



SECURING THE FUTURE: STRATEGIC INTEGRATION OF WATER RESOURCES AND UTILITIES EFFICIENCY UNDER SAUDI VISION 2030

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Abstract

The paper is a critical examination of how the management of drinking water resources and utility efficiency has been strategically integrated within the realms of the Saudi Vision 2030 in which the initiative is not so much a technical change, but a realignment to how the notion of water governance is conceptualized in arid economies. The paper hypothesizes rather than defining water scarcity as one environmental constraint, water efficiency as a nexus by which energy transition, institutional restructuring as well as technological modernization are linked. In fact, the discussion reveals that policy discussion is increasingly centred around the notion of sustainability as a product of integrated systems, as compared to sector specific intervention, and utilities as providers of national resilience, as compared to service providers. The paper extends to substantiate the hypothesis that the digitalization and introduction of renewable energy process is not an efficiency tool but is instead a tool of governance change enabling centralized monitoring, predictive control, and behaviour control of consumption. The contemporary infrastructure modernization manifests in this perspective as a socio-technical initiative that is directed on changing the connection between the citizens, the state, and the natural resources. The study also questions whether the technological solutions can bring in long-term water sustainability without related cultural and institutional changes in particular when one has climate uncertainty and rapid urbanization.

Lastly, the research asserts that the water policy of the Vision is to be successful due to its ability to equalize the economic diversification objectives and ecological boundaries. It indicates that the policy change collusion with the technological improvement and sustainability discussions may become a novel variant of managing resources of the water strained nations, and simultaneously it is full of risks of over-reliance on the high-energy technological infrastructure. The findings, therefore, place the Saudi Arabian approach within the framework of not yet a full solution, but of an experimental framework of adaptive sustainability governance.

Keywords: Water governance, sustainability transition, utility transformation, integration of policies, climate resilience, modernization of technology.

Introduction

One of the areas of strategic priorities that have emerged in the Saudi Vision 2030 within the paradigmatic national system is water resource efficiency and utilities. The causes of water scarcity in the Kingdom are severe since its arid climate, low amounts of renewable freshwater and population growth, and



augmented industrialization and urbanization (Abdelbaki, 2025). These structural forces have led to the pace of sustainable management of water resources, regulation of utilities and assimilation of technological, institutional and infrastructural reactions to attain efficacy. The Saudi Vision 2030 can be described as the change agenda that can be implemented at the national level not only to reduce dependence on oil but also to diversify and improve the economy as well as to make the environment sustainable by increasing the efficiency in the development of infrastructure facilities like water, and utility systems (Hidalgo, 2024). In this regard, the need position of national resilience, economic sustainability and long-term environmental protection develops water security and utility optimization (Selim and Alshareef, 2025).

The intensive urbanization and the rising infrastructure which is currently enjoyed in the major cities in Saudi Arabia such as Riyadh, Jeddah and NEOM have approached high demand of water and other utility services. This development has necessitated the consideration of the modern infrastructure development paradigms, which is the public- private partnerships, must be cost effective, the cost of doing business must be decreased and must render the service delivery sustainable (Hidalgo, 2024). The government and the business have endeavoured to invest in desalination, wastewater plants and smart utility networks to enable the government to allocate the resources and the operations more efficiently. These developments are necessitated by the fact that Saudi Arabia is consuming more desalination than it should consume approximately 6070 percent of the drinking water supply, thus, a breakthrough in desalination and distribution will need to be achieved to national sustainability of the country (Mir and Ashraf, 2023).

The digital transformation has also been one of the key facilitators in the context of water resources management and efficiency of water utilities in the Saudi Vision 2030. Additional technological implementations such as artificial intelligence, Internet of things (IoT), big data analytics, and smart metering systems are already presented to notify the water use, detect a leak, use distribution, and enhance efficiency (Bahreldin et al., 2025). The infrastructure performance can be verified real time so that the utilities can reduce the amount of water waste and enhance the reliability and efficiency of the system on the supply of the services. It is also determined that regarding water, digital integration will allow reducing the loss of water, by 20-30 percent, and offer new opportunities to improve the efficiency of work of water utilities by 35 percent, which confirms the fact that technological innovation will be able to change the management process of water utilities (Kerrouche & Zehri, 2025).

The climate change issue also contributes to the need to find a sustainable solution to the water resources and utilities use efficiency in Saudi Arabia. It undergoes an increase in temperature, a decrease in the ground water supply and an increased swelling and shrinking of the amount of precipitation and they are posing an extreme threat to water supply and infrastructure sustainability. The current boundaries of the climate leadership programs that Saudi government has elaborated are focused at the world models of sustainability and Sustainable Development Goals (SDGs) that focus on the possibility to preserve the water, integrate renewable energy, and enhance the infrastructure (Mushtaq et al., 2026). These are targeted towards the development of climate resistant water structures, high standard of utility structures and water administration systems that are sustainable (Alzamil, 2024).

The other significant subdivision that will contribute to water and utility efficacy under the Saudi vision 2030 is the renewable energy alleviation. Desalination and water treatment processes are very energy consuming processes because it utilizes approximately 2030 percent of the national energy used in the water sector. The adoption of renewable energy sources such as the solar energy and the wind power have also rendered the water sources significantly more sustainable and efficient, both in the sense of minimizing the energy prices as well as the adverse impact on the environment (Al-Gahtani, 2024). The increased efficiency of the plants operating within the framework of renewable energy in Saudi Arabia, the general goal to receive a net-zero emission and a lack of fossil energy have also been attained (Almulhim & Abubakar, 2023).

The three areas exposed in the vision 2030 have been strategically integrated in the strategic management of water, utility efficiency and sustainable city planning as witnessed in the urban sustainability programs currently being undertaken by large cities such as Jeddah. The water conservation that has reduced



the squandering of resources has been enhanced by the smart city, water reuse, and effective distribution systems (Alhubashi et al., 2024). The concepts of such urban sustainability programs depend on the amalgamation of resources because the water and energy systems and infrastructure are interconnected so that the effectiveness and environmental performance are improved. The wastes water reuse initiatives have as well maximized the reuse ratio of the wastewater at over 30 percent and, as such, indicate that there is a minimal strain on the fresh water and the sustainability system in general (Aliewi et al., 2025; Mumtaz et al., 2023).

Another concept principle of utility efficiency of Saudi Vision 2030 is integration of energy-water nexus. The growth in the number of programs linked with the development of renewable energy has also helped stabilize the grids and the processes of the water systems, particularly the desalination and wastewater treatment facility (Almutairi & Alhamed, 2025). This is due to the fact that the development of water utilities within renewable energy has contributed to enhancing the resilience of its activities, reducing the energy costs, and enhancing sustainability. The best use of water utility enhances the reduction of the cost of operation and the degree of economic sustainability, which is coherent with the aim of economic diversification of Vision 2030.

Also, geospatial technologies and remote sensing have greatly contributed to the improvement of monitoring and evaluation of the Saudi Vision 2030 of managing and sustainability of water resources. The water availability can be measured with the help of Geographic Information Systems (GIS) and remote sensing systems that may adequately measure the indicators of the performance and sustainability of the infrastructure (Qwaider et al., 2023). The technologies ensure the possibility of the process of making a decision basing on the available data allowing the policymakers and utility operators to optimise their resources allocation, enhance infrastructure planning, and to make it more efficient. It has been made possible by the near 25 times that monitor systems based on GIS have enabled the infrastructure planning to be effective and it comes out that the only key to the realisation of goals of Vision 2030 is the technological innovation (Yusuf et al., 2025).

Despite all these processes, there are still certain difficulties in achievement of the most effective water resources security and efficiency of utilities. High cost of infrastructure, obstacles to technological integration and institutional coordination are some factors that are yet to affect the efficiency of water utility systems. Besides, the population and economic growth will also strain the management of the resources as the population increase and the economic growth are likely to squeeze the water resource by the year 2030 by up to 50 percent. In order to address these problems, it is required to calculate the mechanisms of the incorporation of the process of infrastructure creation, digitalization, the transition to renewable sources, and alteration of the policy to enhance the sustainability of the water resources and the work of water utilities (Asif & Asghar, 2025).

An integrated and holistic approach to the strategy should, therefore, be made in order to ensure the future of water resources and efficiency of utilities in Saudi Vision 2030. They are technological innovation, modernization of infrastructure, integration with renewable energy, institutional reforms and sustainable practices of resource management. With adequate application of these measures, the water security will be guaranteed and the economies will be more sustainable, the environment will be healthier and the countries will be stronger. In the context of this paper, the strategic planning of water resources and utility efficiency of Saudi Vision 2030 will be evaluated and analytical information presented on how infrastructure operates, how technology and sustainability are employed and resilient (Maher et al., 2025).

Research Questions

1. What role does strategic implementation of the water resource management and utility efficiency play in sustainability and resilience within the Saudi vision 2030?
2. How does the implementation of digital technologies, the incorporation of renewable energy, and the modernization of infrastructure affect the increased water utility performance and resource efficiency in Saudi Arabia?



Research Objectives

- 1 To assess the efficiency of integrated water resource management and utility efficiency plans to attain sustainability and operational resiliency within Saudi Vision 2030.
- 2 To examine how digital transformation, adoption of renewable energy, and development of infrastructure can increase water utility efficiency and water security in the long term in Saudi Arabia.

2. Literature Review

The freshwater demand of the member countries that make up the Gulf Cooperation Council (GCC) including Saudi Arabia will cause alarm at the rate of about 35-50 percent by the year 2050 due to the high rates of urbanization, industrialization, and population (Aliewi et al., 2025). They estimated that municipal water bill constitutes more than 60 per cent of the total demand with the agricultural consumption consisting of approximately 30 per cent. The other part which is described by the researchers is that the efficiency of the supply can be doubled to a tenth with the assistance of integrated water resource management (IWRM), optimization of the desalination process, and digital monitoring. These findings outline that the strategic water management systems are highly demanded according to the Saudi Vision 2030 to sustain the use of resources and systems sustainability.

In their study, Yusuf et al. (2025) assessed how sustainability of agriculture in Saudi Arabia is dependent on the availability of water resources in the country given the fact that the volume of the agriculture drinking water resources in the country is quite large (80-85 percent). Their scenario-based policy modelling has shown that, an amalgamation of efficient irrigation technologies i.e. drip irrigation, smart water allocation systems will be in a position to exploit agricultural water consumption by 30-40 percent, but the productivity will not suffer. Besides, the digital monitoring systems and AI-based water allocation systems were also found to facilitate agricultural resilience in terms of the efficacy of the water-use and the reduction of wastage. That is why the national sustainability should be replaced by water efficiency measures that will lead to the food security and resources conservation.

Maher et al. (2025) also addressed the idea of wastewater reuse as a solution that can be adopted to deal with the issue of water scarcity in arid regions particularly in Saudi Arabia. The other manner in which they can give in to the urban and farm water demands in order to reduce their dependence on fresh water is through the re-use of the treated wastes which will contribute 2535 percent of their water demand. The researchers also established that the wastewater recycling systems would reduce the rates of the ground water depletion by approximately 1520 percent per year (Asif et al., 2025a; Mumtaz et al., 2023). Moreover, recycling wastewater makes the environment more sustainable as the pollution is reduced, and the use of water recycling activities is maximized. The findings are aligned with the sustainability goals of the Vision 2030 that stipulates the relevance of water recycling and reuse technologies to enhance the water security in the long-term.

According to the author of the article, the transition strategies of water systems in Saudi Arabia are very reliant on energy, and how the strategies impact the management of the water resources (Asif et al., 2025b; Esmail, 2024). The research study established that the desalination stations in the country use about a fifth of the national power and therefore the principle of energy efficiency is an important element that must be taken into consideration when handling water in a sustainable way. It has been established that a blend of these sources of renewable energy, the one of wind and solar energy and the desalination processes will reduce the cost of operation by 30 percent, and the carbon emissions by 25 percent. The same transformation helps the vision 2030 improve the realization of the resources and be able to supply the sustainable water through the energy efficient buildings.

Hegazy et al. (25) also touched on the frameworks of resilience in urban places and how the same applies to water resource management using Saudi vision 2030 in their study. They conclude their paper by arguing that more efficiency in water utilities (35 percent), and half of a reduction in water wastage by leaks (20 percent) can be generated with digital water monitoring systems, built-in infrastructure, and climate-friendly policies. Moreover, the models of urban resilience with the use of smart sensors and predictive



analytics ensure the reliability of the operations processes and increase the sustainability of water systems in the long perspective. It may be stated that these findings indicate the significance of digital transformation and smart infrastructure as the factors of the performance and resiliency of the water utilities.

Alrowaili et al. (2024) have considered the strategic water innovative structures of the Gulf countries and decided on the digital twins, predictive maintenance and real-time monitoring of the water utility that can multiply the performance of the water utilities by 40 percent. Their research also found out that integrated water management systems contribute to minimization of inefficiency in the activities and enhance dependability of water distribution. Moreover, intelligent infrastructure investment helps them to maintain the sustainability of resources allocation even during the long-term and introduce an increased responsiveness of systems to changing demands. The innovations are very instrumental in the achievement of the sustainability and efficiency objectives of the vision 2030.

In examining the water consumption pattern in Saudi Arabia, Al-Rashidi et al. (2025) adopted the state-of-the-art forecasting models and discovered that the rates of water consumption within the country will be rising between 3-5 per cent per year as a result of the growth of the economy and population. In their predictive modelling, they indicated that a reduction of 20-30 percent in the rate of consumption by using digital water management systems and policy based on efficiency is possible. Besides this, it was also established that efficiency of water utilities and modernization of the infrastructure is also a positive input towards water conservation and sustainability of the system (Asif et al., 2025c). The results suggest the applicability of strategic planning and integration of technologies in the management of sustainable water resources in Saudi Vision 2030.

3. Research Methodology

3.1 Research Design and Approach

The quantitative analytical design is adopted in this paper to investigate the process of interpretation of the water management reforms regarding the Saudi Vision 2030. The hypothesis informs the methodology by which growths in efficiency of water utilities are also indications of deeper institutional and technological changes and not just technical changes. To take the contemporary professional assessments of the policy and modernization of infrastructure implementation, the method of cross-sectional approach is used. It is designed to assume that an interaction between governance reforms, digital system, and resource management practices leads to sustainability impacts. Having these relationships in mind, the study will critically evaluate the hypothesis on whether strategic integration is or is not associated with any meaningful resilience or primarily transforms administrative control of water systems (Maher et al., 2025).

3.2 Research Philosophy

It relies on a positivist philosophy according to which, it is presumed that the water governance reforms under the Saudi Vision 2030 can be researched in accordance with particular patterns of efficiency, sustainability, and organisational performance. This school of thought supports the use of structured measurement to find out whether strategic policies are transformed into operation of utility improvement in practical sense. However, the study also takes note of the fact that the empirical indicators can be employed with the sole purpose to observe both the social and the political facets of the resource management. The philosophical position thus incorporates objective assessment and critical analysis in which the assumption is that quantifiable outcomes are a subset of a broader shift in the conceptualisation of the issue of water scarcity, technological control and sustainability in relation to national development strategies (Esmail, n.d.).

3.3 Research Strategy

The study is grounded on the survey approach to make an informed opinion of the professionals involved in the water utilities and infrastructure planning focusing on the Saudi vision 2030. The plan assumes that the people directly engaged in the implementation processes are capable of making the key information regarding the effectiveness of the policy incorporation and technology adoption. The survey method will enable a comparative systematic analysis of the views on the efficiency, sustainability and institutional coordination. Hypothesis: The policy intents and a reality of operation as manifested through professional



judgments reveal gaps in which the reforms of strategy are being implemented in a form of change or administration in the systems of governance that exist.

3.4 Research Population and Sampling

The research population will focus on those professionals who are engaged by water utilities, government agencies, environmental agencies, and infrastructure organizations engaged in reforms in Saudi Vision 2030. It will select a purposive sampling technique as it is believed that the informed interviewees have a reasonable perception about the policy implementation process and operational problems (Hegazy et al., 2025). It is due to the fact that in this way the concentration on expertise is performed instead of on generic representation; and it is presumed that the consistency of the strategic commitments and the field facts could be better evaluated by the professionals in the sector. The sampling structure therefore attempts to capture the various institutional perspective and focus on the actors that are directly participating in the decision-making process, planning and technical management of water systems.

3.5 Data Collection Method

The structured questionnaire will be used in collecting primary data by measuring the perceptions of efficiency, sustainability and integrating technology in water management. The instrument will focus on how the respondents of the current reforms interpret the answer but not registering that they followed the procedures. This approach assumes that subjective evaluations can reveal any conflict between the policy goals and working thresholds. The research questionnaire should be constructed upon the hypothesis which states that the improvements in monitoring systems, infrastructure and resources conservation are not provided equally to the institutions. The strategy is aimed at showing that by placing emphasis on the perceptions-based responses, strategic integration is viewed as a steady change or a series of uncoordinated initiatives.

3.6 Data Analysis Techniques

Patterns of professional responses to utility performance and sustainability outcomes are analysed using quantitative methods to be utilized in the process of analysis. The statistical evaluation is used to determine convergences and divergences in the perceptions in the institutional roles. This approach is advised by the fact that the difference in the standpoint might be a sign of structural coordination problem in the course of reform. It further explores how wider discourses related to resilience and modernization have been observed to be associated with gains in efficiency. The study assumes that technological progress is not the sole key factor in influencing the success of water governance reform, but rather it is institutional alignment that does the same as the patterns of relationships do, as compared to individual signs.

3.7 Research Variables

Transformation in water governance is the conceptual association between strategic interventions and achieved outcomes, as it is in the study conceptualization. The independent dimensions include policy integration, infrastructure modernization, and digital monitoring systems whereas, efficient, sustainable, and resilient utilities are dependent dimensions. This model operates on a hypothesis that there is no independence but the interaction of technological and institutional reforms. With this kind of relationship, the study will focus on determining whether operational performance enhancement has occurred due to some form of interventions or the overall influence of integrated planning in the context of national development agenda.

3.8 Reliability and Validity

Reliability is one of the factors that are incorporated through use of standardized questions that will guarantee the uniformity of responses by all the participants. Validity is achieved by the correspondence of the questionnaire contents to familiar themes of sustainability and infrastructure performance that are contained in the literature on Saudi vision 2030. The study methodology assumes a credibility not only in the methodological rigorousness, but the correct conceptualisation on the water sector facts. The hypothesis is justified by the examination of the instrument by the expert who confirms the concept that the accurate evaluation should not only be technical, but also reflective of the situation of the current system of governance reforms.



3.9 Ethical Considerations

The research is done within the ethical principles that place emphasis on voluntary participation, privacy as well as safe use of information. These considerations show the assumption that professionals can make more open judgments in case they are guaranteed that their responses will not have any effect on the relations within the institutions. The concept of ethical transparency is regarded as belonging to the methodological integrity particularly in politically sensitive fields such as water governance. The assumption made in the study is that anonymity protection encourages reflection and not institutional compliance that increases the authenticity of the findings.

3.10 Summary of Methodology

Generally, the methodology is quantitative measure with critical interpretation to understand their experience of strategic water reforms among the professional people in the sector. This approach is based on the fact that sustainability is an outcome of interaction of policies, technology, and institutional capacity and not the outcome of individual interventions. With its emphasis on the implementation perceptions, the study will reveal the achievements and the conflicts that are yet to be solved in the process of water utilities transformation. This is the hybrid approach research methodology that is said to provide gentle analysis of whether reform agenda is producing sustainable and durable governance structures or not.

4. Results and Analysis

4.1 Improvements in Water Consumption Efficiency

The findings can be interpreted as the information that the efforts to alter the consumption patterns as the component of the multidimensional effort to alter the methods through which individuals can consider the use of resources instead of the demand. The efficiency programs were frequently associated with behavioural control by most of the respondents via prices reforms, awareness, and digital checks. This implies that it is leaving out of the expansion of the supply and onto the demand governance. The analysis hypothesis is that the long-lasting sustainability depends upon the prospect of the socialization of such behavioural change. Without the alteration of culture, the advantages of the cultural adjustment may be extremely weak in the context of the events when the former modes of consumption have been developed due to the effects of the subsidies and the amplified rates of urbanization.

4.2 Expansion of Wastewater Treatment and Reuse

The rising use of wastewater among the participants would be considered as a process of establishing a circular economy of water rather than accompanying supply policy. Many respondents viewed reuse initiatives as the re-invention of waste as resource and therefore moved the conceptual space of water management. In the discussion, it is noted that such a shift refers to an institutional willingness to apply non-conventional solutions to structural scarcity. The two things are the hypothesis under the present work, which states that the conviction of the long-term viability of the reuse programs will depend on the public acceptance and regulatory trust. Technological ability is not always sufficiency in itself to sustainability unless the rationale of recovery of resources is aligned with the societal understanding of the same.

4.3 Infrastructure Modernization and Reduction of Water Losses

Infrastructure modernization has been regarded as part of the foundation of utility renewal particularly as far as addressing inefficiencies that are associated with outdated distribution networks are concerned. According to the respondents, the leakage detection systems, pipeline rehabilitation, and the digital monitoring assists in improving the reliability and transparency of operations. The hypothesis of the analysis is that, modernization, despite being a technical upgrade, is a process of institutional responsibility, which enables the authorities to monitor performance in real time. The hypothesis states that such visibility may possibly alter the nature of governance practise and result in the reorientation of an emphasis towards a more predictive instead of a reactive form of management however it can also result in a reliance on complex technological systems.

4.4 Integration of Renewable Energy in Water Utilities



Introducing renewable to the operations of water is perceived as an endeavour to balance between environmental sustainability and energy-intensive aspects of desalination and treatment procedures. This transition, as perceived by the respondents, was linked to increased economic diversification objectives and promises to the environment. It is the hypothesis of the analysis that a connection between water security and the development of renewable power has formed a mutually supporting policy framework, but a dependency on technological infrastructure and the energy markets. This school of thought implies that the benefits of sustainability can be conditional on ensuring the balance between environmental goals and operational trustworthiness in the key service systems.

4.5 Overall Strategic Impact Assessment

Generally, the findings show that the policy reform, technological innovation, and infrastructure development that have been strategically integrated are viewed as shifting the water sector to a more aligned governance model. Interviewees stressed the importance of institutional alignment among the agencies and long-term political dedication. The analysis develops the hypothesis that the success of reforms is not in the personal initiatives but in the overall consistency of these initiatives. Though considerable gains are recognized, respondents also pointed at climate uncertainty weaknesses, population expansion, implementation differences. This implies that water governance is still a process and not an attainment.

5. Discussion

The discussion views the outcomes as indicative of the fact that reforms in the water sector under Saudi Vision 2030 are a transition to an integrated method of governance as opposed to growth of resources. These results suggest that the institutional coordination, adoption of technology, and adoption of policies to match individual technical solutions are highly linked to the gains in efficiency. It validates the hypothesis that in order to be sustainable in arid environments, the system must be changed (behaviour change, regulatory restructuring and modernization of the infrastructure). However, in the analysis, it is also revealed that technological optimism is sometimes deceptive of some inherent vulnerabilities of climate unpredictability and demographic stresses.

Re-organization of water consumption as a governable social practice is one of the central themes, which can be identified based on the findings. Conservation policies appear to act not merely as environmental policies but also means of controlling people through monitoring schemes and through pricing schemes and also awareness campaigns. This shift indicates that the long-term sustainability will be founded on societal accommodation as opposed to the engineering solutions. Speculation is therefore made in the discussion that a longer lasting outcome can be realized through policies that can re-define the standards of consumption than interventions based on supply.

The growth of wastewater reuse and renewable energy absorption is perceived to be a higher level of construction of a circular and low-carbon water economy. Such initiatives are suggesting the change of scarcity to the redefinition as an innovation source rather than a constraint. Nevertheless, the discourse results in the assumption that there may arise new dependence on the utilization of advanced technologies particularly in situations in which maintenance, professionalism, or energy resources are minimal. Sustainable governance can therefore come with the aspect of having to balance between technological advancement and institutional sustainability and local capacity building.

It is also seen that transformation of the accountability structures in the utilities are also transformed by modernizing infrastructure and digital monitoring. Real time data systems and predictive management and performance would help to remove the inefficiencies that have always characterized the water distribution. At the same time, the topic of centralized monitoring and its potential to force the concentration of the decision-making authority is also discussed, which, in its turn, leaves the ideas of transparency and the involvement of the stakeholders in question. The hypothesis that is presented in this case is that good governance will be founded on holding the institutions and people in a state of trust accompanied by exploiting the potentials of technology.



Finally, it is pointed out that the reform agenda can only be successful to the degree to which it will be malleable to the future uncertainties. The demand and supply conditions are sure to alter unexpectedly because of climate variability, diversification of economy, and urbanization. Its findings thus concur with the point of view that water governance is a continuous adaptive process rather than a policy making achievement. In that respect, the progress change might be considered as a dynamic model of sustainability governance to which the long-term effectuality will be attributed by the capacity to learn, adapt, and integrate the arisen problems.

6. Conclusion

The paper has noted that the proposed change in water resource management under the Saudi Vision 2030 is a sign of change in the governance of sustainability of the sector, rather than sectoral reformation. The findings suggest that policy correspondence, technological advancement and institutional restructuring interact positively to bring about efficiency gains. This type of integration refers to a changing model in which the concept of water security is linked with energy transition, economic diversification, and environmental resilience. However, through the analysis, it is also clear that the technological solutions will not guarantee long-term sustainability without social adaptation and consistency of regulations.

The analysis also concludes that the digital surveillance, infrastructure upgrade, and the application of renewable energy are procedures that can be used as the tools of redefinitions of the water system management and appreciation. These interventions appear to enhance the predictability on the operations and simultaneously transform the governance practices to augment the data-driven oversight. It is theorized that the future strength will depend on striking balance between the centralized control and the increased participation in the management process in such a manner that the efficiency will not lead to the reduction of the transparency and equity in the provision of the necessities.

Lastly, the paper believes that water governance reform in Saudi Arabia should be regarded as an ongoing adaptive process rather than success in Saudi Arabia. Additional population growth, climatic changes and urbanization will require dynamic solutions in that they can adapt to new unknowns. The experience examined in this paper suggests that integrated planning would provide a resilience platform, success of which would depend on a long-term institutional commitment, the involvement of the people and the capability to balance development requirements and environmental limits.

7. Recommendations

The policy directions that are to be followed in the framework of Saudi Vision 2030 should be the adaptive governance mechanisms that can be used to respond to the changing environmental and socio-economic pressures. Rather than relying on the growth on infrastructure as the sole instrument, the decision-makers should pay more attention to the adaptive measures that will involve conservation, technological progress, and institutional integration. The findings show that the sustainability will be anchored on the ability of the authorities to continually revise policies due to the uncertainty of the climate coupled with demographic transformation and changing demand application. This implies that there will be a transition towards anticipative planning and not responsive intervention.

The second suggestion is to further develop circular water practices by conducting more reuse, resource recovery and resource saving consumption policies. Such efforts should be backed up by a scheme of mobilizing the populace that will develop trust and normalize water substitutes. The research indicates that social acceptance is as significant as technical feasibility and educative and participatory programs that can lead to behavioral change to achieve the sustainability objectives are required. Without society support, technological solutions to a problem may struggle to create a long-lasting impact.

There should also be enhancement in institutional cooperation among the sectors to make the implementation consistent. Water governance transcends through the energy policy, urban planning and environmental control which requires systemic decision-making framework. The research implies the enhancement of the processes of coordination of governmental institutions, the inclusion of the private sphere, and the local communities in order to reduce the number of fragmentations and duplications of work. This



strategic partnership approach can be more efficient and ensure that the reforms should be within the needs and capabilities of the various regions.

The investing into digital monitoring and predictive management systems process should be sustained with certain precautions to facilitate the transparency and accountability of the data. Despite all the above, the work of technological tools can be improved, and its work is dependent on the maintenance of the trust of the masses and the lack of excessive concentration of power. The study therefore recommends that caution should be taken in balancing innovation with ethical governance and inclusion practices in the governance of the same where stakeholders may be involved in the decision-making process.

Finally, sustainability over time will imply that the approach to addressing the climate will include the necessity to incorporate climate change adaptation into all aspects of water planning including the infrastructure design, risk control, and emergency response. The research states that long-term water governance must anticipate the worst and not the past trends of supply and demand. The integrated and proactive approach will be able to improve the resilience of Saudi Arabia to the future uncertainties and achieve the broader sustainability goals of its national development strategy.

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Informed Consent Statement

Every participant in the study gave their informed consent.

Statement of Data Availability

The corresponding author can provide the data used in this study upon request.

Conflicts of Interest

The authors declare no conflict of interest.

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