and are conscious of the problem of scarcity, their water-saving behaviors are not the most effective, negatively impacting social responsibility.

2.2 Intention to adopt sustainable practices

Regarding individuals' intention to save water, climate change mitigation and resilience building require a multidimensional approach that combines the modification of personal habits, such as reducing shower time and collecting rainwater, with the adoption of efficient infrastructure through the use of water-saving products (Mitev et al., 2024; Muenratch and Nguyen, 2023; Guo et al., 2022; Djayasinga, 2021). In addition, the intention to adopt sustainable practices may manifest in various areas, such as responsible consumption, sustainable mobility, waste management, conservation of natural resources (Lowe et al., 2015), and electricity savings (Fatoki, 2022).

According to Truong (2024), individuals' intention refers to their willingness to purchase or adopt products based on personal experiences, relying on internal aspects (emotions) or external aspects (cost–benefit relationships). In the same vein, AlHaddid et al. (2024) state that adopting sustainable water-related practices at the household level is hindered by the intention–behavior gap; in other words, the difference between observed or desired practices and actual practices at the household level.

2.3 Consumption economics and sustainable water management

Within the field of water economics, Mitev et al. (2024) and Muenratch and Nguyen (2023) argue that resource conservation is essential to mitigate climate change and strengthen the resilience of supply systems. However, they warn that the effectiveness of these strategies faces the barrier of excessive consumption habits, which are so deeply rooted that they hinder the adoption of new conservation behaviors, such as greywater reuse, rainwater harvesting, reducing shower time, and using water-saving devices, among others. Indeed, Tijs et al. (2017) state that, to promote pro-environmental behavior, it is necessary to provide information on the environmental costs of consuming energy, water, gasoline, among others. For example, Otaki et al. (2024) found that applying discounts to low-consumption households as an incentive for water conservation led to a reduction in their use, but had no noticeable effect on high-consumption households, as low water consumers wished to keep their bills low. Previously, de Koning et al. (2016) showed that the middle-class population in Vietnam was motivated to adopt environmentally friendly activities for health reasons and, above all, to save money.

It is worth noting that few studies compare the effectiveness of monetary appeals versus environmental appeals in reducing water use (Fielding et al., 2013; Tijs et al., 2017).

2.4 Moral commitment in sustainable water management and intention

According to Imani et al. (2021), moral commitment is one of the variables that directly affect indivi-

duals' intention to adopt more sustainable practices. Indeed, Menatizadeh et al. (2024) demonstrated that moral commitment is a variable that reinforces farmers' intention to engage in practices that lead to the conservation of water resources. Likewise, Yayla et al. (2020) showed that employees of eco-friendly hotels exhibited a higher moral commitment to carrying out environmentally friendly activities.

However, Almulhim and Abubakar (2024) highlighted that individuals in Saudi Arabia do not perceive water conservation as a moral commitment, as they associate it with socio-economic characteristics.

3 Materials and Methods

3.1 Sample and sampling technique

The present research was conducted in the city of Puebla, Mexico, which is the fifth most populated city in the country. The sample size was calculated using the formula for an infinite population (more than 500,000 elements) (Pelayo and Arroyo, 2015), resulting in 385 elements; however, a total of 450 surveys were obtained. Accordingly, the sample consisted of citizens from this locality (Balbin-Romero et al., 2024; Zhang et al., 2025), who were invited to complete the online survey. For this purpose, a non-probabilistic convenience sampling technique was applied, as this method allows saving resources and time, while also providing original responses (Jabeen et al., 2023; Keles et al., 2023).

Prior to the implementation of the study, the instrument was subjected to a validation process through expert judgment. Five specialists, both national and international, evaluated the relevance, clarity, and coherence of the items in relation to the variables of the EGCI model (Consumption Economics, Sustainable Water Management, Moral Commitment, and Intention of Sustainable Practices) (see Figure 1). Subsequently, a pilot survey was administered to 90 individuals in order to verify the comprehension and wording of the questions, as well as their ability to adequately measure each construct. The results of the pilot test confirmed the face and content validity of the instrument, and minor wording adjustments were made to improve its precision. Finally, the administration of the final survey was carried out between January and March 2025.

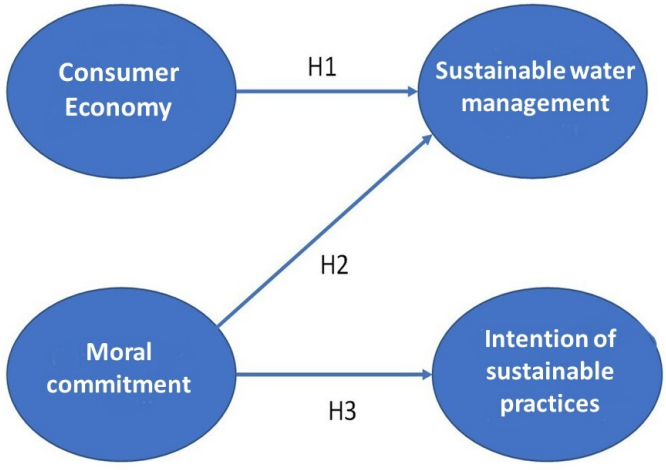

Figure 1. Study model based on Chenoweth et al. (2016); Lowe et al. (2015); Salem and Ertz (2023); Imani et al. (2021); Keles et al. (2023); Rusyani et al. (2021).

3.2 Instrument

The questionnaire administered is divided into three parts. In the first part, respondents were asked about their current habits regarding water use in their homes (Molina et al., 2018; Rivera-Pérez et al., 2020; Zulqarnain and Khan, 2024). In the second part of the questionnaire, the variables of the study model were measured using a 5-point Likert-type scale, where $1 =$ strongly disagree and $5 =$ strongly agree. In the third part, demographic data of the participants were collected.

With regard to the measurement of the consumption economics variable, the items were based on Lowe et al. (2015), Salem and Ertz (2023), and Chenoweth et al. (2016). Regarding moral commitment, the items were based on Lowe et al. (2015), Salem and Ertz (2023), and Chen (2020). For sustainable water management, the items were based on Chenoweth et al. (2016) and Molina et al. (2018). Finally, for the variable intention to adopt sustainable practices, the items were based on Lowe et al. (2015), Salem and Ertz (2023), and Chenoweth et al. (2016).

In relation to the latter, items were generated to test the following hypotheses:

H1: A reduction in the costs associated with household water consumption will lead to the implementation of sustainable water management practices.

H2: A high level of moral commitment toward environmental protection is a decisive predictor of sustainable water management in the domestic/citizen context.

H3: A high level of moral commitment toward environmental protection positively and significantly influences the intention to adopt sustainable water-care practices.

3.3 Data analysis method

For the analysis of demographic data, SPSS software version 25 was used. Regarding the analysis of the study model, the partial least squares structural equation modeling (PLS-SEM) technique was applied using SmartPLS 4. One of the advantages of using PLS-SEM is that it does not require any particular restrictions regarding data normality and is also applicable to the analysis of relatively small datasets (Hair Jr. et al., 2019). Likewise, the use of PLS-SEM allows for the prediction of the effects of independent variables on dependent variables (Thanki et al., 2022).

4 Results and Discussion

4.1 Demographic profile of respondents

Regarding the age of the respondents, 70.3 % were between 18 and 23 years old, 10.5 % were between 24 and 29, 0.8 % between 30 and 35, 2.3 % between 36 and 41, 2.3 % between 42 and 47, 4.5 % between 48 and 53, and 1.5 % were older than 53. With respect to sex, 59 % were women and 39.1 % were men. Regarding educational level, 84.2 % were undergraduate students, 5.3 % were enrolled in a master's program, 1.1 % were doctoral students, and 1.5 % were pursuing a specialization.

4.2 Reliability and validity analysis

Regarding the reliability and validity of the constructs in the conceptual model, these were assessed following the recommendations of Hair Jr. et al. (2019). Convergent validity was tested using factor loadings (> 0.70), average variance extracted (AVE > 0.50), Cronbach's alpha (> 0.70), and composite reliability. Table 1 shows that the constructs exhibit convergent validity; however, the GSA3 variable did not achieve the acceptable factor loading and was therefore removed, after which the analysis was conducted again.

Regarding discriminant validity, Henseler et al. (2015) described the Heterotrait–Monotrait (HTMT) criterion for assessing discriminant validity, with a cutoff value of 0.90; therefore, discriminant validity is indicated in Table 2, where the diagonal values correspond to the square root of the AVE. In addition, variance inflation factor (VIF) values were measured to detect multicollinearity problems, since, according to Kock (2015), the values must be below 5 for the variables used in this study to be considered free of multicollinearity issues. Table 3 shows that the established criteria are met for each construct.

Table 1. Reliability and validity results of the model

Items	Factor loadings	Cronbach's alpha	Composite reliability	AVE
Consumption economics				
ECON1	0.723			
ECON2	0.819	0.835	0.846	0.671
ECON3	0.828			
ECON4	0.896			
Moral commitment				
COM_M1	0.934			
COM_M2	0.914	0.960	0.963	0.892
COM_M3	0.967			
COM_M4	0.963			
Sustainable water management				
GSA1	0.931			
GSA2	0.792	0.854	0.895	0.773
GSA4	0.909			
Intention of sustainable practices				
INT1	0.732			
INT2	0.847	0.823	0.858	0.650
INT3	0.847			
INT4	0.793			

Table 2. Heterotrait–Monotrait criterion

	COM_M	ECON	GS	INT
COM_M				
ECON	0.823			
GS	0.826	0.872		
INT	0.483	0.679	0.690	

Table 3. Hypothesis testing results

Hypothesis	VIF	Path	*p*-value	f^2	Result
ECON → GSA	2.266	0.413	0.000	0.228	Not rejected
COM_M → GSA	2.266	0.461	0.000	0.283	Not rejected
COM_M → INT	1.000	0.447	0.000	0.250	Not rejected

4.3 Structural model evaluation

After confirming the validity of the measurement model, the explanatory power (R^2) and predictive relevance (Q^2) of the model were tested. The evaluation of the structural model was carried out by applying the PLS bootstrapping algorithm with a complete output, using a subsample of 5,000 and a one-tailed t-test, with a significance level of 0.05 (Hair Jr. et al., 2019), as shown in Figure 2.

Based on the results obtained, the variable that had the greatest impact on sustainable water management was moral commitment ($\beta = 0.461$, $p < 0.001$); therefore, Hypothesis 1 is not rejected. This was followed by the consumption economics variable ($\beta = 0.413$, $p < 0.001$); thus, Hypothesis 2 is not rejected. Finally, the moral commitment variable positively and directly affects the intention to adopt sustainable practices ($\beta = 0.447$, $p < 0.001$); therefore, Hypothesis 3 is not rejected.

Regarding the coefficient of determination (R^2), the effects of the consumption economics and moral commitment variables on sustainable water management were examined, as well as the effect of

moral commitment on the intention to adopt sustainable practices. The R^2 obtained was 0.669, which is moderate to high for explaining the variation in sustainable water management based on the consumption economics and moral commitment variables. In turn, the R^2 obtained to explain the variation in the intention to adopt sustainable water-care practices was 0.200 (weak).

Finally, the Stone-Geisser predictive relevance Q^2, which is an indicator of out-of-sample predictive power or predictive relevance, where a value greater than 0 for a specific endogenous variable indicates the predictive relevance of the model for a dependent construct (Hair Jr. et al., 2019), showed that the sustainable management construct has a $Q^2 = 0.640$ and the intention construct has a $Q^2 = 0.183$.

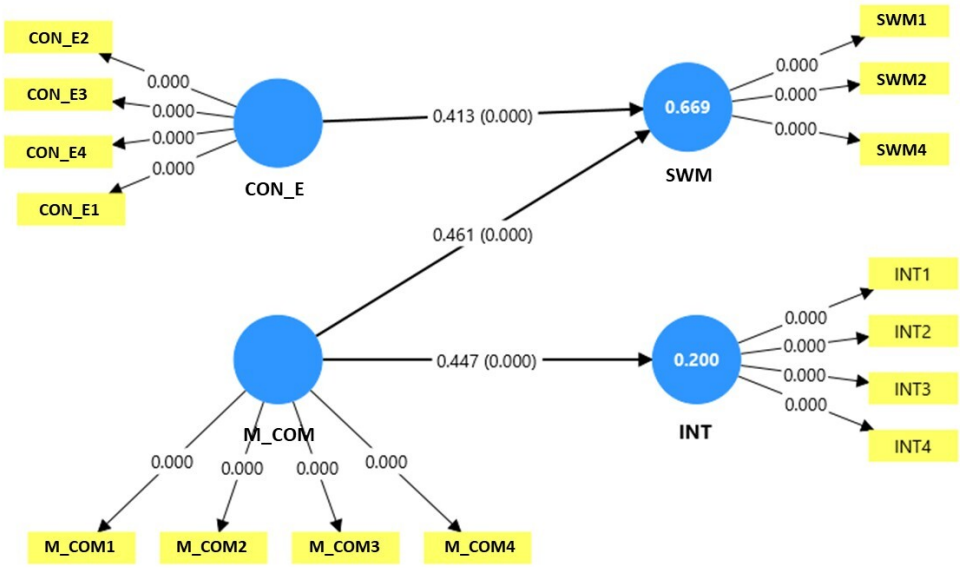

Figure 2. Results of the structural model evaluation.

5 Discussion

As observed in the results, it is necessary to provide information on the environmental costs of water consumption, as well as on the monetary costs borne by users, as mentioned by Tijs et al. (2017), raising awareness among individuals about saving water when spending time in the shower or when letting water run while washing dishes. In addition, applying discounts to low-consumption households for water conservation can help reduce both their water use and monetary expenses simultaneously (Otaki et al., 2024). For this reason, Hypothesis 1 was not rejected.

Regarding the moral commitment variable, it was the one that most strongly and positively impacted sustainable water management; therefore, Hypothesis 2 was not rejected. These results confirm the findings reported by Imani et al. (2021), who demonstrated that moral awareness is a predictive variable in environmental protection activities. Likewise, Müller-Pérez et al. (2022) pointed out that Mexican citizens are aware of environmental problems and, therefore, feel morally obliged to adopt pro-environmental behaviors.

Finally, moral commitment positively and directly affected the intention to adopt sustainable water-care practices; thus, Hypothesis 3 was not rejected. Some previous studies have shown that this variable is important to consider in environmental protection studies (Müller-Pérez et al., 2022; Yayla et al., 2020), since citizens who exhibit higher moral commitment have greater motivation to engage in environmentally friendly activities. Therefore, it

is necessary to engage future generations in improving water-use efficiency, as well as to raise awareness about the conservation and sustainable use of water resources.

6 Conclusions

The present study focused on analyzing the factors that influence citizens' intention to adopt sustainable water-care practices, integrating the variables of the EGCI model from a responsible consumption perspective. Among the most innovative results, it is evident that moral commitment not only directly and significantly influences sustainable behavioral intention, but also has a positive impact on efficient water management, a finding that underscores the ethical dimension as a key driver of water conservation among students in Puebla.

Additionally, confirmation of the positive effect of the perceived reduction in costs associated with water consumption on sustainable management provides a concrete economic perspective that strengthens the understanding of the motivators of citizen behavior. These results highlight the need to integrate multidimensional approaches—combining moral and economic factors—into the design of policies and educational campaigns. Finally, the validated instrument represents a valuable and pioneering tool for future research related to water conservation.

6.1 Theoretical and practical implications

Regarding theoretical implications, this study can be used as a basis for future research focused on the conservation of water, electricity, gas, among others. In addition, it provides guidance for extending economic and responsible consumption study models within sustainability and circular economy theories. However, further studies are needed that combine economics, ecology, and public policy to address the water problem from a comprehensive perspective.

With respect to practical implications, the results highlight the need to design campaigns targeting different sectors of society to modify consumption patterns through initiatives that promote the use of water-saving devices in households, as well as to inform citizens about the different ways in which water can be reused. Similarly, it is important to encourage water supply companies to implement dynamic tariffs or subsidies to promote efficient water consumption among citizens; for example, implementing discounts for semiannual or annual advance payments and, at the same time, offering water-saving devices with monthly charges included in utility bills.

6.2 Future lines of research

Regarding future lines of research in water conservation, studies may be considered that evaluate how technology (IoT, artificial intelligence) can improve water-use efficiency. Likewise, studies on citizen behavior focused on strategies for water recycling and reuse in different sectors, such as the automotive industry, may be conducted. Finally, comparative studies on sustainable water behavior in other states of the Mexican Republic and in other countries are recommended.

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Authors' contribution

J.M.P.: Conceptualization, Formal analysis, Data curation, Project administration, Investigation, Methodology, Software, Validation, Visualization, Writing–original draft, Writing–review & editing. **A.A.D.:** Conceptualization, Formal analysis, Data curation, Project administration, Investigation, Methodology, Software, Validation, Visualization, Writing–original draft, Writing–review & editing. **M.S.E.:** Conceptualization, Formal analysis, Data curation, Project administration, Investigation, Methodology, Validation, Visualization, Writing–original draft, Writing–review & editing. **I.Y.V.:** Conceptualization, Formal analysis, Data curation, Project administration, Investigation, Methodology, Validation, Visualization, Writing–original draft,

Writing–review & editing. **R.A.B.:** Conceptualization, Formal analysis, Data curation, Project administration, Investigation, Methodology, Validation, Visualization, Writing–original draft, Writing–review & editing.

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