Optimizing the Financial Risk Management Strategies in Water Supply Projects in Sri Lanka

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ABSTRACT

Infrastructure construction projects are considered highly susceptible to risks and uncertainties due to their complicated designs, sizes, functions and structural complexities. Among the different types of risks, the financial risks and the ability to manage them will have great implications for the cost performance of the relevant infrastructure projects. Therefore, high attention is paid to the financial risk management aspect of public infrastructure projects. In that concern, water supply infrastructure projects share several characteristics in common with other infrastructure construction projects while holding several other characteristics unique to themselves. Although many studies have been conducted on financial risk management in building and infrastructure projects, observed scanty of studies that address the financial risk management aspects of water supply projects in the Sri Lankan context. Therefore, this study is meant to fill significant void in terms of developing a financial risk management framework to address financial risk factors in Sri Lankan water supply projects. In carrying out this study, a mixed methodology was followed under an exploratory sequential design. Accordingly, the risk factors and risk management strategies identified in the reference literature were screened and shortlisted for their applicability in designing water supply projects in Sri Lanka and were validated through findings achieved at interviews with experts capable of highlighting new risk financial factors and strategies unique to the water supply projects in Sri Lanka. Subsequently, the risk factors and strategies identified in this process are mapped to develop a financial risk management framework for implementation of water supply projects in Sri Lanka in the future.

KEYWORDS: *Financial Risks, Risk Management, Strategies, Water Supply Projects*

1 INTRODUCTION

Infrastructure development is essential for economic growth and improvement of access to essential services which also leads to creating new jobs, expanding production capacity, and improving connectivity to the national and international markets (Asian Development Bank & Sugiyarto, 2012). As a developing country, Sri Lankan construction sector is significant for its own developments and for its contribution to the country's economy. Sri Lankan construction industry plays a vital role in the local economy and it contributes 7.6% to the Gross Domestic Product (Madushanka & Tilakasiri, 2020). In any country, the public infrastructure sector plays a significant role within the construction industry. Randeniya et al. (2022) have identified critical infrastructure as a "system of identifiable sectors whose destruction or incapacity would have an enervative impact on the economic sustainability, public health and safety, quality of life, and national security of a country." Among the many different infrastructure project categories defined by Hosny et al. (2022), water supply projects have been recognized as one of the major and vital infrastructure projects for developing countries.

While water supply projects play a significant role in ensuring public health, economic development, and quality of life in a country (Nguyen et al., 2021), Sri Lanka is facing challenges in providing adequate drinking water to citizens due to limitations of financial resources (Shanthasiri & Wijesooriya, 2004). In general, a water supply system comprises a raw water source, a treatment facility, and a distribution system (Nyende-Byakika et al., 2011). However, water supply projects pose risks and uncertainties due to the project's conditions. As per Clough et al. (2004) and Wibowo & Mohamed (2008) many water supply project initiatives have substantial and irregular expansion potential, significant initial costs, minimal ongoing costs, and substantial irrecoverable costs.

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Hillson (2004) has defined risk as uncertainty that is measured and claims that uncertainty remains a risk as long as it cannot be measured. When considering the categorization of risks in construction projects, many studies have identified financial risks as a prominent category (Mhetre et al., 2016), (Perera et al., 2009), (Kamalanathan et al., 2014), (Szymański, 2017). As per Purnuş & Bodea (2015), financial risks are uncertainties and adverse events that affect the financial health and stability of the overall economy.

The research problem was identified where a lack of attention was given in previous studies regarding the financial risk management in water supply projects in Sri Lanka (Rajapakshe, Termansen and Paavola, 2023). Previous studies of water supply projects in other countries have identified the risk of inflation as one of the reasons to raise the project cost (Nguyen et al., 2021). With the demand for pipe-borne water in Sri Lanka, the number of water supply projects has been increasing and a considerable amount of the national budget is allocated to water supply infrastructure development (Perera & Halwatura, 2012). In the recent past, water supply projects have failed to meet the time targets and in return, the delays are considered to be expensive and to involve loans with interests and ongoing inflations in wage and material prices. The major parties such as contractors and consultants believe financial risks especially in funding and payments are one of the top ten causes of construction delays in traditional contracts (Perera & Halwatura, 2012). It is important to focus on the financial risk factors that affect the water supply projects in Sri Lanka and applicable strategies in order to overcome the challenges faced. The purpose of this research in this context is to develop a proper framework for managing the financial risks in Sri Lankan water supply projects. Accordingly, four objectives were set to achieve this aim: 1) to review the financial risk factors in infrastructure projects; 2) to review the existing strategies and investigate strategies in managing financial risk of infrastructure projects; 3) to identify the financial risk factors associated with water supply projects in Sri Lanka; and 4) to propose a financial risk management framework.

2 LITREATURE REVIEW

An extensive literature review was carried out to identify the financial risk factors in infrastructure projects which have led to cost overruns and to identify the existing strategies in managing financial risk factors. Therefore, to enhance the factors and strategies related to water supply projects in Sri Lanka, it is important to analyze the financial risk factors and strategies that are related to infrastructure projects.

2.1 Financial Risk Identification

Construction projects are highly vulnerable to high risks and uncertainties due their nature, sizes and complexities (Mhetre et al., 2016). Among the variety of risk categories in infrastructure projects, financial risk can have detrimental impacts which may also lead to the project cost overruns (Ahady et al., 2017). The above stance can be further reinforced through the findings of Mhetre et al. (2016), Purnuş & Bodea (2015), and Alshihri et al. (2022) through their studies. Furthermore, Perera et al (2009) in their study revealed that contractors are often exposed to economic risks due to project funding issues. Moreover, Park & Papadopoulou (2012) have mentioned that project cost overruns are a common occurrence in infrastructure projects. Under the financial risks, 3 elements have been stated by Kakimoto & Seneviratne (2000) as project risks that arise from overestimating or underestimating project cost, competitive risk, and market risks due to unforeseen changes in project cash flows caused by shifts in the political landscape, the economy, interest rates, and inflation rates. Thus, studies have discussed about dealing with risk factors as crucial management processes related to cost, time, safety, quality, and environmental sustainability (Alshihri et al., 2022; Mhetre et al., 2016; Park & Papadopoulou, 2012; Shibani et al., 2022; Srinivasan et al., 2022).

2.2 Financial Risks in Construction Projects

There are several studies focusing on financial risks in Sri Lankan construction projects. The studies relevant to Sri Lankan context focused on construction project types such as high-rise apartment buildings and road construction (Perera, Dhanasinghe & Rameezdeen, 2009; Perera, Samarakkody & Nandasena, 2020). None of them have focused on the water supply projects in Sri Lanka. Most of the

studies are consistent on the construction financial risk factors in both local and global contexts (Alshihri et al., 2022; Perera et al., 2014; Perera, Samarakkody, Nandasena, 2020; Rathnayake & Ranasinghe, 2020; Shibani et al., 2022; Srinivasan et al., 2022). Studies mentioned below have been identified as more or less similar 43 financial risk factors in global and local infrastructure projects.

Table 1. Identified Financial Risks

Code	Financial risk factors	Paper identity
F1	Financial resource management	(Allahaim & Liu, 2015)
F2	Project management and contract administration	(Mhetre et al., 2016)
F3	Contractors site management	(Allahaim & Liu, 2015)
F4	Increase in material cost	(Mhetre et al., 2016)
F5	Increase in labour costs	(Mhetre et al., 2016)
F6	Increase in machine prices	(Mhetre et al., 2016)
F7	Shortage of skilled labour	(Perera et al., 2014)
F8	Client's late contract award	(Baloyi & Bekker, 2011)
F9	Project complexity and size	(Perera et al., 2020)
F10	Unrealistic estimations	(Allahaim & Liu, 2015)
F11	Decision-making errors	(Alshihri et al., 2022)
F12	Payment issues	(Perera et al., 2009, 2014)
F13	Waste on site	(Allahaim & Liu, 2015)
F14	Currency fluctuations	(Allahaim & Liu, 2015; Shibani et al., 2022)
F15	Lack of technology resources	(Shibani et al., 2022)
F16	Changes in design and scope	(Baloyi & Bekker, 2011)
F17	Political obstacles	(Allahaim & Liu, 2015)
F18	Poor strategy management	(Perera et al., 2020)
F19	Rework due to mistakes	(Allahaim & Liu, 2015; Subramani, 2014)
F20	Problems in land acquisition	(Subramani, 2014)
F21	Wrong estimation/ estimation method	(Perera et al., 2020)
F22	Lowest bid procurement policy	(Perera et al., 2020)
F23	Additional work	(Allahaim & Liu, 2015)
F24	Unrealistic contract duration and financial difficulty faced by contractors	(Allahaim & Liu, 2015)
F25	Changes in government regulations	(Shibani et al., 2022)
F26	Inappropriate government policies	(Shibani et al., 2022)
F27	Liquidated damages	(Perera et al., 2020)
F28	Inadequate payments for variations	(Perera et al., 2014, 2020)
F29	Payment risk of completed work	(Allahaim & Liu, 2015)
F30	Non –return of retention	(Perera et al., 2020)
F31	Insufficient insurance	(Perera et al., 2020)
F32	Import/export restrictions	(Perera et al., 2020)
F33	Decrease in Gross National Product (GNP)	(Perera et al., 2020)
F34	Delays due to changes in factors of weather, climate, and natural disasters	(Perera et al., 2020)
F35	Contract price adjustment clause	(Shibani et al., 2022)
F36	Cause of contract dispute	(Allahaim & Liu, 2015)
F37	Complexity of construction site clearance compensation	(Baloyi & Bekker, 2011)
F38	Changes in tax policies	(Allahaim & Liu, 2015)
F39	Poor management information system	(Perera et al., 2020)
F40	Due to the repair after the commissioning test	(Perera et al., 2020)
F41	Risk of labor disputes and strikes	(Baloyi & Bekker, 2011)
F42	Risk of defective material from supplier	(Perera et al., 2020)
F43	Corruption including bribery at sites	(Perera et al., 2020)

2.3 Risk Management

The concept of risk management is the process of identifying, assessing and reducing risk to a manageable level (Tohidi, 2011). As stated by (Pawar et al., 2015), risk management supports efforts to gain better control over a project in terms of time, cost, quality, scope and organization. Pawar et al. (2015) state that risk identification, risk classification, risk analysis, and risk response as risk management processes in their study. Meanwhile, Szymański (2017) came up with 4 different types of risk responses, i.e., acceptance of risk, transfer of risk, risk reduction/mitigation, and avoiding risk.

2.4 Risk Management Strategies

There are several potential risk management strategies that are applicable for public infrastructure projects in Sri Lanka identified through literature. Thus, 19 strategies were identified through the literature review.

Table 2 Identified Risk Management Strategies

Code	Risk management strategies	paper
S1	Tendering a very high bid	(Perera et al., 2020)
S2	Placing conditions on the bid	(Perera et al., 2020)
S3	Pre-contract negotiations	(Perera et al., 2020)
S4	Not bidding on the high-risk portion of the contract	(Perera et al., 2020)
S5	Planning alternative methods/options as a stand-by	(Perera et al., 2020)
S6	Looking for marketable and land in demand for a reasonable price	(Kululanga & Kuotcha, 2010)
S7	Transferring the risk to a specialist subcontractor	(Perera et al., 2020) (Mhetre et al., 2016)
S8	Transferring the risk to an insurance company	(Perera et al., 2020) (Mhetre et al., 2016)
S9	Design and build obligations to the contractor	(Perera et al., 2020)
S10	Claiming for damages	(Perera et al., 2009, 2020)
S11	Development of a coping strategy on material price fluctuations	(Srinivasan et al., 2022)
S12	Selection criteria of supplying materials contractors such as prestige and financial capacity	(Srinivasan et al., 2022)
S13	Active plan for adapting a firm policy (Establishing a group of people responsible for preventing policy risk, such as a thorough understanding of new policy changes, or monitoring authorities' policies to be applied during the project construction investment process.)	(Srinivasan et al., 2022)
S14	Avoid unclear and general terms in the contract such as construction progress, construction quality and forms of payment. (employ legal advisory in drafting and negotiating contracts to reduce risk)	(Srinivasan et al., 2022)
S15	Carry out check accountability of funds at each level of implementation to have a sufficient basis for payment by investors and bidders.	(Madushanka & Tilakasiri, 2020)
S16	Calculate and compare many options during the preparation process to find the most effective and optimal one that takes into account the price slippage problem.	(Madushanka & Tilakasiri, 2020)
S17	The evaluation of bidders must be carried out based on the bid evaluation criteria and other requirements in the bidding documents, on submitted bids, explanatory documents to ensure the selection of a qualified and experienced contractor with feasible solutions to execute the bidding.	(Madushanka & Tilakasiri, 2020)
S18	Produce a proper schedule by getting updated project information.	(Madushanka & Tilakasiri, 2020)
S19	Refer to previous and ongoing similar projects for accurate programmes.	(Madushanka & Tilakasiri, 2020)

3 RESEARCH METHODOLOGY

This section identifies appropriate research methods to achieve the research aim and objectives. This research is based on financial risk factors and strategies in water supply projects in Sri Lanka. As the first stage, it is crucial to identify the financial risk factors and strategies for infrastructure projects through literature review. The research problem is reviewed through past studies and thereby the different financial risks in infrastructure and proposed strategies to overcome the negative impact of financial risks were listed out. The prevailing knowledge gap is verified from the literature review and carried forward in collecting the required data to close the knowledge gap. The research design must be identified to clearly understand the process of research. The data collection methods are then decided as proceeding to data analysis, successfully achieving the aim and objectives, and concluding the research study.

The mixed-method research design selected for this study is an exploratory sequential design (Sharma et al., 2023). The exploratory sequential design first starts off with qualitative data analysis and later on proceeds to quantitative data analysis (Manu, 2023). The research design aims at four objectives:

1 To review the financial risk factors in infrastructure projects which were successfully completed through the literature review focusing on forty-three financial risk factors.

2 To review the existing strategies and investigate strategies in managing financial risk of infrastructure projects which were also completed through the literature review proceeding with nineteen strategies.

3 To identify the financial risk factors associated with water supply projects in Sri Lanka which was done through eight interviews where 20 most prominent risk factors from literature review out of 43 were identified considering if the final applicability rate for each factor in water supply projects, Sri Lanka was above or equal to 50% according to the interview answers, additionally 3 new risk factors proposed by the interviewees have proceeded to the questionnaire survey. The rejection of literature findings was mainly because of not applicability in Sir Lankan water supply projects. The ten out of nineteen applicable strategies from literature review were taken out and it was also selected using the applicable rate above 50% from answers of interviews. Additionally, seven new strategies proposed by interviewees were taken forward to the questionnaire.

4 To propose a financial risk management framework that links the risk factors to the applicable strategies. It was completed through the data analysis of the responses to the questionnaire survey.

The research initially commenced with ascertaining financial risk factors and curbing strategies in infrastructure and building projects. The main purpose of conducting expert interviews was to collect data from the interviewers' experiences and perceptions on the applicability of these financial risk factors and curbing strategies on the water supply projects and ascertaining the new financial risk factors and curbing strategies applicable to the water supply projects. Therefore, the interpretivism method with deductive theory was adopted under the mixed method approach to carry out this research. In the first place, eight expert interviews were conducted to collect data. All selected participants had experience in Sri Lankan water supply projects.

In the next step, a questionnaire survey was distributed via online survey form among the people who composited the knowledge of risk management in water supply projects. A group of 21 participants have responded to the online survey. The participants were selected from purposive sampling where the survey is needed to be filled out only by potential experts in the area. During this stage, the validity of collected data from interviews was checked and the strategies which linked to risk factors was identified.

Table 3 Sample Participations

Interview number	Occupation	Work Experience (Years)
R1	Senior Contract Manager	Over 15
R2	Charted Quantity Surveyor	Over 20
R3	Senior Quantity Surveyor	21
R4	Senior Quantity Surveyor	15
R5	Senior Quantity Surveyor	9
R6	Senior Quantity Surveyor	Over 15
R7	Senior Quantity Surveyor	24
R8	Assistant Quantity Surveyor	4

4 DATA COLLECTION AND ANALYSIS

As discussed above, the data obtained from conducting data collection methods were analyzed using the manual content basis. The following analysis brought the findings and highlights of data analysis.

4.1 Assessing the Financial Risk Unique to a Particular Project Before Implementation

Interviewees had different views on ways of assessing the financial risk unique to a particular project before implementation. R1, R2, R6, and R5 interviewees suggested that getting guidance from previous similar nature projects, understanding possible financial risks and preparing a risk management plan can be a good method. R1, R2 and R3 interviewees mention that doing a proper and strong risk assessment, project management and planning accordingly can also assess the financial risks before implementing projects. Interviewees R2, R4 and R5 suggest that hiring experienced cost estimators, and quantity surveyors who have the ability to manage financial issues and conduct proper site visits, gather data, and price the bill while balancing the risks is important. R2, R3, and R8 interviewees mention that establishing proper communication and coordination systems for the project teams is important. R2 and R4 suggest that required mechanisms of engaging appropriate resources and information to do tasks must be collected considering long-term and short-term aspects i.e., required information to do ground conditions, information related to workmanship, pipe supply information. R2 interviewee also mentions that preparing a highly accurate budget taking all constraints into account and planning financing mechanisms will be valuable and in addition, interviewee R4 mentions that experts must price in water supply projects and also after pricing it should be verified by an operational estimate which means taking advice from a senior operational manager about the project cost. R3 interviewee mentions that being proactive is very important and additionally, R6 also mentions feasibility study can improve awareness of future risks. R7 has considered the pricing techniques where he suggests adding percentages for items in BOQ when pricing rates, for variation claims for markup for overhead and profit, for provisional sums claims in markup, for attendance fee for provisional sums by others and preparing correct rate breakdowns while tendering can be valuable in assessing the financial risk unique to a particular project before implementation.

4.2 Financial Risks Affecting Water Supply Projects in Sri Lanka

This was achieved through the interview where the question was to validate whether the identified general risk factors from previous studies apply to the specific context of water supply projects. As the first step of the interview question, the financial risk factors identified from the literature review filtered through a desk study and thereafter were presented to the interviewers for their validation. They were asked to select the significant financial risk factors related to the Sri Lankan water supply project with "Yes" / "No" answers with reasoning especially in case the answer was "No". And the results were analyzed accordingly. According to the interviewees, out of 43 factors, 20 most significant risk factors were identified as related to Sri Lankan water supply projects. F1, F2, F4, F5, F6, F7, F9, F10, F11, F12, F14, F16, F18, F19, F24, F32, F34, F35, F41 and F42 were the 20 most significant risk factors

related to water supply projects in Sri Lanka. Twenty-three (23) risk factors were not considered as applicable to the water supply projects in Sri Lanka, by many of the respondents. Additionally, interviewees proposed three new factors which in total had 23 most significant financial risk factors.

Accordingly, F1 risk factor was denied by R4 and R6 with the reasoning that although it is generally applicable for construction projects not highly relevant for water supply projects. F4 and F5 risk factors were rejected by the R4. R4 said that the contractor is not liable as the client is paying for the materials. Thus, the contractor should have the ability to manage the material quantities, and the rest of the material should be returned to the client. His opinion on the F5 factor was that labor cost escalations would not significantly impact cost overruns. F8 risk factor was rejected by R3, R4, and R5. Three of the interviewers gave the same answer that was not significant due to the paying for price escalation. The F13 factor was rejected by R3, R6 and R7 due to the reason that the contractor was responsible for site wastages. F15 factor was denied by the 4 people including R3, R4, R5 and R6. The reason was that water supply projects in Sri Lanka do not require technical resources like building construction and water supply projects do not use complex technology. F17 risk factor was rejected by R3, R4 and R5 with the reason that not relevant and obstacles can be claimed by the contractor. F20 one was also rejected by the R3, R4 and R5. The reason given was that it is the client's responsibility, and the contractor can claim it. F21 risk factor was identified as the duplicate with risk no.10 by seven out of eight interviewers. Therefore, the F21 risk factor was removed from the risk list. F22 risk factor was rejected by R3, R6 and R7 claiming that the risk was not in the construction stage and not relevant in the construction stage of the water supply projects. F23 risk was rejected by R4, R5, R6 and R7. The given reason was similar to each interviewer. They contended that risk as a variation and the contractor can claim it. F25 risk factor was declined by the majority of the interviewers due to if any government regulation changes, the contractor can claim. F26 was rejected by seven out of eight interviewers. For the rejection of R4 the reason given was due to legal protection for the contractor, F26 factor would not be considered as a risk. Similar to his idea, R8 said that factor depends on the staff's experience and their qualifications. Therefore, that risk was counted as a non-risk factor by R8. F27 and F28 risk factors were rejected by the majority of interviewers who commented as non-related to risks. F30 factor was rejected by the majority of the participants due to the contractually considered indestructible reason. R3 said that factor would not be considered as risk and non-related to water supply projects. F31 risk factor was rejected by 4 out of 8 interviewees by mentioning that was not a risk. F33 risk factor was rejected by 5 out of 8 interviewees by saying that not applicable to the topic and scope. F37 risk factor was declined by the majority of interviewees saying not applicable to the topic. F38 risk factor was rejected by saying that contractors' ability to claim it. F43 risk factor was rejected by the majority by mentioning that not affect to cost overruns.

4.3 Other Financial Risks Related to Water Supply Projects in Sri Lanka

R1 and R6 introduce the same new risk factor which is currency related issues and suspension of donor funds. **F44** which is caused by "existing ground conditions and unforeseen underground conditions, mainly the presence of a high volume of underground utilities crossing the pipe laying path" was mentioned by the 6 interviewees who are R2, R3, R4, R5, R7 and R8 out of eight. **F45** which is "lack of information availability (e.g.: underground or existing MEP details)" was mentioned by 3 interviewees who are R5, R4, R7, R8. **F46** which is caused by "unforeseen financial or other catastrophic conditions having an impact globally or internally (ex. financial crisis, wars between major supplier countries, COVID 19 etc.)" was the answer given by R1, R2, and R3. F44, F45, F46 were the new three risk factors added to the list of 20 prominent risk factors found through literature review making 23 prominent financial risk factors in total.

Unpracticable clauses in the subcontract agreement that affect the financial status of the subcontractor or partnering company and missing items in BOQ were mentioned by the R2 as the risk factors in water supply projects. Emergency needs and expenditures, objections of residents during the project, causing an adverse project delay resulting in a financial risk were defined by the R3.

Lack of inter-departmental coordination and national policies between the water supply agency and water supply projects was a risk factor stated by the R4 according to his opinion. Furthermore, he has mentioned that the procurement method can lead the project to cost overruns. If the design and build method is chosen for a water supply project, the contractor will face cost overruns for unnecessary

design steps. As an example, the time used to develop the shop drawings can be arising as a major time-consuming issue.

R5 and R6 have given similar answers to this question. Under their opinions, they have mentioned that due to unsolicited proposals, the contract is awarded at a higher contract price, the contractor's withdrawal from the contract due to their internal problems (such as bankruptcy), and long time taken to approve variation as financial risks in water supply projects.

4.4 Financial Risk Management Strategies in Water Supply Projects in Sri Lanka

The interviewees have selected the strategies applicable to managing financial risks and rejected the not applicable strategies. S1 strategy was rejected by the majority of respondents due to mentioning that strategy was not applicable for the scope. S4 strategy was rejected by the 4 out of 10 interviewers. R4 stated that bidding cannot be counted as a strategy and cannot be taken as a strategy. S6 strategy was declined by 4 out of 8 interviewers. S9 strategy was rejected and R4 said that factor was not a strategy in required scope. Due to the price escalation clause included in the contract S11 strategy is considered as non-strategy by the majority of responses. S14 strategy was rejected on the grounds that the contractor could not avoid or ignore the terms of the contract by R2 and R8. S16 and S17 were also rejected by R2, R3, R4, R5 and R6 interviewees due to not being relevant to the particular scope. Therefore S1, S4, S6, S9, S11, S14, S16, S8 and S17 were rejected and was not considered for the questionnaire survey. S7 and S8 were considered similar, therefore, S8 was removed and S7 was proceeded as "transferring risk to third party" to the questionnaire survey.

4.5 Other Commonly used Financial Risk Management Strategies in Sri Lankan Water Supply Projects

Interviewees R1 and R7 are given similar strategies. As a strategy, S20 - "accept the risk and add budget allocation for price the risk" was mentioned by R1 and R7 has mentioned adding physical contingency and price contingency provisions. S21 - "Adding contract price adjustment clause" was suggested by R1, R5 and R7. S22 – "Using mechanism as a tool (e.g. price fluctuation formula) or proper cost value reconciliation to conduct the project was suggested by R1, R3 and R4. S23 -"Identify the mechanism of engaging appropriate resources, both in long term and short term" was mentioned by R3 and R6. Meanwhile, R2, R4 and R8 stated that S24 - "establishing proper communication and coordination systems for the project team will enhance the project efficiency and work accuracy". In addition, R4, R5 and R8 mentioned that in the contract period, S25 – "should hire an experienced manager who can take strategic decisions and an experienced staff including Engineers, Quantity Surveyors to manage the financial matters and appoint experienced professionals as staff to make strategic decisions". S26 – "Selecting experienced and qualified contractors and subcontractors" was recommended by R4 and R6 interviewees.

4.6 Prominent Financial Risk Factors and Strategies Applicable to Water Supply Project in Sri Lanka

Considering prominent factors and strategies found through literature review and prominent factors and strategies proposed newly by the interviewees; finally, 23 financial risk factors and 17 strategies were taken into account to proceed to the questionnaire survey.

A desk study was done to check the responses of the questionnaire survey and one response was not completely filled therefore it was omitted. The questionnaire survey was answered by a total of 20 respondents. 5% have more than 25 years of experience, 5 % of the respondents have 21-25% years of experience, 40% are 6-10 years of experience and 50% are 0-5 years of experience. 85% of the professionals who responded to the questionnaire were from the contractor category whereas, 10% of the professionals were from the consultant category and 5% were from the academia category. The total of 20 respondents were 4 charted quantity surveyors, 1 project manager, 3 quantity surveyors. 8 assistant quantity surveyors and 4 senior quantity surveyors. The questionnaire survey consisted of a matrix to mark the suitable strategies that can manage the stated financial risk factors.

4.7 Strategies with a High Prominence in Avoiding Financial Risk Factors

The below figure displays the summary of the questionnaire survey findings. From the collected responses, the agreed percentage of the proposed strategy to minimize the risks is given in Figure 1. "X" represents the 0% which indicates no possibility in overcoming the risk from said strategy. Accordingly, top 9 most prominent strategies applicable for financial risk factors in water supply projects in Sri Lanka were identified namely S20, S5, S7, S3, S25, S2, S10, S19 and S18 from rank 1 to 9 respectively.

	S20	S5	S7	S3	S25	S2	S10	S18	S19	S22	S26	S21	S24	S13	S23	S12	S15
F1	70%	10%	5%	50%	35%	15%	X	5%	15%	70%	10%	10%	20%	15%	35%	25%	50%
F2	X	40%	5%	20%	40%	40%	5%	60%	40%	30%	45%	5%	45%	40%	35%	45%	10%
F4	65%	X	40%	X	X	35%	10%	X	X	40%	X	85%	X	X	20%	20%	X
F5	20%	X	50%	30%	5%	30%	10%	X	5%	10%	5%	75%	X	X	15%	X	X
F6	50%	X	30%	5%	X	30%	35%	45%	X	35%	X	60%	5%	X	25%	X	X
F7	5%	50%	X	35%	30%	X	5%	X	X	X	60%	X	X	X	20%	10%	X
F9	40%	10%	40%	50%	40%	15%	X	55%	50%	25%	35%	X	50%	15%	5%	5%	X
F10	55%	X	20%	70%	25%	5%	35%	30%	15%	45%	5%	40%	5%	10%	X	X	X
F11	35%	10%	45%	10%	40%	10%	X	45%	25%	55%	X	X	45%	50%	X	10%	5%
F12	35%	55%	25%	5%	35%	50%	65%	5%	X	10%	X	5%	X	X	X	5%	50%
F14	5%	50%	40%	35%	20%	40%	25%	5%	15%	35%	X	55%	X	X	X	X	10%
F16	35%	55%	5%	10%	10%	20%	45%	50%	35%	X	10%	X	25%	5%	35%	X	X
F18	25%	30%	15%	10%	30%	5%	5%	45%	30%	X	40%	X	15%	50%	20%	55%	10%
F19	30%	45%	50%	X	10%	30%	10%	15%	10%	X	55%	X	40%	X	15%	5%	X
F24	30%	40%	40%	50%	20%	35%	15%	20%	40%	15%	20%	5%	5%	15%	5%	X	15%
F32	30%	30%	35%	X	X	15%	45%	X	X	5%	X	X	X	35%	X	X	5%
F34	40%	45%	40%	X	25%	15%	40%	15%	10%	5%	X	5%	30%	X	X	X	X
F36	X	30%	X	45%	15%	5%	35%	5%	5%	X	10%	X	60%	35%	15%	X	X
F41	55%	50%	10%	X	45%	5%	X	X	5%	X	20%	X	5%	45%	5%	X	X
F42	35%	40%	55%	20%	5%	5%	5%	X	5%	X	55%	X	5%	5%	20%	40%	X
F44	65%	70%	40%	35%	35%	25%	25%	5%	30%	X	10%	X	X	X	X	X	X
F45	10%	5%	55%	35%	50%	5%	5%	10%	75%	X	5%	X	15%	X	X	X	X
F46	30%	45%	55%	35%	30%	45%	20%	5%	10%	25%	X	35%	5%	X	5%	X	50%

Figure 1 Summary of Questionnaire Survey Findings

The S21 strategy has shown the highest prominence of 85% among all the strategies for the "Increase in Material Cost" financial risk factor. The financial risk factors "lack of information availability (e.g.: underground or existing MEP details), increase in labor costs" had a prominence of 75% among all the strategies for S19 and S21, respectively. There are two strategies for the financial risk factor "issues in financial resource management" with a prominence of 70% which are S20 and S22. The strategy S3 has shown a prominence of 70% for "unrealistic estimation" and strategy S5 with a prominence of 70% prominence for "unforeseen underground conditions, mainly the presence of a high volume of underground utilities crossing the pipe laying path". Risks like 'increase in material cost', 'lack of information' and 'increase in labour costs' have shown that, particularly only very few strategies would help in overcoming the drawbacks (Figure 2, 3 and 4). Whereas Figure 5 shows many possible options for mitigating financial risks that occur due to decision-making errors.

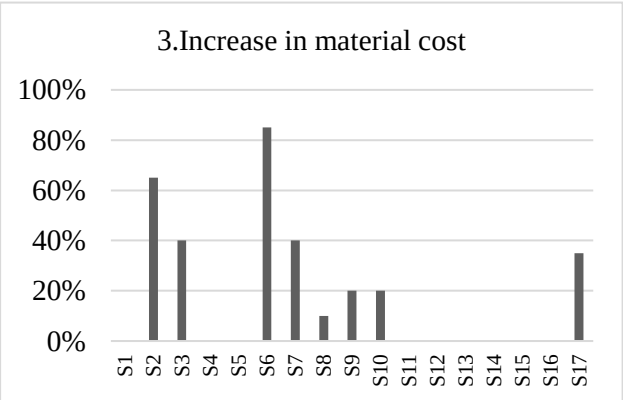

Figure 2 Increase in material cost

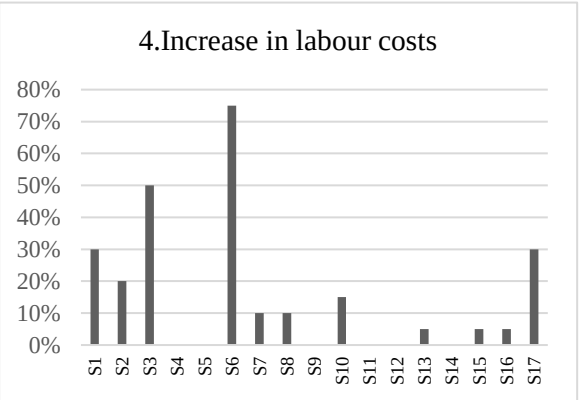

Figure 3 Increase in labour costs

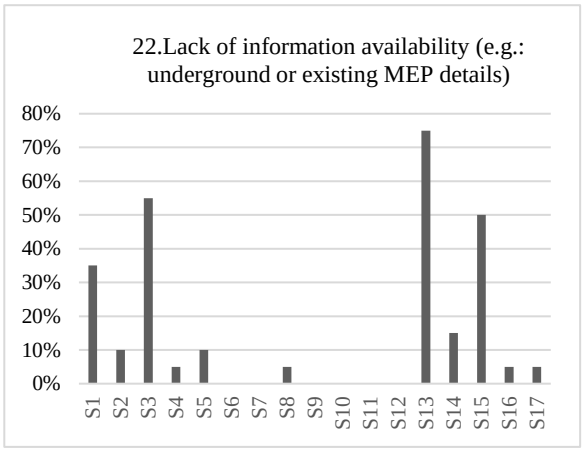

Figure 4 Lack of information availability

Figure 5 Decision making

Accordingly, the developed framework on overcoming financial risks in Sri Lankan Water Supply Projects can be presented Table 4 as follows.

Table 4 Framework on overcoming financial risks in Sri Lankan Water Supply Projects

Risk Code	Significant Strategies	Risk Code	Significant Strategies	Risk Code	Significant Strategies
F1	S20, S22, S3, S15	F11	S7, S18, S22, S24, S13	F34	S5
F2	S18, S26, S24, S12	F12	S10, S5, S2, S15	F36	S3, S24
F4	S20, S21	F14	S5, S21	F41	S20, S5, S25, S13
F5	S21, S7	F16	S5, S10, S18	F42	S7, S26
F6	S20, S18, S21	F18	S18, S13, S12	F44	S5
F7	S5, S26	F19	S5, S7, S26	F45	S19, S7, S25
F9	S3, S18, S19, S24	F24	S3	F46	S5, S7, S2, S15
F10	S3, S20, S22	F32	S10		

5 CONCLUSION AND RECOMMENDATIONS

This section refers to an outline of the research findings. The main aim of this research study was to develop a financial risk management framework to address cost overruns in Sri Lankan water supply projects. To begin with, four objectives were set to achieve this aim. Initially, it is important to identify the financial risk factors and strategies applicable to infrastructure project considering both Sri Lanka and the global context. The first objective is to review the financial risk factors in infrastructure projects which was successfully completed through the literature review. The second objective is to review the existing strategies and investigate strategies in managing financial risk of infrastructure projects which was also completed through the literature review. The third objective is to identify the financial risk factors associated with water supply projects in Sri Lanka which was done through eight interviews where analyzed data has proceeded to a questionnaire survey to fulfill fourth objective.

The findings revealed that the identification of financial risks in water supply projects initially is important, thereby planning and managing the risks save time and costs. Specifically, a country like Sri Lanka faces a tremendous downfall of financial feasibility in water supply projects owing to unfair payment conditions, currency depreciation, suspension of donor funding, community objections, poor coordination between departments, problems in procurements, etc. The top 9 strategies were shortlisted and absorbing the risks into the financial proposal has been recorded most prominent strategy to secure its feasibility. Some risks had more than 3 strategies for overcoming the financial risk in water supply projects in Sri Lanka whereas few has only one option (Table 4).

In recommendations, extensive focus must be given to the identified financial risk factors and all the applicable strategies in order to reduce or avoid financial risks. The framework will be a useful guide for avoiding financial risks in water supply projects in Sri Lanka. It is highly recommended to

use the framework to minimize financial risk factors in water supply projects in Sri Lanka. There are limitations in any research paper. This research is limited to financial risk factors for water supply projects in Sri Lanka only. The sample size of the interview was mostly focused on chartered quantity surveyors, senior quantity surveyors, assistant quantity surveyors and a project manager where this sample size can be more widened to collect more knowledge and data for this research.

The sample of the questionnaire survey can be widened to a large sample involving more professionals and experts in the construction industry. Further studies can be done to elaborate on and provide detailed strategies and develop the research framework. Risk factors such as "import/export restrictions, delays due to changes in factors of weather, climate, and natural disasters" have less prominence with the strategies found in this research study where the highest prominence rate was recorded as 45%. Therefore, this study suggests more applicable strategies for factors such as delays caused by import and export activities and natural disasters.

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