



Critical Success Factors for Urban Water Projects in Nigeria: A Comprehensive Analysis and Review

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ABSTRACT

Water projects are essential for meeting the demand for safe and accessible water resources, but they often face challenges leading to delays and unsatisfactory outcomes. To address these issues, project stakeholders must understand critical success factors (CSFs) that influence successful implementation. This research presents a comprehensive analysis of CSFs for urban water projects in Nigeria, aiming to identify key impacts, relationships and other elements for planning, execution, evaluation and their impact on project outcomes. The methodology is fully centered on systematic literature review. Nine CSFs were identified: adequate funding, stakeholder engagement, effective project planning, technical expertise, a robust regulatory framework, community participation, efficient operation and maintenance, climate resilience integration, and monitoring and evaluation. These factors are interconnected and crucial for project success, emphasizing the need for a holistic approach. The findings offer valuable insights for practitioners and policymakers, guiding decision-making and improving project outcomes. Stakeholders can enhance project performance, optimize resource allocation, and maximize social, technical, economic, and environmental benefits. The research contributes to existing knowledge, serving as a foundation for further research and practical application in promoting sustainable water management practices and supporting successful water project implementation worldwide, especially in developing countries like Nigeria. These insights can aid effective water projects and address water supply project challenges.

Keywords: Water Projects, Success Factors, Implementation, Stakeholders, Sustainability.

1.0 INTRODUCTION

1.1 Background to the Study

Infrastructural projects encompass various technical structures such as water supply projects, dams, roads, bridges, electrical grids, and more, which are vital for societal living conditions and economic development (Asaju, 2023). Such projects contribute to social well-being by providing essential services and improving the quality of life. Infrastructural projects differ in terms of objectives. Social infrastructure, including schools and hospitals, enhances access to education, healthcare, and support systems. Adequate water and sanitation infrastructure promotes public health and environmental sustainability. Reliable public utilities like electricity, gas, and water services contribute to a higher standard of living. Investment in infrastructure development by governments, organizations, and communities supports economic growth, job creation, and improved living (Okosun et al., 2023).

In recent years, there has been a significant increase in the implementation of infrastructural projects worldwide, particularly public water projects, driven by rapid urbanization. Access to safe and clean water is fundamental for societal development, but a substantial portion of Nigeria's population still lacks access to pure water sources, leading to health issues and hindering socioeconomic progress. To address this, numerous water supply initiatives have been implemented nationwide, aiming to improve access to

clean water for Nigerian communities. These initiatives address challenges related to water scarcity, inadequate infrastructure, and poor water quality while contributing to crucial aspects of development, such as public health, poverty reduction, and economic growth (Adeoti et al., 2023a).

Access to safe water, sanitation, and proper management of freshwater ecosystems are crucial for human health, environmental sustainability, and economic prosperity. While a large portion of the global population has access to improved drinking water sources and sanitation facilities, those without access are mainly in rural areas. Achieving universal access to water and basic sanitation requires successful water infrastructure projects, with active involvement from local communities (Isukuru et al., 2024). The United Nations reports emphasizes the importance of addressing the global water issue and the need to enhance clean water provision, good practices, better sanitation, and hygiene behavior modifications are essential. Sustainable water infrastructural projects must prioritize sustainability measures throughout development, construction, and operation. Water supply projects consist of four components: collection, treatment, transmission, and distribution, enabling efficient urban water systems in cities, towns, and semi-urban area (Okesanya et al., 2024). Several studies have explored the impacts of water provision on various settlements and affirmed



water's utmost importance to life on Earth. Despite progress, a water crisis persists in urban centers, cities, metropolitan centers, and rural regions in Sub-Saharan Africa, Latin America, and Asia (Leal Filho et al., 2022).

As such, it is evident that Nigeria, like most developing countries in the world, encounters various challenges in implementing urban water infrastructure projects due to its large land size, population growth, rapid urbanization, limited funds, and high project costs. Even within the country, different settlements with diverse requirements and environmental conditions influence project design and planning (Adeniran et al., 2021). Despite some progress, Nigeria still struggles to meet its water security commitments, leaving a significant portion of the population without access to clean water, highlighting the urgency of addressing water infrastructure issues (Zhang et al., 2024). Hence, the identification and understanding of factors that contribute to the success or failure of projects, as well as those deemed critical success factors (CSFs), play a pivotal role in project management and delivery. Recognizing and comprehending these factors is crucial for effective project planning, execution, and achievement of desired outcomes. By identifying the key elements that influence project outcomes, project managers can make informed decisions, allocate resources appropriately, and mitigate potential risks and challenges. Critical Success Factors (CSFs) play a vital role in the successful implementation of urban water projects in Nigeria. These factors are essential for effectively addressing water supply and sanitation challenges, benefiting the communities they serve and contributing to overall development and well-being. By identifying and prioritizing critical factors, water projects can ensure that their resources, efforts, and strategies are focused on the most impactful areas, resulting in improved project outcomes. These CSFs can play a pivotal role in achieving sustainable water infrastructure projects in developing countries like in Nigeria (Lamprou and Vagiona, 2022).

1.2 The Research Problem

Although, several water projects were initiated in Nigeria, they mostly suffered from project delays, abandonment and overruns which were directly due to some critical factors hindering their progress. In addition, there is a lack of in-depth research on identifying and analyzing CSFs specific to urban water projects, which limits our understanding of project delivery successes and failures and how to improve project management practices. Furthermore, there is a dearth of project data that would facilitate understanding the impacts of CSFs in sustainable water infrastructure development projects in African countries like Nigeria. These adds to the several gaps in the existing literature in such area. These gaps

pertain to the specific contextual factors that influence the effectiveness of CSFs in the unique socio-economic, political, and environmental conditions of Nigeria. Understanding these nuances is crucial for tailoring strategies and interventions to ensure more effective implementation of water supply projects. The identified research problems and gaps in this study will highlight the need for further examination of urban water supply projects from a project management perspective, considering the obstacles that may impede the application of best practices. This thoroughly examine the CSFs for urban water supply projects, shed light on their critical impact, and consider their role in achieving the sustainable development goals (SDGs).

1.3 Research Objective

The main objective of this research paper is to thoroughly investigate the Critical Success Factors (CSFs) in urban water supply projects in Nigeria. The research aims to offer valuable insights into the pivotal factors that significantly impact the success or failure of these initiatives. By delving deeper into the factors that contribute to project success, we can gain a better understanding of the complex interactions between various components and their overall impact on the project's outcomes.

2.0 RESEARCH SCOPE AND METHODOLOGY

The study uses a desk study methodology to thoroughly examine Critical Success Factors (CSFs) for urban water projects in Nigeria as a developing country. Desk study / desk research or secondary research, is a research method that draws primary data sources from existing literature, reports, and documents. It is an efficient and cost-effective approach that allows researchers to quickly access a wide range of information. Desk research is especially useful for conducting literature reviews, exploring historical data, and investigating past research findings. To ensure the validity of their findings, researchers must critically evaluate the quality and credibility of the sources they use. Overall, desk research is an important and widely used research method that provides valuable insights and knowledge on a specific research topic (Dithebe et al., 2019).

As such, to identify and analyze CSFs for urban water projects, the researchers collect and review relevant academic papers, government publications, project reports, and other relevant sources. The desk study methodology enables researchers to conduct a thorough and comprehensive analysis of the topic without collecting new data via surveys or interviews. Instead, they rely on the wealth of data available in published studies and reports. A literature review is conducted to identify and collect relevant studies and reports on CSFs for urban water projects in



developing countries. The chosen sources are then analyzed, and key CSF-related findings are extracted and synthesized. The researchers cover a wide range of literature and capture the experiences and insights from various projects and stakeholders by using the desk study methodology. It also enables them to identify common patterns, trends, and best practices for urban water projects in developing countries. Moreover, the desk study methodology is a useful approach for understanding and evaluating the critical success factors that contribute to the effectiveness and sustainability of urban water projects in developing countries. Hence, the research scope is limited to urban water projects in Nigeria (li et al., 2020).

2.1 Critical Success Factors (CSFs) for Urban Water projects in Nigeria

Success factors for infrastructural projects are not one-size-fits-all and can be influenced by a variety of factors, including the nature of the project, its scale, the location, and the unique challenges it presents. Nevertheless, certain key success factors consistently play a crucial role in determining the project's outcome and impact. These are critical than other factors. The term "success factors" was created in 1961 by D. Ronald Daniel of McKinsey & Company; it was modified into key success factors in 1981 by John F. Rockart; and since then, numerous researchers and writers have released lists of critical success factors (Produção et al., 2022). Project Critical success factors (CSFs) are key restricted number of areas in which satisfying outcomes would assure successful performance of the project; CSFs are crucial success variables with major influences on project successes; they are components of a project that are crucial to the project's goals, objectives and deliverables; CSFs must be implemented in order for the project to be completed successfully. They establish an atmosphere that allows the project initiative to exist and closing phase. The few crucial variables or aspects that a project manager or the project team should focus in order to fulfil present and future goals of a project (de Miguel et al., 2020).

Project success and failure is sometimes attributed to the concerned project players because they can heavily influence the performance of the businesses, projects, operations or industries especially whose support is needed if it is to be successful. These people or organizations, in turn, have certain expectations from the company, and assessing the degree to which these expectations are currently being satisfied in a balanced fashion provides a valuable indicator of current and future performance. Stakeholders will almost always include the "big three": Clients, Contractors and Consultants. Whereas, in construction industry, they are referred to as the big four: Client, Contractor, Consultant, End-user/customer (Naseer et al., 2022). Project

organizations, be it consulting, contracting and clients, undertake projects with the sole aim to complete and utilize the project. However, only few projects do. The success and abysmal failure of projects are attributed to some factors which are deemed success factors, determinant factors, barriers/hindrances factors. Altogether, these are deemed project critical success factors. The key determinant of success is the relationships between the project team and other people involved in the project, collectively called the Project's Stakeholders. This web of relationships will enable or obstruct the flow of information between people and, consequently, directly affect the ability of the project team to achieve the project's objectives and the organization's outcomes. Projects do not exist in isolation; the communication ecosystem that supports the project is developed by the organization and extends beyond its boundaries to the wider community (Labedzki, 2022). The essential criterion for project success is effective and efficient management of CSF. Past and recent studies have highlighted the issues of project performance and its related metrics for assessing project success at the conclusion of its lifespan. As such, CSFs are not hazy concept but should be well-defined aspects that may be tracked using Key Performance Indicators (KPIs). KPIs will assist project team in appropriately determining and managing all of the CSFs in any given project. As such, the type of project, the nature of project deliverables, the expectations of project stakeholders are very crucial in identifying and measuring CSF in projects especially public water infrastructural development projects in a developing country like Nigeria. As such, the concept of project success whether as a factor or as a criteria that pertain to assessment measurements aimed at determining project success are still subjective due to input influencers to achieve project-desired outcome. These are more prevalent in public projects especially in water infrastructure projects (Ahmed, 2023).

Water supply projects like most infrastructural projects can be hampered, for example, by contentious events with stakeholders and rising stakeholder engagement demands. This has enhanced the relevance of such wants and expectations, as well as the inclusion of concerned project players in project planning (Langsdale and Cardwell, 2022). The fact that external stakeholders (e.g., the general public) are not subject to the project leadership's authority makes their inclusion a substantial issue for projects. These stakeholders participating in the project mostly have divergent interest and influence on the project, and the value of a project is closely linked to the benefit of these groups. This is vital and central to how the outcome will be; and is the project team's responsibility of identifying and understanding the benefits for these concerned project players. In Nigeria, such project players are affected by their



geographical location, culture, environment and socio-economic needs for such infrastructural projects. Furthermore, water infrastructure projects impact their surrounding and the society because of their size, their financial volume and their long-lasting impact. Therefore, it is vital to understand the components and factors that can lead to success and failure of such projects (Dwivedi, 2021). Water projects like most infrastructure projects were known to have poor cost performances due to their large duration (ranging from a few years to decades) diverse social, economic, technological, quality, and environmental implications; these have given a bad reputation to the construction industry due to inevitable overruns especially regarding cost and time. Construction materials affect the industry in Nigeria, which hinges on the high cost of imported materials used for construction. The major factors for the high costs of projects in Nigeria: shortages and cost of materials, fluctuation in prices of materials, mode of financing and payment for completed works, fraudulent practices and kickbacks, poor contract management, and improper planning (Aiyetan and Das, 2021).

Achieving success in infrastructure projects especially urban water supply projects requires clear project goals and objectives, thorough good project planning, adequate finances, and capable project management. Involving relevant stakeholders, complying with laws and regulations, and considering environmental consequences are vital. Implementing effective risk management, quality assurance, safety measures, and communication with stakeholders contribute to favorable outcomes. Timely execution, adaptability, and post-project maintenance plans are indispensable for meeting project objectives. Evaluating social impact and meeting community requirements further ensure positive results. By giving priority to these aspects, infrastructure projects can be efficiently completed, benefiting society and the environment alike (Gyau Baffour Awuah and Bijimi, 2023). Like most developing countries, adequate funding poses a significant challenge for executing water projects in Nigeria. Insufficient financial resources hinder the construction and maintenance of water infrastructure, leading to delays and incomplete implementation. Limited budget allocations and delays in fund disbursement can impede project progress and result in abandonment (Adeoti et al., 2023b). The lack of skilled professionals and outdated technologies in the water sector further complicates the execution of water projects. Adequate expertise and modern technologies are essential for effective planning and execution to improve the overall performance of water supply systems. Policy and governance issues contribute to the challenges in the water sector. Inadequate regulatory frameworks and fragmented institutional structures hamper effective project

implementation. Clear policies, improved governance structures, and stakeholder engagement are needed to ensure transparency and accountability in water infrastructure management. Sustainable water supply projects especially for urban centers is very challenging due to population of the users, residential and commercial uses, magnitude of the demand and the challenges of sustainable distribution. Several studies asserted that failure in water projects involves instances where endeavors related to water infrastructure or management fall short of their intended objectives or encounter significant obstacles, resulting in less than satisfactory outcomes. Such factors differ from project to projects as well as project location (Singh et al., 2023).

The Nigerian government has initiated various infrastructural development projects (IDPs) across various sectors like urban water projects, road construction, railways, and power generation to address the country's infrastructural deficit. These projects aim to improve the inadequate infrastructure and support the country's economic development. However, the scale of investment required exceeds the government's capacity to fund alone, making Public-Private Partnerships (PPP) crucial for financing and implementing these projects. PPP involves collaboration between the government and private investors, but challenges arise from the lack of cooperation between stakeholders (Olowookere & Olayinka, 2017). Inadequate water service levels and coverage hamper both urban and rural areas, posing health and other sustainable development dangers [15]. Sustainable water supply projects are global phenomenon due to rapid urbanization; Also, Davey[85], argued that the core of urban management in the process of urbanization is the matching of the growing population and urban development, such as infrastructure, water, housing, and employment. Infrastructures projects catalyze uneven patterns of development in very diverse contexts with aggregate benefits. While it affects some members of the community positively, it can also affect others negatively such as displacements and relocation/resettlement of communities. The positive impacts on the overall development have been the focus of developing countries like Nigeria; as its shortage have curtail its economic development. A report by African development bank summarized the profile of Water Infrastructural development in Nigeria as follows:

- i. Nigeria has adequate water resources. The total capacity of the existing dams is about 51 billion m³. The total renewable water resources of the country were equivalent to 1,893 m³ per capita in 2008.
- ii. About 47 percent of the water storage capacity in active use is accounted for by single-purpose



- hydropower dams, with multipurpose dams accounting for a further 41 percent of capacity in use.
- iii. Single purpose irrigation and water supply dams account for the remaining 12 percent of active capacity. Access to improved water is much higher in urban than in rural areas.
 - iv. In urban areas, about 70percent of the population had access to improved water in 2010, compared with only 43 percent in rural areas where there is a high dependence on surface water and a much larger share of wells and springs are unprotected.

As such, CSFs (the key elements or conditions) are necessary for the successful planning, implementation, and completion of such infrastructure project. In the context of water supply projects in Nigeria, several critical success factors can significantly impact their outcomes. Critical success factors (CSFs) are extremely important in water projects because they direct project focus, mitigate risks, optimize resource utilization, foster stakeholder engagement, improve sustainability, facilitate performance measurement, and align projects with broader development objectives. These factors are crucial in determining the success, effectiveness, and longevity of water supply projects. Hence, the CSFs identified and analyzed for this study are: Adequate Funding; Stakeholder engagement and Collaboration; Effective Project Planning and Management; Technical Expertise and Capacity Building; Robust Regulatory Framework; Community Participation and Awareness; Efficient Operation and Maintenance; Integration of Climate Resilience; Monitoring and Evaluation (Sobieraj and Metelski, 2021). Adequate Funding: Adequate funding is the cornerstone of any successful water infrastructure project in Nigeria. It refers to the allocation of sufficient financial resources to cover all aspects of the project, including planning, design, construction, operation, and maintenance costs. Ensuring adequate funding is essential to avoid budget constraints that could delay or compromise the project's success. It requires careful financial planning and mobilization efforts to secure the necessary resources from various sources, including government budgets, loans, grants, and public-private partnerships. Proper funding allows the project to proceed smoothly, meet its objectives, and deliver long-term benefits to the communities it serves. Stakeholder Engagement and Collaboration: Stakeholder engagement and collaboration involve actively involving various stakeholders throughout the project lifecycle. These stakeholders include clients, contractors, consultants, and customers which were divided into government agencies, local communities, water utilities, NGOs, and private sector organizations. Engaging stakeholders fosters a sense of collective ownership, support, and responsibility for the project's success. It ensures that the project

aligns with the needs and priorities of the communities it aims to serve. Collaborating with different stakeholders allows for the pooling of resources, expertise, and perspectives, enhancing the project's overall effectiveness. Inclusive decision-making processes empower communities and enhance transparency and accountability in project governance (George-Williams et al., 2024).

Effective Project Planning and Management: Effective project planning and management are essential for ensuring the efficient and timely execution of water infrastructure projects. This involves developing comprehensive and well-defined project management plans that serve as roadmaps from project inception to completion. Thorough planning includes identifying project objectives, defining deliverables, allocating resources, and establishing clear timelines. Effective project management ensures smooth coordination among project team members and stakeholders. It also involves risk assessments and contingency planning to mitigate potential challenges. Sound project planning and management lead to improved project outcomes, reduced risks, and optimized resource utilization.

Technical Expertise and Capacity Building: Technical expertise is critical for successful water infrastructure projects. This includes having qualified professionals skilled in water infrastructure design, construction, operation, and maintenance. Additionally, continuous capacity building programs are necessary to enhance skills and knowledge in the water sector. Capacity building initiatives provide training and professional development opportunities to keep pace with evolving technologies, innovations, and best practices. Well-trained professionals can address emerging challenges, incorporate cutting-edge solutions, and ensure that the infrastructure is built and managed to high standards (George, 2020).

Robust Regulatory Framework: A robust regulatory framework is vital to ensure that water infrastructure projects adhere to appropriate regulations and standards. The regulatory framework governs planning, implementation, and operation, ensuring compliance with quality, safety, and environmental guidelines. By setting clear regulations and guidelines, authorities can promote responsible decision-making, environmental protection, and community welfare. A well-functioning regulatory framework provides certainty to investors and stakeholders, enhances project transparency, and fosters public trust.

Community Participation and Awareness: Community participation and awareness involve actively involving local communities in the planning, decision-making, and implementation of water infrastructure projects. Engaging communities fosters a sense of ownership and responsibility for the infrastructure, promoting its long-term sustainability. Community members can contribute valuable local knowledge and



insights, ensuring that the project aligns with their needs and aspirations. Raising awareness about the project's benefits and responsibilities encourages responsible water usage and proper infrastructure maintenance. Efficient Operation and Maintenance: Efficient operation and maintenance strategies are essential for the long-term functionality and sustainability of water infrastructure. This involves regular monitoring, preventive maintenance, and timely repairs. Monitoring ensures that the infrastructure performs optimally, and any issues are quickly identified and addressed. Preventive maintenance reduces the risk of breakdowns and minimizes downtime, resulting in cost savings and improved performance. Timely repairs are crucial to restore normal operations and prevent further damage. Effective operation and maintenance strategies ensure that the infrastructure continues to provide reliable services and benefits to the communities it serves (Irfan et al., 2021).

Integration of Climate Resilience: Integrating climate resilience into water infrastructure projects is essential due to the impacts of climate change. This involves incorporating climate change adaptation and mitigation measures into the design and planning of the infrastructure. Analyzing future climate scenarios helps make informed decisions on infrastructure design and capacity, allowing for flexibility and adaptation to changing conditions. Using climate-resistant materials and construction techniques enhances the infrastructure's ability to withstand extreme weather events. Implementing adaptive water management strategies, such as storage and conservation measures, ensures a continuous water supply despite changing climatic conditions (Alabi, 2024). **Monitoring and Evaluation:** Monitoring and evaluation (M&E) are critical components for assessing the effectiveness, efficiency, and impact of water infrastructure projects. M&E involves regularly measuring project performance against set objectives and indicators. This process provides valuable insights into the project's progress, outcomes, and potential challenges. By comparing actual results with initial goals, project managers can make informed adjustments to improve project implementation. M&E promotes accountability, transparency, and continuous learning, leading to better-informed decision-making and improved project outcomes. Each CSF represents a crucial aspect of successful water infrastructure projects in Nigeria. Adequate funding, stakeholder engagement, effective project planning, technical expertise, a robust regulatory framework, community participation, efficient operation and maintenance, climate resilience integration, and monitoring and evaluation are all interconnected components that contribute to sustainable and transformative water infrastructure development in the country. By analytically figuring

these CSFs comprehensively, Nigeria can understand its water supply project challenges and may pave the way for improved access to clean and safe water, benefiting its urban as well as rural population and promoting socio-economic development (Ferdowsi et al., 2024).

2.2 Analysis of CSFs for Urban Water Projects

This part analyses the CSFs based on their impacts, criticality, inter and corelationship between the CSFs, relationship with project phases, and their respective impact on the key stakeholders.

3.0 IMPACT ANALYSES OF THE CSFS ON WATER PROJECTS IN NIGERIA

The success factors for water infrastructure projects in Nigeria have a profound impact on their overall success and criticality. Adequate funding is the cornerstone that enables the implementation of other factors. Without sufficient financial resources, it becomes challenging to engage stakeholders effectively, plan and manage projects comprehensively, build technical expertise, comply with regulations, promote community participation, ensure efficient operation and maintenance, integrate climate resilience, and conduct proper monitoring and evaluation. Adequate funding is essential to avoid delays, cost overruns, and compromised quality, ultimately hindering the project's overall success. Stakeholder engagement and collaboration are vital success factors that directly influence the project's success and sustainability. Engaging various stakeholders, including government agencies, local communities, NGOs, and the private sector, fosters collective ownership and support, ensuring the project aligns with the needs and priorities of the communities it serves. Collaboration among stakeholders brings diverse expertise, resources, and perspectives to the table, enhancing decision-making, minimizing conflicts, and promoting responsible project implementation, ultimately driving project success (Ngene et al., 2021).

Effective project planning and management are critical for the successful execution of water infrastructure projects. Comprehensive project management plans provide a roadmap for efficient project execution, resource allocation, and risk mitigation. Well-defined plans help avoid delays, cost overruns, and quality issues. They also ensure that projects are completed on time and within budget, thus maximizing the impact of the investment and meeting the water needs of the population. Technical expertise and capacity building play a crucial role in ensuring the quality and longevity of water infrastructure. Availability of qualified professionals with expertise in water infrastructure design, construction, operation, and maintenance is essential for delivering high-quality projects that meet safety and environmental



standards. Continuous capacity building programs are equally important, as they enable professionals to stay updated with the latest technologies and best practices, improving the effectiveness and efficiency of project implementation. The CSFs listed above are interconnected and essential for the successful and sustainable development of water infrastructure projects in Nigeria. Adequate funding acts as the catalyst that enables the implementation of other factors. Stakeholder engagement, effective project planning and management, technical expertise, and capacity building are all interdependent elements that contribute to successful water infrastructure projects, benefiting communities and advancing the nation's socio-economic progress. By addressing these issues, Nigeria can develop water infrastructure that is both transformative and resilient, giving its growing population access to clean, safe water (Dong and Qiu, 2024).

3.1 Correlating the CSFs with Water Supply Project Phases

The CSFs can be correlated with different phases of a water supply project from initiation, project planning/design, execution and monitoring, project control, closing phase to the operation and maintenance. The success factors in water infrastructure projects are interconnected and have a significant impact on various stages and stakeholders involved. Adequate funding is crucial at the project initiation phase, as it allows for proper planning and resource allocation. Stakeholder engagement and collaboration are essential during the planning phase, ensuring that diverse perspectives and needs are considered, leading to more effective project outcomes. Effective project planning and management set the foundation for the entire project, guiding decision-making and minimizing risks. Technical expertise and capacity building are relevant throughout the project, empowering professionals to handle different aspects and incorporate innovative solutions. A robust regulatory framework at the planning phase ensures compliance with standards and environmental regulations, promoting responsible and sustainable development. Community participation and awareness during the initiation and planning phases foster a sense of ownership and support, aligning the project with local needs and promoting sustainable use of the infrastructure (Al-juboori et al., 2021).

Efficient operation and maintenance strategies are critical at all stages, as they ensure the infrastructure's long-term functionality and minimize disruptions. Integration of climate resilience during the planning and design phases prepares the project to withstand the impacts of climate change and enhances its long-term sustainability. Monitoring and evaluation are ongoing throughout the project, providing insights

into progress, effectiveness, and impact, driving continuous improvement and accountability. By addressing these interconnected success factors comprehensively, water infrastructure projects in Nigeria can achieve successful outcomes, benefiting communities and promoting sustainable development. Each factor plays a vital role in different project phases, and their collective implementation enhances the overall success and positive impact of water infrastructure development in the country (Rathnayaka et al., 2023).

3.2 Inter and Corelationship between the CSFs

Adequate funding is the cornerstone of successful water infrastructure projects in Nigeria, providing the necessary financial resources to cover all aspects of the project, from planning and design to construction, operation, and maintenance. Without sufficient funding, projects may face delays, compromised quality, and cost overruns, hindering their overall success. Adequate funding allows for effective implementation of other critical success factors, ensuring that the project has the necessary resources to succeed. Stakeholder engagement and collaboration are vital for securing funding and ensuring project success. Involving various stakeholders, such as government agencies, local communities, NGOs, and the private sector, fosters collective ownership, support, and commitment to the project. Collaboration with stakeholders also facilitates the mobilization of financial resources, technical expertise, and innovative solutions, enabling the project to overcome funding challenges and implement best practices (Okolie and Edo, 2023).

Effective project planning and management are key to optimizing the use of available funding and resources. Adequate funding allows for comprehensive project management plans, guiding every step of the project from initiation to completion. Thorough planning considers technical expertise, stakeholder engagement, regulatory compliance, and community participation, ensuring that the project is well-prepared and executed efficiently. The integration of climate resilience is essential for long-term sustainability and success. Adequate funding enables the incorporation of climate change adaptation and mitigation measures into the project design, safeguarding the infrastructure against the impacts of a changing climate. Climate resilience planning depends on technical expertise, stakeholder collaboration, and adherence to regulatory standards, all of which are supported by sufficient funding. Finally, adequate funding plays a central role in water infrastructure projects in Nigeria. It enables effective stakeholder engagement, comprehensive project planning, technical expertise, and the integration of climate resilience measures. By securing sufficient financial resources, Nigeria can overcome funding



challenges and pave the way for successful, sustainable, and transformative water infrastructure development, benefiting communities and advancing the nation's socio-economic progress (Sima, 2022).

3.3 Impact of the CSF of water projects on Project Stakeholders

The critical success factors in water infrastructure projects have a profound impact on various stakeholders, contributing to the overall success and sustainability of these projects in Nigeria. Adequate funding plays a pivotal role, ensuring that the client can secure the necessary financial resources to initiate and maintain the project, meeting the needs of the population. Additionally, stakeholder engagement and collaboration foster a sense of ownership and support among various stakeholders, enabling smoother project implementation and reduced conflicts. For the contractors involved, the critical success factors significantly affect their ability to execute the project effectively. Adequate funding allows them to access necessary resources, meet project timelines, and deliver quality outputs. Collaborating with other stakeholders, such as local communities and end-users, helps contractors understand their needs and expectations, ultimately leading to improved project outcomes. Moreover, technical expertise and capacity building enable contractors to perform their work efficiently, adopt innovative practices, and enhance their competitiveness in the market (Toriola-Coker et al., 2021).

The impact of critical success factors extends to the project team, ensuring their effectiveness and performance throughout the project's lifecycle. Adequate funding supports the team's morale and motivation, while effective project planning and management facilitate streamlined workflows and communication, reducing conflicts and misunderstandings. The presence of skilled professionals, thanks to technical expertise and capacity building initiatives, enables the team to overcome challenges and deliver high-quality work, fostering a culture of continuous learning and improvement. Ultimately, the most critical beneficiaries of water infrastructure projects are the end-users, the communities relying on the services provided. Adequate funding and stakeholder engagement ensure that the infrastructure meets the specific needs of the end-users, enhancing their access to clean and safe water. Efficient operation and maintenance strategies guarantee consistent service delivery, reducing the risk of disruptions and promoting long-term sustainability. Additionally, the integration of climate resilience safeguards end-users from the adverse effects of climate change, ensuring the infrastructure remains reliable and resilient even in challenging conditions. As such, the critical success factors significantly influence the success and impact

of water infrastructure projects in Nigeria. Adequate funding, stakeholder engagement, technical expertise, and effective management all play crucial roles in delivering transformative and sustainable water infrastructure. By considering the needs of various stakeholders and investing in capacity building, Nigeria can achieve significant successes in its water infrastructural projects (Masaud, 2024).

4.0 CONCLUSIONS AND RECOMMENDATIONS

In conclusion, the critical success factors discussed for water infrastructure projects in Nigeria are integral pillars that determine the success, sustainability, and positive impact of these endeavors. For Nigeria to achieve successful and sustainable water infrastructure projects, a holistic approach that embraces these critical success factors is imperative. The critical success factors discussed are integral components that hold the key to the successful and sustainable development of water infrastructure projects in Nigeria. Each factor addresses specific aspects and stages of the project lifecycle, but their interconnectedness creates a holistic approach that fosters positive outcomes and impacts. By comprehensively addressing these success factors and embracing a collaborative and forward-thinking approach, Nigeria can achieve transformative and sustainable water infrastructure development, meeting the growing water demands of its population while safeguarding its environmental and social well-being. Emphasizing the importance of these factors and integrating them into policy frameworks and project implementation will lead to a brighter future, where safe and reliable water resources support the nation's progress and prosperity. As stakeholders work in tandem, Nigeria can pave the way for a more resilient, water-secure, and environmentally conscious future, ensuring the well-being and prosperity of its people for generations to come.

4.1 Implications of CSFs on the Water Supply Project Outcomes

This research contribution focuses on identifying and analysing the CSFs for the purpose of enhancing the success and sustainability of water infrastructure projects in Nigeria through a comprehensive analysis of critical success factors from literature. The study recognizes the importance of water infrastructure in meeting the growing water demands of the urban population, promoting socio-economic development, and the environment. By employing a combination of literature review, the research identifies nine critical success factors that significantly impact project outcomes. These factors include adequate funding, stakeholder engagement, effective project planning and management, technical expertise and capacity building, robust regulatory framework, community participation and awareness, efficient operation and



maintenance, integration of climate resilience, and monitoring and evaluation. The study examines the impact and criticality of these factors, emphasizing their influence on project effectiveness, stakeholder satisfaction, and sustainable operations. Through the analysis of relevant literature, the research illustrates practical implications and real-world applications of the identified success factors. Based on the findings, the study highlighted relationships, correlations, impacts analyses for successful water infrastructure projects in Nigeria, highlighting the integration and alignment of critical success factors throughout the project lifecycle (Amies et al., 2024).

4.2 Implication of the CSFs on Stakeholders in Water Projects in Nigeria

The research contributions based on the critical success factors for water infrastructure projects in Nigeria are multifaceted. Firstly, the development of novel financing models and strategies, such as public-private partnerships and collaborations with international financial institutions, can revolutionize funding approaches and overcome financial barriers. Secondly, exploring advanced stakeholder engagement techniques, incorporating emerging technologies like data analytics and artificial intelligence, can enhance community involvement and decision-making processes. Thirdly, implementing comprehensive project management frameworks that integrate agile methodologies and advanced risk assessment tools can optimize project execution and resource allocation. Additionally, establishing specialized capacity building programs that focus on cutting-edge technical expertise and sustainable water management practices can empower professionals to tackle evolving challenges effectively (Hai et al., 2022).

Moreover, fostering collaborative efforts to strengthen the regulatory framework, ensuring compliance with quality, safety, and environmental standards, can streamline project approval processes and boost investor confidence. Furthermore, innovative community participation approaches like social impact assessments and co-design methods can create inclusive, community-driven projects. Integrating smart technologies into operation and maintenance strategies, along with predictive maintenance and remote monitoring, can ensure efficient infrastructure management and cost-effectiveness. Additionally, researching climate-resilient design practices and evaluating the long-term impact of climate adaptation measures can enhance infrastructure resilience. Lastly, investigating the effectiveness of monitoring and evaluation systems, using data-driven insights for continuous improvement, and developing performance-based incentives can advance project effectiveness and sustainability. Overall, the study serves as a valuable resource for decision-makers,

researchers, and practitioners involved in water infrastructure development in Nigeria, providing guidance for transformative and sustainable projects that improve water access, quality, and socio-economic development nationwide (Akano et al., 2024).

4.3 RECOMMENDATION

In summary, the key recommendations for successful water infrastructure projects in Nigeria include ensuring adequate funding through innovative financing mechanisms like public-private partnerships and collaborations with international financial institutions. Stakeholder engagement and collaboration should be prioritized, involving local communities, government agencies, NGOs, and the private sector in decision-making and project design. Robust project management plans should be developed to ensure efficient execution, resource allocation, and risk management. Investing in technical expertise and continuous capacity building is essential for professionals involved in water infrastructure projects. Strengthening the regulatory framework to enforce quality, safety, and environmental standards is crucial. Empowering community participation and awareness through communication and education fosters ownership and responsible water usage. Efficient operation and maintenance strategies are vital for the longevity and sustainability of the infrastructure. Climate resilience should be integrated into project design to address climate-related risks. Lastly, monitoring and evaluation should be implemented throughout the project lifecycle to assess performance and identify areas for improvement. Nigeria can achieve transformative and sustainable water infrastructure development by following these recommendations, benefiting its communities and advancing socioeconomic progress.

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