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# Identification of Water Crisis Management Policy Indicators in the Country Based on the Interpretive Structural Modeling (ISM) Approach

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A B S T R A C T

**Objective:** The aim of the present research was practical in terms of its objectives and descriptive-survey in terms of its data collection method, utilizing an Interpretive Structural Modeling (ISM) approach.

**Methodology:** The participants of this study were 15 managers, policymakers, and water sector experts, who were purposefully invited to participate in this research. The tool used in this investigation was a closed-response questionnaire in a matrix format. The criterion for expertise at this stage was the respondent's professional legitimacy.

**Findings:** The results of implementing the research model indicate that the most important components of the study include legal and regulatory environment factors, economic environment, cultural environment, conflict of interest management, culture building, participation drivers, trust, political strategies, crisis management necessity, constructive institutional interaction, motivation, communication factors, governmental actions, reform and adaptation, facilitative leadership, decision-making stability, financial support, guarantee of sustainable development, control of marginalization, attention to local capacities, appropriate water pricing, promotion of public monitoring, improvement of agricultural water use efficiency, consumption pattern improvement, and legal support.

**Conclusion:** Therefore, issues such as economy and budgeting, healthcare, welfare and social security, education, energy, environmental damage, foreign policy, and national internal security, as well as threats to occupational and job security, or matters like insufficient access to healthcare services should be examined by the government, the private sector, and the commitment of individuals and companies, or a combination of both.

**Keywords:** *Policy-making, Model, Interpretive Approach, Water Crisis.*

## 1 Introduction

One of the most significant challenges facing the world today is related to the water crisis. This challenge will intensify with the continued increase in the global population and environmental changes. According to the World Health Organization, one in every three people worldwide lacks access to safe drinking water, equating to one-third of the global population. Additionally, due to disparities in access to water, sanitation, and hygiene (WASH), more than half of the world's population lacks access to safe sanitation services. Approximately 2.2 billion people globally do not have access to safely managed drinking water services, 4.2 billion lack access to safely managed sanitation services, and 3 billion are without basic handwashing facilities. The World Health Organization reports: "Children and their families in poor and rural communities are at greater risk of being left behind: To close these economic and geographical gaps and ensure these fundamental human rights, governments must invest in their communities" (Salem et al., 2022). Every year, nearly 300,000 children under five years old die from diarrhea due to inadequate washing. Poor hygiene and contaminated water are also associated with the transmission of diseases such as cholera, dysentery, hepatitis A, typhoid, etc. According to Naylor, "Addressing inequalities in access, quality, and availability of water, sanitation, and hygiene must be at the center of government budgets and planning strategies. Failing to invest in universal coverage undermines decades of progress at the cost of future generations. Water competition will intensify more than ever, as the total global population is expected to reach 8.6 billion by 2030 and 9.8 billion by 2050. This means that an additional 2.4 billion people are expected to be added to the global population between 2015 and 2050, with Africa being the main contributor. On the other hand, global water demand is expected to increase by 55% between 2000 and 2050. Many farmers in developing countries suffer from the adverse effects of lacking access to fresh water (both now and in the future), while conflicts over water resources arise worldwide, especially in the presence of various scenarios related to climate impacts. Although there are clear signs of an impending water crisis worldwide, as confirmed by current events including droughts, prolonged pollution of water sources, and the effects of climate change, policymakers and strategists have yet to confront these implications" (Icyimpaye et al., 2022; Ross & Baldwin, 2022).

Undoubtedly, water is the most vital need of human societies, and access to fresh water that is cost-free, low-risk, sustainable, and long-term creates a ground for competition, conflict, and collaboration among states, influencing their foreign policy behavior towards each other. This situation is of great importance in the Middle East region, where over 50% of the population lives in shared water basins, leading to potential conflicts and insecurity due to population growth and high water consumption (Nasri et al., 2022).

Currently, these challenges have advanced to the extent that over time, changing beliefs have led to deeper structural problems, and the complexity of the issue (based on the dimensions related to the phenomenon and path dependence) has made solving these problems more complicated. The importance of this issue has reached a point where, in the competition between theories, neither prescriptive views nor those based on the assumption of complete rationality and cooperative behavior can address the problems of groundwater resources (Farzaneh et al., 2017).

On the other hand, unsustainable extraction from groundwater resources has widely caused increasing economic, social, and ecological consequences in the country. Specifically, since the enactment of the "Law on the Preservation and Protection of the Country's Groundwater Resources" in 1966, numerous policies and laws have been enacted and implemented regarding the protection of groundwater resources. Nevertheless, we witness a more severe decline in groundwater levels and an increase in prohibited plains each year. Therefore, the question arises as to where the problem lies and why, despite nearly 50 years of efforts in "policy-making, legislation, and implementation," the country's groundwater resources have not only been unprotected but have also been further degraded (Farzaneh et al., 2017).

Thus, another significant issue in choosing this thesis is the compilation of a coherent literature on the necessities and requirements of policy-making related to the water crisis in the country. According to the National Climate Center and Drought Crisis Management, rainfall in Kermanshah during 2020 was 50% below normal, and in 2022, it was also 48% below normal, with rainfall in Ilam reported to be 61% below normal. Therefore, when long-term rainfall in an area is more than 50% less than normal over one and two years, and the drought period becomes prolonged, the country faces extremely severe and unprecedented conditions. The National Climate Center and Drought Crisis Management reported on the decrease in rainfall in the country: In areas such as Tehran, where rainfall was recorded as more than



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20% below normal in 2020, this figure increased to about 38% below normal in 2022. However, this situation is not unique to Tehran; severe drought is also prevalent in Qazvin, Semnan, South Alborz, Razavi Khorasan, North Khorasan, and generally in the northeast of the country. It is also mentioned that other parts of the country are not in a much better situation, as rainfall in Sistan and Baluchestan and Kerman is about 50% below the normal threshold, Fars is 30% below the normal threshold, and the average rainfall in Bushehr province has significantly decreased, with no area in the country experiencing rainfall above normal levels. Therefore, the aim of the present research was practical in terms of its objectives and descriptive-survey in terms of its data collection method, utilizing an Interpretive Structural Modeling (ISM) approach.

## 2 Methods and Materials

The aim of the present research was practical in terms of its objectives and descriptive-survey in terms of its data collection method, using an Interpretive Structural Modeling (ISM) approach. The population relevant to this section was determined based on the research topic, individuals' ability to respond, and their potential and actual role in water crisis management in the country, including all managers and water sector experts. The participants of this study were 15 managers, policymakers, and water sector experts, who were purposefully invited to participate in this research. Purposeful sampling was used in this study, such that a closed-response questionnaire in a matrix format was provided to experts in the relevant field. The criterion for expertise at this stage was the respondent's professional legitimacy. In fact, the method of data collection in this section will also be based on completing questionnaires that were provided with closed-ended questions to facilitate and expedite the response process. After identifying the main indicators of water crisis management in the country, an n×n square matrix of the existing indicators was designed. This matrix is essentially the ISM questionnaire.

## 3 Findings and Results

In the evaluation, 5 factors were eliminated by the experts, and 25 factors progressed to the next stage. In this section, the levels and the impact and influence of the factors were assessed using the Interpretive Structural Modeling (ISM) technique, and then, the mentioned criteria were examined in terms of dependency and driving power using the MICMAC technique.

**Table 1**

*Factors and Their Codes*

| Code | Factor |
|---|---|
| C1 | Legal and regulatory environment |
| C2 | Economic environment |
| C3 | Cultural environment |
| C4 | Conflict of interest management |
| C5 | Culture building |
| C6 | Participation drivers |
| C7 | Trust |
| C8 | Political strategies |
| C9 | Necessity of crisis management |
| C10 | Constructive institutional interaction |
| C11 | Motivation |
| C12 | Communication factors |
| C13 | Governmental actions |
| C14 | Reform and adaptation |



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| | |
|---|---|
| C15 | Facilitative leadership |
| C16 | Decision-making stability |
| C17 | Financial support |
| C18 | Guarantee of sustainable development |
| C19 | Control of marginalization |
| C20 | Attention to local capacities |
| C21 | Appropriate water pricing |
| C22 | Promotion of public monitoring |
| C23 | Improvement of agricultural water use efficiency |
| C24 | Improvement of consumption patterns |
| C25 | Legal support |

The next phase was conducted in three steps. In the first step, the self-interactive structural matrix of the research was formed using the respondents' opinions. In the second step, the initial reachability matrix was formed by converting the self-interactive structural matrix into zeros and ones. In the third step, the initial reachability matrix was made consistent by adding secondary relationships that may not have existed to the initial matrix.

**Table 2**

*Self-Interaction Matrix*

| | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11 | C12 | C13 | C14 | C15 | C16 | C17 | C18 | C19 | C20 | C21 | C22 | C23 | C24 | C25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **C1** | | A | X | V | A | A | A | V | X | V | V | V | V | V | A | X | V | V | X | A | X | A | A | X | V |
| **C2** | | | V | A | O | V | A | V | O | X | A | O | A | X | O | A | V | V | V | X | A | A | A | A | A |
| **C3** | | | | A | A | A | A | X | A | O | A | A | V | V | O | A | A | O | A | A | A | A | A | A | A |
| **C4** | | | | | A | A | O | V | X | V | V | O | V | V | O | X | O | O | A | X | V | X | A | A | A |
| **C5** | | | | | | V | A | V | A | O | A | O | V | V | V | V | V | O | A | A | V | V | A | X | A |
| **C6** | | | | | | | A | V | A | V | V | V | V | V | V | V | V | V | A | X | X | A | A | A | A |
| **C7** | | | | | | | | X | A | V | A | X | V | V | V | V | V | X | X | A | V | X | A | X | A |
| **C8** | | | | | | | | | A | A | A | A | X | A | V | X | X | O | X | X | A | A | A | A | A |
| **C9** | | | | | | | | | | V | O | X | O | X | V | V | V | V | V | O | A | X | A | X | A |
| **C10** | | | | | | | | | | | X | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| **C11** | | | | | | | | | | | | A | V | V | V | X | A | V | X | X | X | A | A | O | A |
| **C12** | | | | | | | | | | | | | V | V | A | A | V | V | A | A | A | O | A | A | A |
| **C13** | | | | | | | | | | | | | | X | O | A | A | O | A | A | A | A | A | A | A |
| **C14** | | | | | | | | | | | | | | | O | A | X | O | A | A | A | A | A | A | A |
| **C15** | | | | | | | | | | | | | | | | X | A | V | A | A | O | O | A | A | A |
| **C16** | | | | | | | | | | | | | | | | | X | X | A | A | X | A | A | A | A |
| **C17** | | | | | | | | | | | | | | | | | | X | A | X | A | A | A | X | A |
| **C18** | | | | | | | | | | | | | | | | | | | O | A | O | A | A | A | O |
| **C19** | | | | | | | | | | | | | | | | | | | | A | X | A | A | A | A |
| **C20** | | | | | | | | | | | | | | | | | | | | | A | A | A | A | A |



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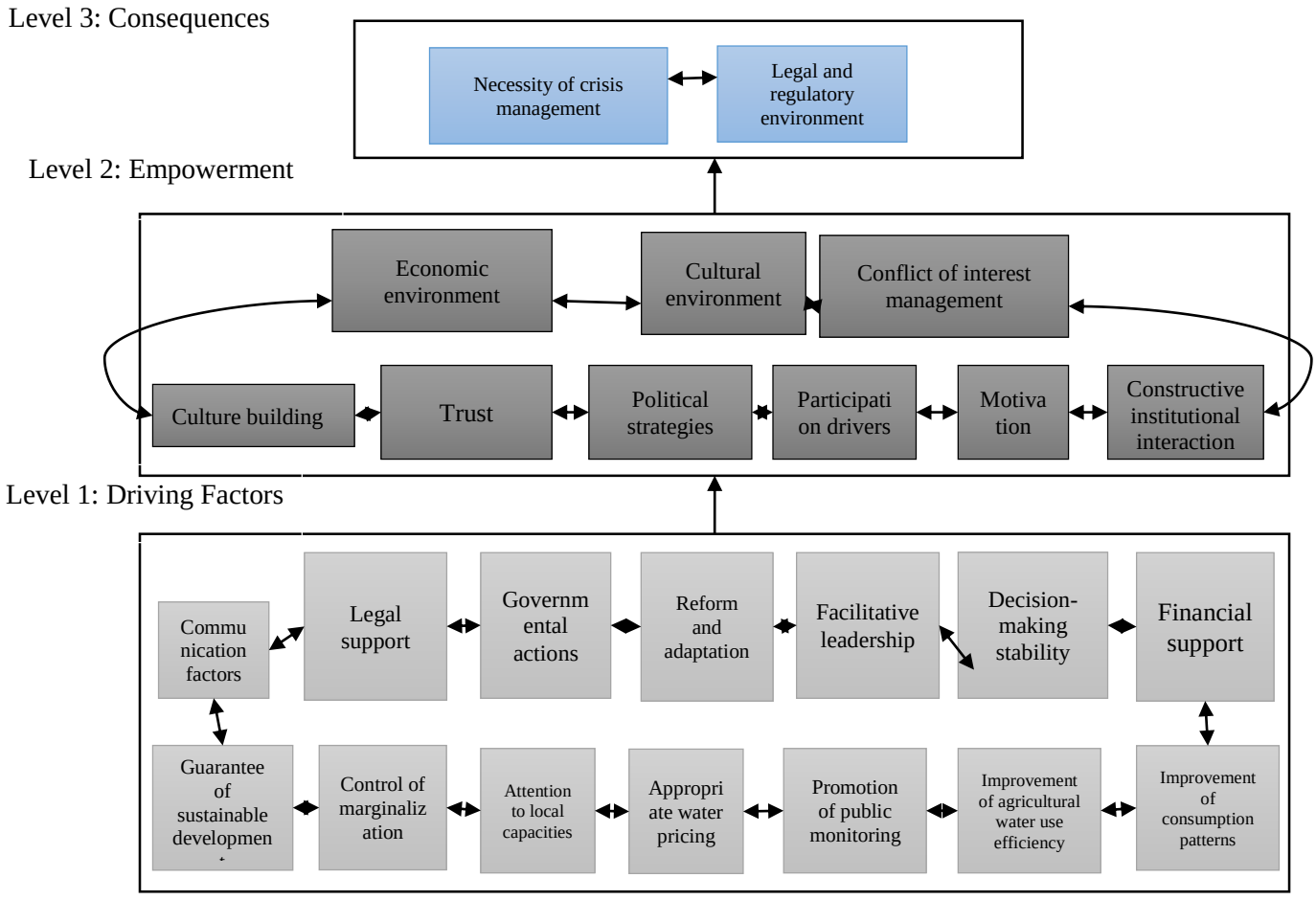
| | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C21 | | | | | | | | | | | | | | | | | | | | | A | A | A | A |
| C22 | | | | | | | | | | | | | | | | | | | | | | A | X | A |
| C23 | | | | | | | | | | | | | | | | | | | | | | | V | X |
| C24 | | | | | | | | | | | | | | | | | | | | | | | | X |
| C25 | | | | | | | | | | | | | | | | | | | | | | | | |

In the fourth step, based on the consistent reachability matrix, the levels of each variable were determined by calculating the sum of input and output variables and their intersection. In each iteration, if the output variable matched the intersection variable, that iteration belonged to level i. Then, in the next iteration, the row and column of that variable are removed from the matrix, and calculations are performed again. To determine the variables of the second level, the rows and levels of the criteria that achieved level 1 are removed from the consistent matrix, and the process of level determination is repeated for level 2.

**Figure 1**

*Final Model of The Study*




To determine the variables of the third level, the rows and levels of the criteria that achieved level 2 are removed from the consistent matrix, and the process of level determination is repeated for level 3. In the fifth step, using the levels obtained from the criteria, the ISM interaction network is drawn. If there is a relationship between two variables i and j, it is shown with a directed arrow. The final diagram created, with the removal of duplicate states and using the segmentation of the obtained levels, is shown in Figure 1.



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The research model can also be illustrated in terms of influence and dependency as shown in Figure 1. Based on this, only the "driving factors" criteria are of the independent type. This variable has low dependency and high driving (influence) power, meaning high impact and low susceptibility are characteristics of these variables. The rest of the criteria are of the linking type. These variables have high dependency and high driving power, meaning their influence and susceptibility are very high, and any minor change on these variables causes fundamental changes in the system.

## 4 Discussion and Conclusion

The aim of the present research was practical in terms of its objectives and descriptive-survey in terms of its data collection method, utilizing an Interpretive Structural Modeling (ISM) approach. The results of implementing the research model indicate that the most important components of the study include legal and regulatory environment factors, economic environment, cultural environment, conflict of interest management, culture building, participation drivers, trust, political strategies, crisis management necessity, constructive institutional interaction, motivation, communication factors, governmental actions, reform and adaptation, facilitative leadership, decision-making stability, financial support, guarantee of sustainable development, control of marginalization, attention to local capacities, appropriate water pricing, promotion of public monitoring, improvement of agricultural water use efficiency, consumption pattern improvement, and legal support.

Unsustainable extraction from groundwater resources has broadly caused increasing economic, social, and ecological consequences in the country. Particularly since the enactment of the "Law on the Preservation and Protection of the Country's Groundwater Resources" in 1966, numerous policies and laws have been enacted and implemented regarding the protection of groundwater resources. Nevertheless, we witness a more severe decline in groundwater levels and an increase in prohibited plains each year. Therefore, the question arises as to where the problem lies and why, despite nearly 50 years of efforts in "policy-making, legislation, and implementation," the country's groundwater resources have not only been unprotected but have also been further degraded.

Furthermore, general issues and problems revert to conditions that are unacceptable to the general public and necessitate some governmental and state interventions. Issues such as economy and budgeting, healthcare, welfare and social security, education, energy, environmental damage, foreign policy, and national internal security, as well as threats to occupational and job security, or matters like insufficient access to healthcare services, should be examined by the government, the private sector, and the commitment of individuals and companies, or a combination of both. In any situation, this choice depends on how the general public defines an issue and the conventional societal attitude towards the role of the government and state in relation to private actions. Therefore, based on the aforementioned results, the following recommendations are offered:

The results of this study underscore the critical importance of crisis management and resilience in addressing water crises, reflecting insights from both domestic and international research. Afzali and Yari Sheghefti (2012) highlight the political dimensions of crisis management, emphasizing the need for maintaining authority and legitimacy during crises, which is particularly relevant in the context of managing water crises where governance and public trust play crucial roles (Afzali & Yari Sheghefti, 2012). Similarly, Basouli and Jabari (2021) discuss the relationship between crisis management and community resilience in tourism destinations during the COVID-19 pandemic, suggesting that crisis management capabilities can enhance resilience in various contexts, including water scarcity (Basouli & Jabbari, 2021).

Pudineh, Miri, and Anvari (2022) focus on the role of crisis management organizations in enhancing urban resilience, a principle that can be extended to the management of water resources (Pudineh et al., 2022). The importance of coordinated response and integrated management strategies is echoed in the work of Zakeri Mahabadi, Yazdani Zazerani, and Mohammadi Kangarani (2022), who examine the causes of water crisis policies in the Zayandeh-Rud basin (Zaker mahabadi et al., 2022). This underscores the need for an integrated approach to water management that considers the socio-political and environmental complexities of water crises.

Rabiei and Shaqasemi (2006) and Roshandel Arbataani (2008) both stress the critical role of communications in crisis management, highlighting the need for effective communication strategies in managing water crises. This is vital for both informing the public and for coordinating among different stakeholders involved in water management (Rabiee & Shaghasemi, 2007). The works of Riyahi Pour,


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Kalantari, and Piri (2020), Farzaneh, Bagheri, and Ramezani Ghavamabadi (2017), and Ghandi and Rouzbahani (2019) further emphasize the significance of planning, policy-making, and the utilization of decision-support systems in the context of water management, suggesting that proactive and informed decision-making is crucial for addressing water scarcity and ensuring sustainable water use {Farzaneh, 2017 #11525;Ghandi, 2019 #11524;Riyahipur, 2020 #11526}.

Mohammadjani and Yazdanian (2014), Mousavi, Sayed Naghavi, Khashei, and Mohammadi (2020), Mughli, Khadem Daqiq, and Hosseini Amini (2016), and Nasri Fakhrodow et al. (2021) all contribute to the discourse on the complexities of water crisis management in Iran, highlighting the challenges of policy-making, institutional frameworks, and the need for integrated resource management to address water scarcity effectively.Bernauer

Comparatively, international research such as by Bothner et al. (2022), Icyimpaye et al. (2022), Ross and Baldwin (2022), Salem, Pudza, and Yihdego (2022), and Schiff (2022) provides a broader perspective on water management strategies, public policy responsiveness, and the importance of adopting a human rights-based approach to water management {Bernauer, 2022 #11514;Icyimpaye, 2022 #11517;Ross, 2022 #11516;Salem, 2022 #11515;Schiff, 2022 #11513}. These studies underscore the global nature of water crises and the necessity for innovative policy solutions, stakeholder engagement, and sustainable management practices to ensure water security.

In conclusion, the findings from this research align with the broader literature on crisis management and water resources management, underscoring the importance of integrated management approaches, effective communication, stakeholder engagement, and resilient infrastructures in addressing the complexities of water crises. The convergence of insights from both domestic and international research highlights the need for innovative, sustainable, and inclusive strategies to tackle water scarcity and ensure the long-term sustainability of water resources.

Establish an inter-sectoral committee to discuss all water-related topics.

Identify and assess institutional, technical, financial, and human resource limitations that have complicated the integrated management of water resources.

Propose scenarios for restructuring the organizational sector of water resource management based on integrated management in the country.

Present proposals to the government and in training workshops with all relevant sectors.

Prepare an action plan for integrated water resource management.

Provide an inventory of water resources and create a GIS-based water field.

Policy should measure all benefits and make decisions on water consumption and systems in the river basin.

Policy should offer all benefits and be under government sovereignty to protect community interests.

Policy should strengthen decision-making, have control power, and formal approval.

Policy should represent executive levels that monitor functional duties and responsibilities.

This study, while contributing valuable insights into the management of water crises, is subject to several limitations that warrant acknowledgment. Firstly, the scope of the study is confined by its geographical focus and the specificity of its case studies, which may limit the generalizability of its findings to other regions with different socio-political and environmental contexts. Additionally, the reliance on expert opinions and interpretive structural modeling, though methodologically sound, introduces a degree of subjectivity and potential bias in identifying and prioritizing the factors influencing water crisis management. The dynamic and complex nature of water crises, influenced by unpredictable climatic events and changing human activities, poses further challenges to the study's ability to capture the full spectrum of variables at play. Lastly, the rapidly evolving landscape of water management technologies and policies means that the study's findings may require updating to remain relevant in the face of new developments and emerging challenges in the field of water crisis management.

## Authors' Contributions

All authors have contributed significantly to the research process and the development of the manuscript.

## Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

## Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.



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**Declaration of Interest**

The authors report no conflict of interest.

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**Ethical Considerations**

In this research, ethical standards including obtaining informed consent, ensuring privacy and confidentiality were observed.

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