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Risk Identification and Assessment in 24x7 Water Supply Scheme for DMA under Smart City project

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Abstract: *The goal of this thesis is to develop a decision support tool for contractors to use before the execution stage of water supply system projects to analyse the likelihood of risks. A total of 51 unique risk variables were discovered and classified into seven groups using a comprehensive literature analysis and expert interviews. The RII approach was used to estimate the relative importance of each risk factor, and the factors and groups were ranked according to their level of importance. The case study findings encouraged a debate about the most influential elements and groups that need to be addressed in terms of risk likelihood. The results were regarded adequate and appropriate for this thesis.*

Keywords: *Relative Importance Index, Risk, Smart city, Factors, District Metered Area.*

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I. INTRODUCTION

In developing countries such as India, intermittent water delivery systems suffer from a variety of flaws, including insufficient and poorly constructed infrastructure, operational and maintenance challenges, and financial limits. Many locations have insufficient quantity and poor quality water at the consumer end, resulting in unacceptable service levels in the water sector even after the country's independence. With an estimated 50% of the population living in cities by 2050, water engineers face a tremendous task in maintaining a safe and uninterrupted water supply. Despite the Government of India's (GoI) criteria, all cities currently provide intermittent water service to their populations. However, under the GoI's initiative, some cities are converting their existing intermittent water supply systems into continuous systems in order to improve service quality.

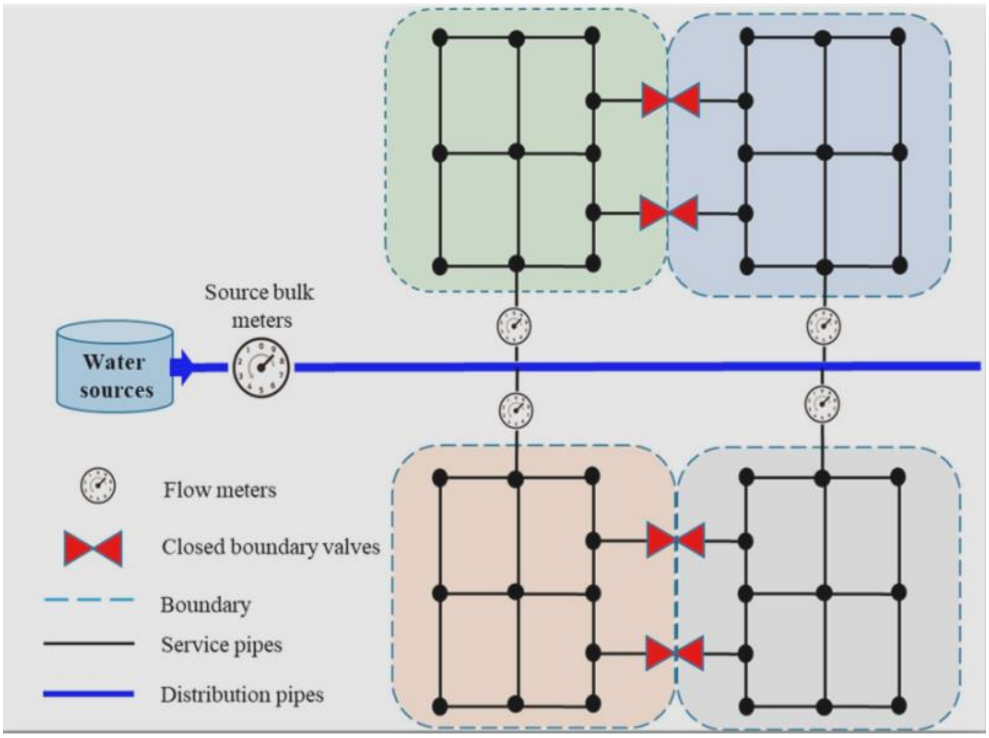

Figure 1: Pictorial view of district metered area (DMA)

1.1.1 Need of the study

There are numerous hazards and obstacles that arise during the execution of water delivery projects in India. Several factors influence these risks during the execution phase of any 24x7 water supply project under the DMA (District Metered Area). It has been found that project execution frequently confronts difficulties and hazards. As a result, it is critical to identify and analyse these risks during the project's execution stage. This proactive strategy will help both the public and commercial sectors avoid risks, assuring timely project delivery to the public. An in-depth investigation into this topic will aid in the proper management of the Construction, Operation & Maintenance, and Transfer stages, as well as risk detection.

1.1.2 Objectives

i. To identify the risk factors associated with projects involving 24x7 water supply schemes.
ii. To determine the relative importance of these hazards and rank variables and groups depending on their level of importance.
iii. To investigate and highlight the most influential elements and groups where dangers may exist, as well as those that require special attention.

II. REVIEW OF LITERATURE

The following literature review presents some theoretical and analytical studies conducted in this topic.

[1]. Minh Thanh Nguyen et al. (2021) conducted a thorough investigation that found 26 major risks that have a significant impact on schedule delays in Water Supply Projects. These hazards were rigorously assessed and ranked based on their level of influence, with actionable advice to mitigate or eliminate their effects provided. The study's findings provided significant insights for investors and contractors, assisting them in completing projects on schedule and maximizing the benefits connected with Water Supply Projects.

[2]. Anca Elena Gurzau et al. (2011) used a case study of the central water supply system in Luna locality, Cluj County, from 2009 to 2010 to provide approaches for identifying and evaluating risks in central water supply systems. The system was evaluated using historical data on water quality monitoring and water sample analysis, with a particular focus on metrics stipulated by Law 458/2002 (audit monitoring). The Environmental Health Centre's laboratory facilities were used for this purpose.

[3]. F. Cubillo and P. Perez (2014) proposed a risk assessment technique that included the calculation of three different types of indicators. These indicators were developed based on the likelihood of threat episodes occurring and the subsequent assessment of their repercussions. The impact on service disruption, the extent of the disruption (usually assessed by the number of affected properties), and the duration of the disturbance were used to calculate the repercussions. The duration of the outage is related to the concept of system resilience or response capability.

[4]. S. J. T. Pollard et al. (2004) investigated several risk management frameworks, as well as risk analysis methods and procedures typically used in the water sector. They investigated the use of such frameworks and tools at various levels of decision-making, such as strategic, programmatic, and operational contexts. Furthermore, the scope of the analysis was broadened beyond public health issues to include financial risk management, reliability and risk-based maintenance, and the application of business risk maturity models in the water sector.

[5]. B. Tchorzewska-Cieslak (2011) provided a complex model of risk management of failures in drinking water technical systems, namely in water pipe networks, that may be used in the decision-making processes of system operators. A fuzzy set theory adaptation to assess the danger of water main failure was not popular water works strategy.

[6]. Bixiong Ye et al. (2015) allocated 13 and 12 utility operational limits, respectively. Water sources, water processes, water disinfection systems, and water utility management were identified as the key risk factors affecting water safety. To address these hazards, many control measures were implemented, including increasing water source protection, closely monitoring water treatment processes, establishing emergency protocols, improving chemical use, and improving operating system management. According to the findings, implementing Water Safety Plans (WSP) was a realistic technique for efficiently managing water resources in rural regions.

[7]. According to Albert P. C. Chan et al. (2015), completion risk, inflation risk, and price change risk have a stronger influence on water Public-Private Partnership (PPP) projects in China. Government corruption, flaws in the legal and regulatory systems, and fluctuations in market demand, on the other hand, have a relatively minor impact on the water supply business. The findings provided project stakeholders with useful insights into how to improve the success of privatization in public utility services. Furthermore, when engaging under the PPP model, they provided private investors with a better grasp of the enormous Chinese water market.

[8]. Andreas Lindhe et al. (2009) used fault tree analysis at an integrated level to conduct a complete probabilistic risk study on a substantial drinking water infrastructure in Sweden. The study had two basic goals: (1) to create a technique for conducting integrated and probabilistic risk analyses of complete drinking water systems, and (2) to assess the effectiveness of Customer Minutes Lost (CML) as a risk metric.

[9]. According to Davood Fereidooni (2015), the predominant seismic sources in the research area were tiny and big faults that were mostly orientated NW-SE. Both the MCE and PGA were computed using the DSHA and PSHA approaches.

[10]. Swarup Varu and Dipsha Shah (2018) conducted research, designed a 24-hour water delivery system, and implemented it in Ahmedabad's Sabarmati and old Wadaj wards in order to provide a complete project report.

[11]. A. Tawalare and Y. Balu (2016) evaluated the efficiency of continual water supply projects in the context of multiple risks. To investigate this issue, the study used a case study research approach. Various dangers linked with water delivery projects were discovered through a review of available literature.

[12]. K. Vairavamoorthy et al. (2007) presented IRA-WDS, a novel software tool. This GIS-based algorithm predicts the risks of dirty water entering water distribution systems from surrounding foul water bodies such as sewers, drains, and ditches.

[13]. In 2013, Abbas Roozbahani created the integrated fuzzy hierarchical risk assessment model for water supply systems (IFHRA-WSS) to study hazards in a complex UWSS using a methodical methodology that takes into account both water quantity and quality issues. To reduce the overall complexity of the system, this model employs a hierarchical framework to split the UWSS infrastructures into interrelated component pieces.

[14]. In 2019, Janusz R. Rak suggested a method to measure the hazards to individuals and property posed by waterworks systems that operate within self-government units (SGUs). Consumers of tap water face four risks: frequency or possibility of exposure (P), financial losses (C), health-related damages (HL), and degree of security (S). In light of this, a four-parametric risk matrix was developed. Risk was assumed to be a function of the factors listed above: R = f (P, C, HL, S). For each parameter, the five-parametric weight scale was used as the default.

[15]. Janusz Karwot (2016) reported on the current stage of investigation as well as implementations in practice of selected outcomes of research projects on water consumption in urban areas that have been ongoing since 2004 in the City of Rybnik, Upper Silesia Region, Poland. This paper describes the topic of water distribution and consumption, as well as the challenges of managing water management's technological infrastructure, from the views of both scientists and practitioners involved in the projects.

[16]. P. Katarzyna and E. Mohamed (2022) explore challenges of failure risk assessment in water distribution systems. Failures in water delivery networks are a critical issue in the water distribution sector. The subject of risk assessment in light of risk acceptance criteria has received attention. In addition, the signs of water network failure were evaluated. The method described here can be used to define the typical characteristics and technical state of a water distribution system. The purpose of this chapter was to call attention to the need for more technical and organizational improvements, as well as further standardization of the failure risk assessment in the water distribution system.

[17]. V. Razmju and A. Rahmani's (2019) study used Water Safety Plans (WSP) to examine and identify weak locations in the Semnan water supply system in 2018. The Water Safety Plan Quality Assurance Tool (WSP QA Tool) software was used to examine the water safety plan's shortcomings and progress. Initially, a team of professionals designed and completed WSP checklists, and data analysis was performed using the WSP QA Tool. Following that, system hazards were discovered and ranked using the WHO matrix, taking into account the team members' expert judgments. Following that, risk assessments were performed. The data show that the system description phase had the highest degree of compliance in implementing the water safety plan, with a score of 100%. The phase with the lowest level of compliance, on the other hand, was the improvement plan, which received a score of 0%.

[18]. K. Westpha (2003) presented an instructive instance of developing a real-time Decision Support System (DSS) for the adaptive management of a reservoir system that serves as a drinking water supply for the Boston metropolitan region. The DSS uses a systems framework to connect models of the watershed, reservoir hydraulics, and reservoir water quality, together with linear and nonlinear optimization techniques. The DSS optimizes daily and weekly reservoir operations using short-term climate projections to meet four key goals: maximizing water quality, maintaining ideal flood control levels, attaining optimal reservoir balance, and maximizing hydropower earnings.

[19]. Akram Beigi Bazgir (2020) established a water safety plan (WSP) in 2019; the study's goal was to evaluate the risk connected to the drinking water supply and distribution systems in Zanjan City,

specifically from the Tahm dam. The World Health Organisation (WHO) and the International Water Association's WSP were both used in this descriptive cross-sectional investigation. Interviews with water industry professionals were held after the checklists had been completed. The specialists then determined the most important threats after analyzing the data with the data tool. The team of the company employed the risk analysis matrix supplied by WHO to rank the dangers. The results showed that the level of implementation of the WSP plan received a score of 325 out of 440.

[20]. L. Rose (2010). The comprehensive and quantitative risk model introduced in this study intends to assess different risk-reduction strategies and support decision-making in order to meet specified water safety objectives. The risk analysis is organised using a fault tree technique in the study, and the risk is expressed in terms of Customer Minutes Lost (CML). In order to increase transparency and promote long-term planning for drinking water systems, the study emphasizes the importance of completing a thorough and methodical review of risk-reduction methods.

III. METHODOLOGY

Participants with construction expertise in water supply projects were questioned using a questionnaire method to assess the risks and their impact on the construction process. The questionnaire was created after reviewing current literature on the risks and hazards connected with water supply system construction projects, with a specific focus on the Nashik Smart City. The Relative Importance Index Method (RII) was used to assess the questionnaires. The purpose of RII is to assess the relative importance of various risk factors. For each factor, a five-point scale ranging from 1 (less influencing or very less severe) to 5 (more influencing or extremely high severe) is used and turned to relative significance indices (RII) as follows:

RII = $\frac{\sum (\boldsymbol{W1} + \boldsymbol{W2} + \boldsymbol{W3} + \ldots\ldots + \boldsymbol{Wn})}{(\boldsymbol{M} * \boldsymbol{n})}$, where W denotes the weight assigned to each factor in the questionnaire, M is the maximum rating on the Questionnaire Scale (5 in this example), and n denotes the total number of replies received (64 in this case).

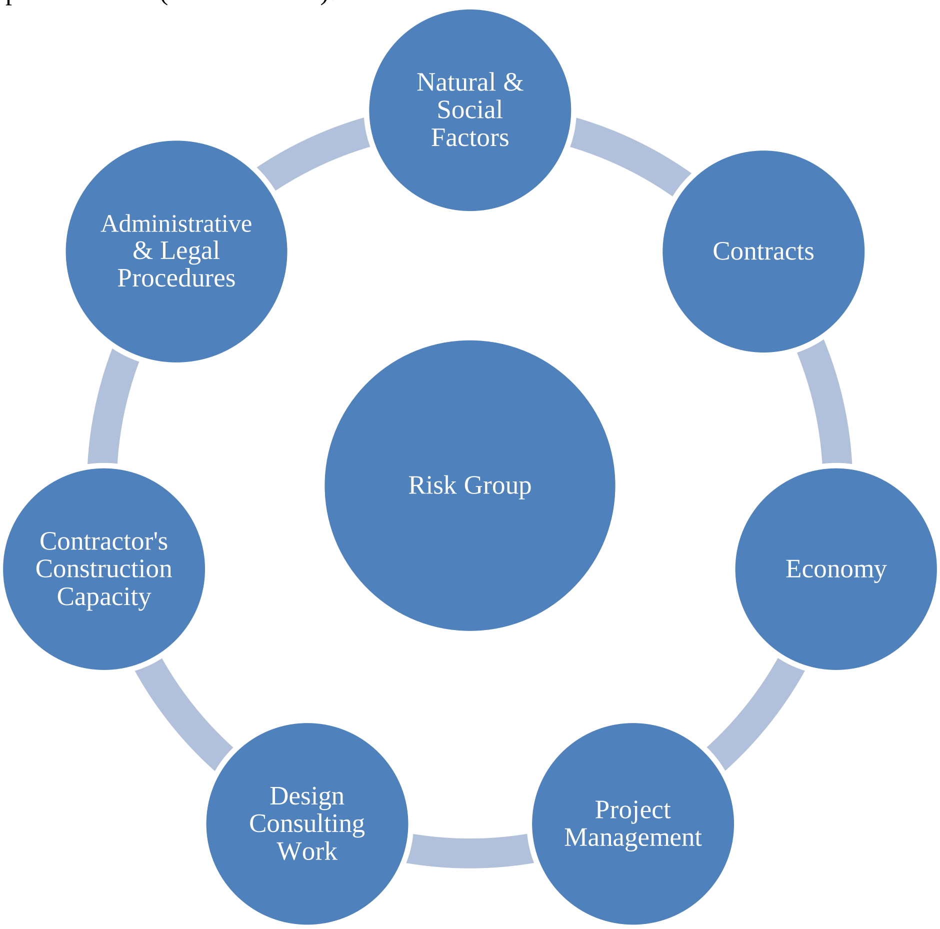

Figure 2: Risk Categorization

The Risk groups are further divided into various risk factors as shown in table below.

Table 1: Base input factors and groups of factors to construct the assessment model

Code	Categories
(A) Risks related to Natural and Social factors	
RNSF1	Volatility in raw material prices
RNSF2	Volatility in the labor market
RNSF3	Fluctuations in capital market
RNSF4	Changes in weather, climate, and natural disasters
RNSF5	Policy changes
RNSF6	Caused by topography and geology
RNSF7	Caused by security
RNSF8	Construction site is unfavorable & overlapping with other work items
RNSF9	Cause of pandemic
(B) Risks due to Contracts	
RC1	Implicit transaction to sign the contract (Collusion)
RC2	Due to uncertain and unclear contract terms
RC3	Due to changes or additions to the terms of the contract
RC4	Terms of responsibility of the two parties are not clear
RC5	Contract price adjustment clause
RC6	Cause of contract dispute
(C) Risks due to Economy	
RE1	Caused by the financial resources of the investor
RE2	Investor is slow to pay the contractor
RE3	Financial capacity of the contractor
RE4	Construction ground clearance compensation is overly complicated
RE5	Due to risks of inflation
RE6	Due to fluctuations in interest rates of bank
RE7	Changes in tax policies
(D) Risks due to Project Management	
RPM1	Construction project supervisor is not good
RPM2	Poor construction safety management
RPM3	Poor coordination of the investor and general contractor
RPM4	Quality control of materials
RPM5	Poor management information system
RPM6	Not enough human resources to manage the project
RPM7	Staff’s management capacity is not good
RPM8	Due to repairs after the commissioning test
RPM9	Poor access to operation management technology
(E) Risks due to Design consulting work	
RDCW1	Capacity of construction supervision consultancy
RDCW2	Capacity of the design consultant
RDCW3	Use of typical design drawings & lack of actual correction
RDCW4	Incorrect use of Technical Standards
RDCW5	Using the job code in the incorrect estimation
RDCW6	Calculation of the quantity of materials of the consultant is incorrect
RDCW7	Due to the field experiment
(F) Risks due to Contractor’s Construction capacity	
RCCC1	Construction crews’ capacity
RCCC2	Investment in purchasing asynchronous and poor-quality equipment
RCCC3	Weak technical capacity of the general contractor
RCCC4	Poor technical skills and human resources
RCCC5	Not enough technical workforce
RCCC6	Poor finished product
(G) Risks due to Administrative and Legal procedures	

RALP1	Construction unit lacks understanding of law
RALP2	Relationship of the investor, the contractor with the competent agency to the project
RALP3	Local construction management regulations
RALP4	Complicated administrative procedures
RALP5	Adjustment of the project's scale of the investor
RALP6	Causes of labor safety
RALP7	Changes in laws, regulations, standards, etc.

IV. CONCLUSION

1. **Risks related to design consulting work:** In terms of potential risks, the group connected to design consultancy work was regarded as the most critical. This was mostly due to issues such as the use of standard design drawings without sufficient modifications, the consultant's improper estimate of material quantities, and the use of incorrect job codes in estimations.
2. **Risks related to the economy:** The economic group was ranked as the second most important group where risks can develop. This was mostly due to variables such as the risks posed by inflation, the contractor's financial capabilities, and changes in tax rules.
3. **Risks related to project management**: The project management group was regarded as the third most critical group where risks can develop. This was linked to causes such as poor construction safety management, insufficient coordination between the investor and general contractor, and shortcomings in the management information system.
4. **Risks associated with the contractor's construction capacity:** In terms of importance, the group relating to the contractor's construction capabilities was ranked fourth. Inadequate technical workforce, substandard completed product quality, and insufficient technical skills and human resources all led to the relevance of this group.
5. **Risks due to administrative and legal procedures:** Administrative and legal procedures were identified as the sixth most important group where risks can occur. This was mostly due to reasons such as cumbersome administrative procedures, the investor's changes to the project's magnitude, and compliance with local construction management standards.
6. **Risks related to natural and social factors:** Natural and social factors were placed sixth in terms of relevance. Raw material price volatility, labour market fluctuations, and capital market shifts were recognised as key contributors to this group.
7. **Risks due to contracts:** Contracts were considered to be the least important group where risks could develop. This was mostly due to contract disputes, uncertainties and ambiguities in contract provisions, and contractual revisions or additions.

The first goal was to identify the risk variables in projects using 24x7 water supply schemes. A total of fifty-one (51) risk indicators were discovered through an exhaustive literature study and expert interviews with a large construction business.

The second goal was to quantify the relative importance of the identified risk variables and rank them. This goal was met through conducting interviews with a panel of specialists. All factors and groups were ordered according to their calculated relative relevance indices, with the most and least important factors and groups determined.

The final goal was met by where each significant risk factor was labelled based on its RII score, which ranged from high to low. The hazards associated with design consulting work were the most influential and must be addressed to minimise future risks.

REFERENCES

[1]. Abiola K., "Strategy for Development of the Petrochemicals Industry in Nigeria", Department of Chemical Engineering, University of Lagos.
[2]. Aderogba, K. A., "Significance of Kaduna River to Kaduna Refining and Petrochemicals Complex", African Journals, Vol. 5, No. 2 pp. 83-98, 2011.
[3]. Ahmad Daaboul, "LAB Project - Environmental Impact Assessment", Section 3, pp. 4-42.
[4]. Irena O. D., Dolganov I. M. and Ivanshkina E. N., "Development of Computer Modeling System as a Tool for Improvement of Linear Alkylbenzene Production", J. Petroleum and Coal. Vol. 53, No.4, pp. 244 - 250, 2011.
[5]. Sadal O.I., Marwa S.M., Wala T.A., "Linear Alkylbenzene Production from Kerosene", Seminar presented to the Department of Chemical engineering University of Khartoum, 2012.
[6]. Thaer, A. A., "Process Simulation Analysis of HF Stripping Column Using HYSYS Process Simulator", J. of Engineering Sciences, Vol. 17, No. 2, pp.87 - 96, 2010.
[7]. Xiaoming J., Gang Rong and Shuqing Wang, "Modelling and Advanced Process Control (APC) for Distillation Columns of Linear Alkylbenzene Plant Key Lab of Industrial Control Technology", Institute of Advanced Process Control, pp. 1-6, 2003.