Journal of Entrepreneurship & Project Management

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ISSN: 2616-8464

Stratford Peer Reviewed Journals and Book Publishing
Journal of Entrepreneurship & Project Management
Volume 7||Issue 5||Page 21-44||June||2023|
Email: info@stratfordjournals.org ISSN: 2616-8464

Factors Affecting Cost and Execution Period of Trail Bridge Construction Project in Nyamagabe District, Rwanda

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How to cite this article: **Frederic, H., & Irechukwu, E. N. (2023). Factors Affecting Cost and Execution Period of Trail Bridge Construction Project in Nyamagabe District, Rwanda.** ***Journal of Entrepreneurship & Project Management, 7*****(5), 21-44. https://doi.org/10.53819/81018102t5192**

Abstract

The general objective of this study was to assess the factors affecting execution period (delays) of trail bridge construction project in Nyamagabe district of Rwanda, in southern Province. The study was guided by the following objectives: To assess the effects of environmental factors on bridge completion period in Nyamagabe district, to assess the effect of financial factors on bridge completion period in Nyamagabe district and to assess the effect of changes on bridge completion period in Nyamagabe district. A sample of 80 individuals was selected from a pool of 396 participants involved in the construction of bridges. The data analysis was conducted using SPSS Version 23, and the primary tool for data collection was a questionnaire. Linear regression analysis was employed to identify the factors that influence the delays in the execution period, with a 95% confidence interval and a statistically significant threshold set at a P-value of less than 0.05. The study revealed a significant negative influence of environmental factors on the completion of bridge construction projects, as evidenced by the regression coefficient of 0.425 and the t-value of -0.343. This statistical significance was confirmed by the p-value of 0.002, which is below the threshold of 0.05. The study also identified that financial issues may have an impact on the timely completion of the project, as indicated by the regression coefficient of -0.142 and the t-value of 1.655. However, the statistical analysis showed that this relationship was not statistically significant, as the p-value of 0.102 is above the significance level of 0.05. Furthermore, the study revealed negative effects of changes that occur during the implementation of bridge projects in Nyamagabe District. This is evident from the regression coefficient of -0.294 and the t-value of -3.318, both of which are statistically significant. The p-value of 0.001 is less than the threshold of 0.05, indicating a significant impact of changes on the project.his study concluded that environmental factors and changes related factors have a negative influence on the project execution. This means that those factors contribute more in the delaying and execution of project. Through this, the project stakeholders should conduct deep situational analysis in order to avoid cost and time overrun.

Keywords: *Cost, Execution Period, Trail Bridge Construction Project, Nyamagabe District, Rwanda*

1.0 Background of the Study

Many developing countries have been experiencing cost and time overrun in development projects and sometimes exceed 100% of the anticipated cost and duration of the project (Niazi & Painting, 2017). Schedule overrun is very frequent and is associated with nearly all projects. In Nepal, implementation delays in public sector investments seem to be common features (Aljohani , 2017). Large-scale construction of bridges is concentrated in several regions: in Moscow and Moscow Region of Russia, Saint Petersburg, Volga basin region, Western Siberia, and the area near Surgut (Gustafson, 2020). At the same time, there is a great demand for bridge construction in northern regions, including areas with severe Arctic conditions (Korchagin & Zaycev, 2021). The volume of bridge construction performed over the past 10–12 years has already exceeded the corresponding value for the previous 20 years (Poltava & Korchagin, 2019). In recent years, numerous studies were conducted in the field of improving the reliability and efficiency of the operation of road and construction facilities and vehicles, development, design and implementation of traffic control systems (Belyaev , 2020).

The number of projects on the construction of artificial transport facilities is not expected to decrease in the foreseeable future since the scale of transport infrastructure improvement and development exceeds the long-term average value by 60%. Bridge structures and construction technologies have been upgraded significantly, which makes it possible to simultaneously optimize labor intensity and construction time as well as improve facilities' quality, reliability, and durability (Belyaev , 2020). It has been proved that Civil structures play an important role in our daily life transportation. As one of the most important civil structures, trail bridges have been built because of fulfilling the constant human needs for communication, trading and transportations (McDonald, 2020). Currently, construction industry serves in many ways: makes magnificent buildings that shine in the city, trail bridges that connect people from one place to another, bridge networks that provide comfort to the citizens and airport terminals that help to connect the different parts of the world (Budha & Joshi, 2022).

Delays in trail bridge construction projects pose significant challenges to national development, and it is crucial to complete projects on time (Khanna, 2016). In Nepal, trail bridge projects often experience time overruns, causing difficulties for implementing agencies (Khanna, 2016). Delays can be categorized as excusable, non-excusable, or concurrent, depending on the cause (Braimah, 2013). Trail bridges are essential structures that span over waterways or unstable ground, requiring safety measures such as railings (Anderson & Wolter, 2022). Construction delays are common in developing countries, affecting project success in terms of time, cost, and quality (Larsen, 2016). Trail bridge construction, which relies on traditional methods and faces challenges like slopes and landslides, contributes to rural poverty due to limited access to essential services (Gollin, 2014).

Cost overruns in infrastructure projects are a critical issue, and studying the factors causing them is important for maximizing project benefits (Al-Hazim, 2017). Accurate cost estimation is crucial, influenced by factors and project conditions (Demirkesen & Ozorhon, 2017). Estimators consider various factors when forecasting project costs (Hatamleh, 2018). Bridges

to Prosperity (B2P), a non-profit organization, builds trail bridges to connect rural communities to critical destinations, and studies have established economic and livelihood benefits associated with these bridges (Thomas, 2020; Brooks & Donovan, 2019). Objective measurement technologies, such as motion-activated cameras, are used to assess bridge use (Thomas, 2020). Various methods, including in-person counting and digital video analysis, have been deployed to track bridge usage (Kothuri, 2017; Ghadiyaram, 2017). However, these methods are often cost-prohibitive and not suitable for low-income rural settings (Thomas, 2020). Thus, the research aimed to assess the relationship between environmental factors and trail bridge completion delays, explore the financial factors influencing construction projects, and identify key factors of change in trail bridge construction projects in Rwanda. By understanding these factors, it will be possible to address delays, manage costs effectively, and improve the execution of trail bridge construction projects.

1.1 Problem Statement

The construction of trail bridge has been adopted in most of hillsides countries due to a certain number of factors not only limited to environmental factors like heavy rain fall but also to factors inundation, and flooding. Regardless to these factors, Trail bridges often serve as a focal point for trail users and people usually stop on these structures and contemplate their surroundings. Selecting a crossing site that provides pleasing views of the stream or vistas of the surrounding countryside can have a dramatic impact on the user's experience. Crossing locations with these attributes combined with a bridge design that complements or enhances the natural setting should be the goal of every trail designer. How a bridge fits into the natural setting can be either a positive or negative attribute. Construction of trails fits a wide range of budgets and may be a viable health amenity for most communities (Lynch , 2020). To increase trail cost-effectiveness, efforts to decrease cost and increase the number of users should be considered (Lynch , 2020).

Some researchers have studied the reasons of and the factors affecting cost overrun and time delay in trail bridge construction projects. However, there is a lack of studies concerned with the cost overrun and time delay in the implementation of infrastructure projects in Rwanda. This study aims at investigating the most important factors that can be the reasons behind cost overrun and time delay of infrastructure projects in Rwanda. By analyzing the factors affecting cost and execution period of a bridge construction project in Rwanda by analyzing relationship between environmental factors associated to delays of trail bridge completion period, financial factors affecting Trail bridge construction project and come up with better understanding on the effect of change in design on completion period of trail bridge construction project of the selected trail bridge construction.

The top affecting factors in the consultants' opinions are materials price instability, size of contract and incomplete drawings. Also the research conducted by Durdyev and Hosseini (2019) stated that about all the projects suffering from cost diverge exceeded the execution period due to change in design of the primary project presented to the donor. Also, it was found

from the study that about 76% of projects have cost over estimation while 24% have cost underestimation (Durdyev & Hosseini, 2019). Thus, the objectives of this study was to explore the factors associated to delays of trail bridge completion rate (including availability of local materials, slope, climate change, bridge conditions, distance from loading materials to site locations), determine the main reason behind delays in construction of bridges under the bridge project in Rwanda, and to assess whether there is a relationship between the change in design of the project and the execution period of the trail bridge construction project.

1.2 Research Objectives

(i) To assess the effects of environmental factors on bridge completion period in Nyamagabe district.
(ii) To assess the effect of financial factors on bridge completion period in Nyamagabe district.
(iii)To assess the effect of changes on bridge completion period in Nyamagabe district.

2.0 Literature Review

The literature review included the empirical literature, Theoretical Framework and conceptual framework.

2.1 Empirical Literature

Timilsina (2020) conducted research on the problems and impacts of delays in the construction industry in Pakistan. They identified natural disasters, such as floods and earthquakes, as the most common cause of delays, along with financial and payment issues, inadequate planning, poor site management, lack of experience, and shortages of materials and equipment (Thakur, 2021). According to the analysis of final reports from infrastructure projects, 20 factors were found to contribute to delays and cost overruns. Among these factors, terrain and weather conditions were identified as the primary causes of completion delays and cost overruns in infrastructure projects in Jordan (Al-Hazim, 2017). The dynamic load encompasses environmental factors beyond normal weather conditions, such as sudden gusts of wind and earthquakes, all of which must be considered during bridge construction (Ghosh & Gupta, 2021). Karunakaran (2019) identified factors such as poor project planning, design changes, underground utilities, shortage of materials, and poor communication as causes of significant delays. Bista and Dahal (2018) found low bidding to be a major reason for delays in Nepal, influenced by unrealistic norms, contract ambiguities, and social acceptance issues.

In Jordan, Al-Hazim (2017) highlighted terrain and weather conditions as the primary factors leading to completion delays and cost overruns in infrastructure projects. The causes of delay in trail bridge construction projects have been studied in various locations. Suwal and Shrestha (2016) identified factors like low bids, lack of pre-execution planning, delays in obtaining clearances, poor site management, and labor issues as contributing to delays in Nepal. In Saudi Arabia, factors such as security concerns, corruption, qualification of technical staff, and payment delays were found to be the main causes of delay (Zidane & Andersen, 2018; Durdyev & Hosseini, 2019). Other common causes of delays in construction projects include

inexperienced contractors, inadequate planning, delays in payments, design changes, bureaucratic decision-making processes, and site management issues (Rachid et al., 2019; Amarkhil et al., 2021; Rahman et al., 2013).

Factors like financial difficulties, skills shortages, inaccurate time estimates, and unforeseen ground conditions also contribute to project delays (Mpofu et al., 2017; Aziz & Abdel-Hakam, 2016). Financing difficulties and issues related to payment, profit margins, and capital are frequently cited as causes of delays in construction projects (Kassa, 2020; Sanni-Anibire et al., 2022; Tesfa, 2016). Delays in progressive payments by clients have been identified as a significant cause of project delays in multiple locations (Al-Emad et al., 2017). The adverse effects of changes on project time and cost performance are widely acknowledged in the literature. Harold (2021) emphasizes the inseparability of time and cost management in projects. In Malaysia, building projects often experience time and cost variances of 5% to 20% due to design changes, leading to significant non-value adding implications in terms of time and cost. This finding aligns with the studies conducted by Larsen et al. (2016) and Mpofu et al. (2017) in the UK, which highlighted the inhibiting effect of design changes on time and cost control in construction projects.

2.2 Theoretical Framework

A theory of change is a method that outlines how a specific intervention or set of interventions is expected to bring about desired development change. It is based on a causal analysis and draws on available evidence (De Silva, 2014). Developing a theory of change for engineering work involves conducting thorough analyses, consulting with key stakeholders, and learning from the experiences of beneficiaries and partners to understand what approaches are effective in different contexts (De Silva, 2014). A theory of change helps identify solutions to address the root causes of problems, guides decision-making processes, considers comparative advantages, feasibility, and uncertainties, and highlights underlying assumptions and risks that need to be revisited throughout the process to ensure the desired change is achieved (De Silva, 2014). A theory of change provides a comprehensive description of how and why a desired change is expected to happen in a specific context (Taplin, 2013). It fills the gap between the activities or interventions of a program or change initiative and the achievement of desired goals. By mapping out the outcomes that need to be in place for the long-term goals to be achieved, an outcomes framework is created (Taplin, 2013). This framework then helps identify the types of activities or interventions that will lead to the desired outcomes, enabling better planning, resource allocation, and evaluation (Taplin, 2013). The use of a theory of change in this study is justified for several reasons. Firstly, it provides a framework for learning and making adjustments based on evidence and monitoring and evaluation findings. By understanding the causes of a development challenge and testing assumptions, a theory of change ensures a logical approach to achieving desired results (Davies, 2018). Secondly, it facilitates the development and management of partnerships by involving stakeholders in the planning process, fostering consensus, and demonstrating how different actors contribute to long-term impact (Davies, 2018). Thirdly, it helps address changing circumstances and crises, allowing for adaptability and course corrections (Davies, 2018). In the context of Bridges to

Prosperity, their theory of change posits that trail bridges eliminate the isolation and risks faced by rural communities during flooding events (Davies, 2018). The analysis presented in this study suggests that bridge use is not dependent on rainfall, indicating a preference for trail bridges over alternative river crossings (Davies, 2018). However, further investigation is needed to explore seasonal attributes of bridge use, such as during harvest periods, and extreme weather events like flooding (Davies, 2018). The theory of change is crucial for guiding development interventions, understanding the underlying causes of problems, making informed decisions, fostering collaboration, and ensuring progress towards desired outcomes.

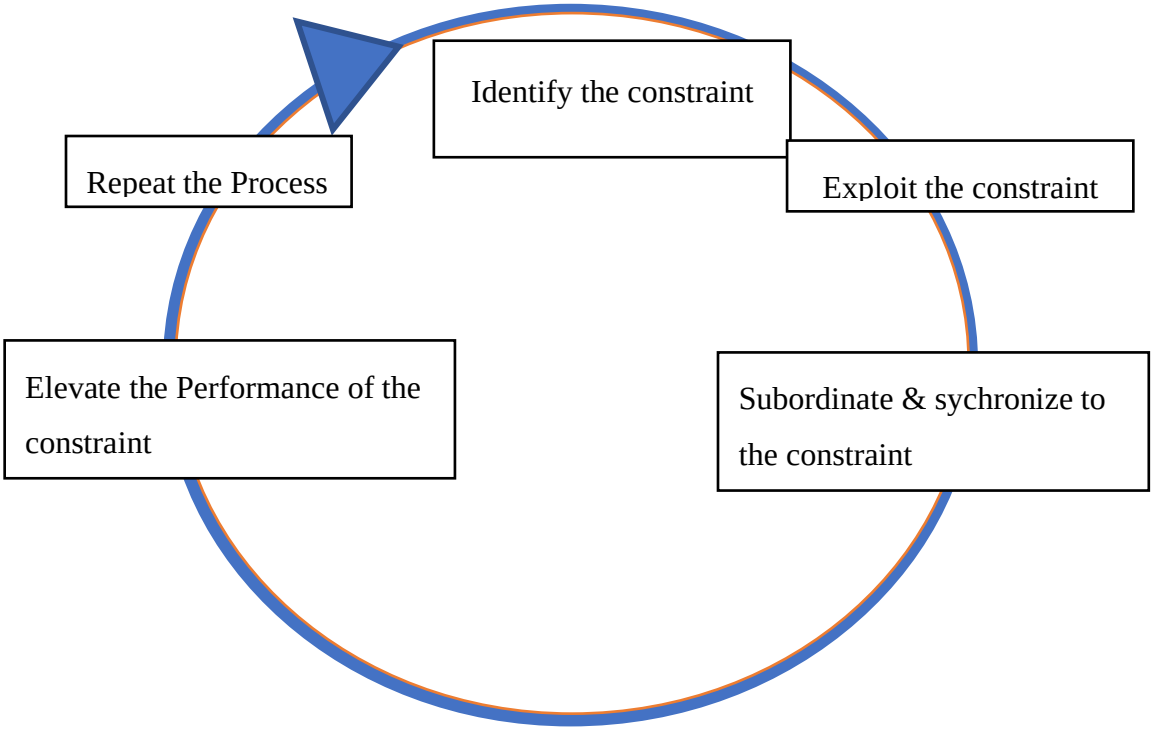

Figure 1: Five Focusing Steps of theory of constraints (TOC)

2.3 Conceptual Framework

The relationship between the established and independent variables is depicted in the Conceptual Framework below. The conceptual framework entails creating thoughts about the link between variables within the observed and graphically depicting the relationship. The independent variables (Predictors) in the conceptual framework are significant features of trail bridge construction which include the environmental factors like heavy rainfall, flooding, inundation, slope area, etc. There are also other variables like financial capacity: capacity building, budget allocation and management support while the dependent variable is performance. Building, budget allocation and management support while the dependent variable is performance.

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Journal of Entrepreneurship & Project Management
Volume 7||Issue 5||Page 21-44||June||2023|
Email: info@stratfordjournals.org ISSN: 2616-8464

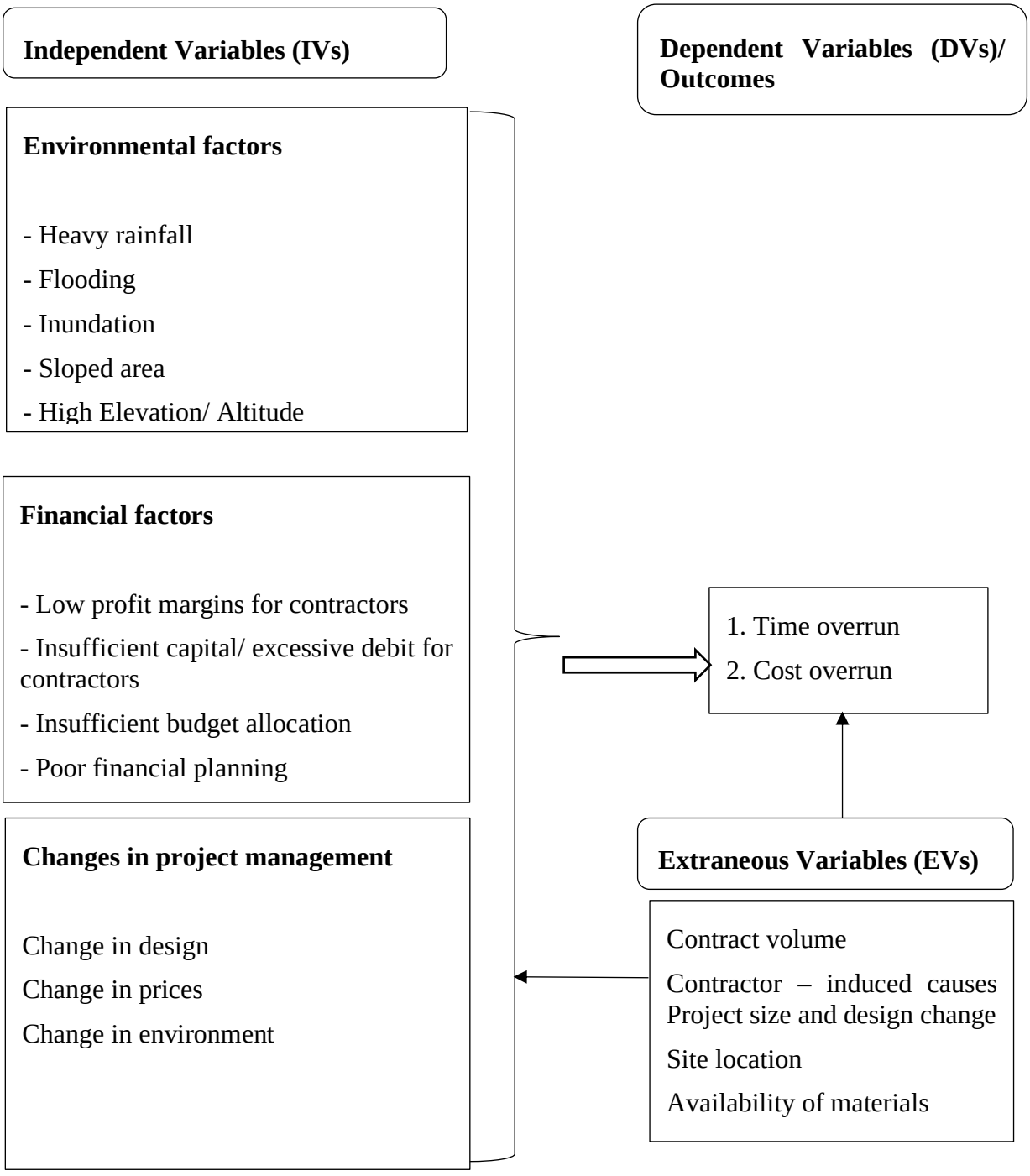

Figure 2: Conceptual framework of the study
Source: (Researcher, 2023)

https://doi.org/10.53819/81018102t5192

3.0 Research Methodology

The research utilized an inductive approach to explore the causes of delays and cost overruns in trail bridge construction projects in the Nyamagabe district of Rwanda. Descriptive statistics were applied to analyze the collected data, and linear regression was used to determine the relationship between variables. Primary data were collected through questionnaires directed at various stakeholders, including users of the bridges, project staff, and beneficiaries. A cross-sectional and descriptive method was applied to survey the research area. The study targeted a population of 396 individuals involved in the construction of three specific trail bridges, with a sample size of 80 individuals selected through stratified random sampling. Both primary and secondary data were gathered and verified for accuracy. The validity and reliability of the research instruments were ensured, with the questionnaire showing a Cronbach's Alpha of 0.750 for 22 items, suggesting a reliable scale. The data were analyzed using SPSS version 26, and ethical considerations were maintained throughout the research process.

4.0 Data Presentation, Analysis and Interpretation

The section includes data presentation, analysis, and interpretation. These components are crucial for effectively conveying the collected data, conducting thorough analysis, and deriving meaningful insights and conclusions from the findings

4.1 Demographic profile of respondents

This section is about the demographic profile of respondents who have participated in this study in order to know the characteristics of people who use to be involved in the implementation of bridge construction project in Nyamagabe District.

Table 1: Gender of respondents

		FREQUENCY	PERCENT
VALID	Male	54	67.5
	Female	26	32.5
	Total	80	100.0

Source: Primary data, 2023

According to table 1, majority of participants in this study who have contributed in bridge construction were found to be male with the percentage of 67.5% while female were found to be 32.5% of the total respondents. The implication of this is that in high risk construction projects men are mostly able to take risks than women and most of the time the construction require endurance which is not the character of women.

Stratford Peer Reviewed Journals and Book Publishing
Journal of Entrepreneurship & Project Management
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Email: info@stratfordjournals.org ISSN: 2616-8464

Table 2: Age category of the respondents

		FREQUENCY	PERCENT
VALID	Below20 years	3	3.8
	10- 20 years	5	6.3
	20-30 years	5	6.3
	30-40 years	38	47.5
	40-50 years	22	27.5
	50-60 years	7	8.8
	Total	80	100.0

Source: Primary data, 2023

Table 2 shows the distribution of respondents by their age. Majority of the participants in this study were found to have age ranging from 30 to 40 years with the percentage of 47.5% of the total respondents. The second group is that of people with age ranging from 40 to 50 years with the percentage of 27.5% of the total respondents. This implies the extent by which construction needs mature people who are certain of what they are doing.

Table 3: Marital Status of the respondent

		Frequency	Percent
Valid	Single	17	21.3
	Married	60	75.0
	Widow	3	3.8
	Total	80	100.0

Source: Primary data, 2023

The above table shows the distribution of respondents by their marital status. Majority of participants in this study were found to be married people with the percentage of 75% of the total respondents while single people were found to be 21.3% of the total respondents and widow were found to be 3.8% of the total respondents. The implication is that married people are known to be responsible of what they are doing and this is good in construction since they are stable.

Table 4: Education attainment of the respondents

		FREQUENCY	PERCENT
VALID	Vocational school (1-2 years)	17	21.3
	Secondary education	28	35.0
	College/university with Diploma	21	26.3
	College/university with Bachelor	10	12.5
	Masters	4	5.0
	Total	80	100.0

Source: Primary data, 2023

https://doi.org/10.53819/81018102t5192

The table 4, shows the distribution of respondents in this study by their education. Majority of the respondents who participated in the study revealed that they hold secondary education with the percentage of 35% of the total respondents. This shows that participants in this study had needed education to understand how construction projects related to bridges are undertaken and their responses would be trusted.

Table 5: Profession of the respondents

		FREQUENCY	PERCENT
VALID	Ordinary worker	46	57.5
	Technician	26	32.5
	Clerk	8	10.0
	Total	80	100.0

Source: Primary data, 2023

According to the above table, majority of the respondents in this study are ordinary workers in construction of bridges considering the percentage of 57.5 % of the total respondents and technicians took the second place with the percentage of 32.5% of the total respondents whiles clerks or people working in office are 10%. This shows that all the levels of employees has been represented in this study and this helped to get significant results in the study.

Table 6: Experience in bridge construction

		FREQUENCY	PERCENT
VALID	1-5 Years	29	36.3
	6-10 years	42	52.5
	More than 10 years	9	11.3
	Total	80	100.0

Source: Primary data, 2023

The table 6, shows the distribution of respondents by their experience working in bridge construction. Majority of the respondents who have participated in this study revealed that they have an experience ranging from 6 to 10 years with the percentage of 52.5% of the total respondents and respondents with the experience ranging from 1 to 5 years with the percentage of 36.3% and those the experience to be above 10 years were found to be 11.3%. This experience is good.

4.2 Factors influencing the cost and completion of project bridges

Project success or completion is due to different factors in this study, after considering the literature and considering how projects are completed in Rwanda, it was decided to see if environmental factors, financial factors, and changes related factors have an influence on the completion of bridges projects where three bridges located in Nyamagabe District.

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Journal of Entrepreneurship & Project Management
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Email: info@stratfordjournals.org ISSN: 2616-8464

4.2.1 Environmental factors influencing the construction of bridge project

Here the researchers were asked to provide their opinions on environmental factors that may influence the completions and costs of bridges. Below table shows the environmental factors that were revealed by participants in the study.

Table 7: Environmental factors influencing the construction of bridge project in Nyamagabe District

	MEAN	STD. DEVIATION	INTERPRETATION
SLOPED AREA	3.88	.946	High mean
FLOODING	2.59	.630	Low mean
EARTHQUAKES	2.14	.759	Low mean
HEAVY RAINFALL	3.42	.652	High man
HIGH ELEVATION	2.95	.825	Moderate mean
INUNDATION	2.00	.763	Low mean
UNFAVORABLE WEATHER CONDITION	2.96	.849	Moderate mean
AVERAGE MEAN	2.8482	.25039	Moderate mean

Source: Primary data, 2023

Note: 5. Strongly Agree= [4.21-5.00] =very high, 4. Agree = [3.41-4.20] =high, 3. Not Sure = [2.61-3.40] =Moderate, 2. Disagree= [1.81-2.60] =low 1. Strongly Disagree= [1.00-1.80] = very low

According to the above table, the environmental factors that can delay the completion of bridges in Nyamagabe and increasing the costs are the following: sloped area considering the mean of 3.88 which is interpreted as high mean, the second was found to be heavy rainfall considering the mean of 3.42 which is interpreted as high mean. Considering the geographical situation of that area those factors are indisputable. Any other factors that could be linked with the first one is high elevation considering the mean of 2.95 which is interpreted as moderate one. Other remaining factors were found to not having a significant role in the completion and costs overrun of the bridges construction projects.

4.2.2 Financial factors influencing the construction of bridge projects

Other factors that were taken into consideration after intense literature review and seeing different reports are those related to financial ones. Below table shows the perceptions of respondents on them.

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Table 8: Financial factors influencing the construction of bridge projects in Nyamagabe District

	MEAN	STD. DEVIATION	INTERPRETATION
LATE PAYMENT DURING WORK PROGRESS	3.10	1.186	Moderate mean
UNREALISTIC CONTACT PERIOD IMPOSED BY THE OWNER	2.41	.630	Low mean
POOR SITE FINANCIAL CONTROL	3.59	.688	High mean
FINANCIAL DIFFICULTIES ENCOUNTERED BY CONTRACTOR	3.44	.777	High mean
COST RELATED TO REWORK DUE TO MISTAKES AND ERRORS	3.65	.618	High mean
MARKET FLUCTUATION IN THE COST OF CONSTRUCT MATERIALS	3.56	.613	High mean
AVERAGE MEAN	3.2917	.40174	Moderate mean

Source: Primary data, 2023

Note: 5. Strongly Agree= [4.21-5.00] =very high, 4. Agree = [3.41-4.20] =high, 3. Not Sure = [2.61-3.40] =Moderate, 2. Disagree= [1.81-2.60] =low 1. Strongly Disagree= [1.00-1.80] = very low

According to the above table, financial factors that were revealed to affect the completion of bridges and their costs are the following: poor site financial control considering the mean of 3.59 which is interpreted as high mean, financial difficulties encountered by contractors considering the mean of 3.44 which is interpreted as high mean, costs related to rework sue to mistakes and errors considering the mean of 3.65 which is interpreted as high mean, and market fluctuation in the cost of construction materials considering the mean of 3.56 which is interpreted as high mean. Other factors on moderate level that were revealed in this study include late payments during work progress considering the mean of 3.10 and the factor of unrealistic contract period imposed by the owner of the project considering the mean of 2.41 which is interpreted as low mean.

4.2.3 Change factors influencing the construction of bridge projects

Project completion may face changes in different form than may happen during the implementation and this may also affect the initial costs. Below table shows the perceptions of respondents on changes that have been observed during the construction of bridges in Nyamagabe District.

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Table 9: Change factors influencing the construction of bridge projects in Nyamagabe

	MEAN	STD. DEVIATION	INTERPRETATION
CHANGES IN GOVERNMENT REGULATIONS	3.25	.864	Moderate mean
CHANGES IN FINANCIAL RESOURCES	2.75	.563	Moderate mean
CHANGES IN DESIGNS ACCORDING TO DIFFERENT REASONS	3.04	.863	Moderate mean
CHANGES IN LABOR MARKET AND COSTS	2.76	.661	Moderate mean
CHANGES IN ENVIRONMENTAL CONDITIONS (WEATHER)	2.19	.638	Low mean
AVERAGE MEAN	2.7975	.37042	Moderate mean

Source: Primary data, 2023

Note: 5. Strongly Agree= [4.21-5.00] =very high, 4. Agree = [3.41-4.20] =high, 3. Not Sure = [2.61-3.40] =Moderate, 2. Disagree= [1.81-2.60] =low 1. Strongly Disagree= [1.00-1.80] = very low

According to the above table, changes that can have an influence on the completion the projects and costs were revealed to be not happening on high degree. Those that some ne may pay attention on them included changes in government regulations considering the mean of 3.25 which is interpreted as high mean, changes in financial resources considering the mean of 3.75 which is interpreted as moderate mean, changes in design according to different reasons considering the mean of 3.04 which is interpreted as moderate mean, and changes in labor market and costs considering the mean of 2.76 which is interpreted as moderate mean. Lowly it has been revealed that changes in environmental conditions may influence the completion of the projects insignificantly.

4.3 Assessment of completions of bridges and their costs in Nyamagabe District

The dependent variables in this study were costs and completion period of bridges. Most of the time those are achieved in form of counting but also opinion based response were considered in order to enhance the level of analysis and interpretation especially in elaborating relationship between variables.

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Table 10: Perceptions of respondents on final costs of project of bridges in Nyamagabe District

	MEAN	STD. DEVIATION	COMMENTS
THE ESTIMATED COST PER ACTIVITY HAS CHANGED	3.30	.719	Moderate mean
ADMINISTRATIVE COSTS HAS INCREASED COMPARING ESTIMATED OF BUDGET	3.24	.917	Low mean
LABOR COSTS HAVE INCREASED COMPARING TO ESTIMATED ONES IN BUDGET	3.66	.615	High mean
AVERAGE MEAN	3.6438	.43896	Moderate mean

Source: Primary data, 2023

Note: 5. Strongly Agree= [4.21-5.00] =very high, 4. Agree = [3.41-4.20] =high, 3. Not Sure = [2.61-3.40] =Moderate, 2. Disagree= [1.81-2.60] =low 1. Strongly Disagree= [1.00-1.80] = very low

Regarding the costs at the end of the projects related to construction of bridges in Nyamagabe District, it has been revealed that labor costs have jumped above the estimated budget considering the mean of 3.66 which is interpreted as high mean, and other forms of costs were revealed to be jumped on moderate level where they include the estimated costs per activities with the mean of 3.30 which is interpreted as moderate mean, and administrative costs with the mean of 3.24 which is interpreted as moderate mean. The average mean shows that the cost has increased comparing to estimated costs considering the mean of 3.64 which is interpreted as high mean and this is confirmed by the below table which compare the estimated costs and final costs for construction of bridges.

Table 11: Comparison between estimated costs and final costs for bridges construction

Bridge	Estimated cost	Final costs	Difference
Munanira	31 7304 06	29574316	2 156 090
Rwasa	26353000	27653000	1 3000 000
Rwangambibi	30124715	31771000	1 246 285

Source: Bridges to Prosperity, 2023

https://doi.org/10.53819/81018102t5192

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Table 12: Perceptions of respondents on period completion of bridges in Nyamagabe District

	MEAN	STD. DEVIATION	COMMENTS
THERE WAS NO DELAY COMPLETION OF PROJECT ACTIVITY PER DEPARTMENT	2.34	.795	Low mean
THERE HAS BEEN NO DELAY IN RESOURCING THE MATERIALS TO BE USED	2.29	.578	Low mean
THERE HAS BEEN NO DELAY IN ALLOCATING FINANCIAL RESOURCES TO USE	2.58	.883	Low mean
THE OVERALL PROJECT MET DEADLINE	2.62	.663	Low mean
AVERAGE MEAN	2.4563	.31010	Low mean

Source: Primary data, 2023

Note: 5. Strongly Agree= [4.21-5.00] =very high, 4. Agree = [3.41-4.20] =high, 3. Not Sure = [2.61-3.40] =Moderate, 2. Disagree= [1.81-2.60] =low 1. Strongly Disagree= [1.00-1.80] = very low

Regarding the completion of bridge projects in Nyamagabe District, according to the above table, it has been revealed that there has been a delay in resourcing the materials to be used considering the mean of 2.34 which is interpreted as low mean, a delay in allocating financial resources to be used considering the mean of 2.29 which is interpreted as low mean, a delay in the completion of the projects per department considering the mean of 2.58 which is interpreted as low mean, and the overall projects surpassed their deadlines considering the mean of 2.62 which is interpreted as low mean. In fact, the completion of bridge projects has been surpassed the expected time considering the average mean of 2.45 which is interpreted as high mean. Below table confirm those changes in completion of bridges construction in Nyamagabe District.

Table 13: Comparison between estimated completion time and final completion time for bridges construction

Bridge	Estimated Completion time (Month)	Final completion time (Month)	Difference (Month)
Munanira	4	10	6
Rwasa	4	5	1
Rwangambibi	5	5	0

Source: Source: Bridges to Prosperity, 2023

https://doi.org/10.53819/81018102t5192

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Volume 7||Issue 5||Page 21-44||June||2023|
Email: info@stratfordjournals.org ISSN: 2616-8464

4.4 Responding the objectives of the study

This study was guided by three specific objectives, the first is assessing the effect of environmental factors on costs and completion of bridges in Nyamagabe District, the second was about the effect of financial factors on costs and completion of bridges in Nyamagabe District, and the third was about the effects of change factors on costs and completion of bridges in Nyamagabe District. For responding those objective the linear regression was used and the p-value (significance level) that was considered is 0.05.

4.4.1 Effects of Environmental factors on completion of bridges in Nyamagabe District

The first objective of this study was to assess the effects environmental factors on completion of bridges in Nyamagabe District. To reach this objective the linear regression was used with the significance level of 0.05 or the p-value.

Table 14: Model summary between environmental factors and completion of bridges

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.343[a]	.118	.106	.29317

a. Predictors: (Constant), Environmental factor

The correlation coefficient (R) of 0.343 indicates that there is a low correlation between environmental factors in combination and bridges completion. The R square indicates how much of the total variation in the dependent variable, environmental factors, can be explained by the independent variable, bridges completion. Here the change can be explained by 11.8% which means that it doesn't require more for environmental factors to influence the completion of bridges in terms of duration.

Table 15: ANOVA between environmental factors and completion of bridges

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.893	1	.893	10.386	.002[b]
	Residual	6.704	79	.086		
	Total	7.597	80			

a. Dependent Variable: Time

b. Predictors: (Constant), Environmental factor

The ANOVA tells us whether our regression model explains a statistically significant proportion of the variance. In this study the ANOVA table shows that the model is statistically significant since the p-value of 0.002 is less than 0.05. Meaning that environmental factors can explain the outcome of bridges completion.

Stratford Peer Reviewed Journals and Book Publishing
Journal of Entrepreneurship & Project Management
Volume 7||Issue 5||Page 21-44||June||2023|
Email: info@stratfordjournals.org ISSN: 2616-8464

Table 16: Regression between Environmental factors and completion of bridges in Nyamagabe District

COEFFICIENTS[A]						
MODEL		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.665	.377		9.732	.000
	Environmental factor	-.425	.132	-.343	-3.223	.002

A. DEPENDENT VARIABLE: TIME

Source: SPSS Results, 2023

According to the above table environmental factors have a negative influence on the completion of projects related to bridge construction considering the regression coefficient of -0.425 and the t value of -0.343 and this was found to be statistically significance since the p-value or Sig. of 0.002 is below 0.05. This mean that environmental factors play significance role in delaying the completion of projects related to trail bridge construction in Nyamagabe District.

4.4.2 Effects of financial factors on completion of bridges in Nyamagabe District

The second objective of this study was to assess the effects financial factors on completion of bridges in Nyamagabe District. To reach this objective the linear regression was used with the significance level of 0.05 or the p-value.

Table 17: Model summary between financial factors on completion of bridges in Nyamagabe District

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.184[a]	.034	.022	.30675

a. Predictors: (Constant), Financial factors

Source: SPSS Results, 2023

The correlation coefficient (R) of 0.184 indicates that there is a low correlation between financial factors in combination and bridges completion. The R square indicates how much of the total variation in the dependent variable, financial factors, can be explained by the independent variable, bridges completion. Here the change can be explained by 3.4% which is very law to influence the completion of bridges.

Stratford Peer Reviewed Journals and Book Publishing
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Table 18: ANOVA between financial factors on completion of bridges in Nyamagabe District

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.258	1	.258	2.738	.102[b]
	Residual	7.339	79	.094		
	Total	7.597	80			

a. Dependent Variable: Time

b. Predictors: (Constant), Financial factors

Source: SPSS Results, 2023

According to the above table, our model is not statistical significant meaning the influence of financial factors on completion of bridges is not significant where the p-value is 0.102 and this is greater than the significance p-value of 0.05.

Table 19: Regression between financial factors and completion of bridges in Nyamagabe District

COEFFICIENTS[A]						
MODEL		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.988	.285		6.980	.000
	Financial factors	-.142	.086	-.184	-1.655	.102

A. DEPENDENT VARIABLE: TIME

Source: SPSS Results, 2023

According to the above table, it has been found that financial issues may hamper the completion of the project on time considering the regression coefficient of -.142 on the t-value of 1.655 but this was found not to be statistically significant considering the p-value of 0.102 which is above the significance level of 0.05. This means that financial factors only can't have a significance negative impact on the completion of the project on time.

4.4.3 Effects of change factors on completion of bridges in Nyamagabe District

The second objective of this study was to assess the effects change factors on completion of bridges in Nyamagabe District. To reach this objective the linear regression was used with the significance level of 0.05 or the p-value.

Stratford Peer Reviewed Journals and Book Publishing
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Table 20: Model summary between change factors on completion of bridges

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.352[a]	.124	.112	.29215

a. Predictors: (Constant), Changes

Source: SPSS Results, 2023

The correlation coefficient (R) of 0.352 indicates that there is a low correlation between changes factors in combination and bridges completion. The R square indicates how much of the total variation in the dependent variable, change factors, can be explained by the independent variable, bridges completion. Here the change can be explained by on 12.4% in changes related factors.

Table 21: ANOVA between change factors on completion of bridges

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.940	1	.940	11.008	.001[b]
	Residual	6.657	79	.085		
	Total	7.597	80			

a. Dependent Variable: Time

b. Predictors: (Constant), Changes

Source: SPSS Results, 2023

According to the above table, our model is statistically significant meaning the influence of changes factors on completion of bridges is significant where the p-value is 0.001 and this is less than the significance p-value of 0.05.

Table 22: Regression between change factors and completion of bridges in Nyamagabe District

COEFFICIENTS[A]						
MODEL		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.633	.250		6.521	.000
	Changes	-.294	.089	-.352	-3.318	.001

A. DEPENDENT VARIABLE: TIME

Source: SPSS Results, 2023

https://doi.org/10.53819/81018102t5192

According to the above table, it has been found that there is negative effects of changes that happen during the project implementation especially for bridge construction projects in Nyamagabe District. This is due to the regression coefficient of -0.294 and t of -3.318 and this is statistically significance since the p-value is 0.001 which is less than 0.05. This means that changes plays a great negative impact on project completion of bridges in Nyamagabe District.

5.0 Conclusion

Project success is the primary requirement of every project organization. If the project managers and project executives do not pay attention to identify and manage all those critical success factors which determine the effective execution of the project, the project will face failure. The previous empirical studies present factors that may delay the execution of the project where this study focused on three factors including environmental factors, financial factors, and change factors. Those factors were chosen in order to know if they affect the execution of bridge project in Rwanda especially in Nyamagabe District where different public projects are known to face delay. This study concluded that environmental factors and changes related factors have a negative influence on the project execution. This means that those factors contribute more in the delaying and execution. Through this the project stakeholders should conduct deep situational analysis in order avoid cost overrun.

6.0 Recommendations

The study provides recommendations in three categories: environmental factors, financial factors, and change-related factors. To address environmental challenges, it is recommended to assess the environment and estimate costs beforehand, consider the construction period in relation to the rainy season, and account for soil-related activities and transportation. In terms of financial factors, increasing professionalism, seeking expert advice, working with financially secure contractors, and performing estimations based on price projections can help control costs and avoid delays. Regarding change-related factors, stakeholders should consult government regulations to meet quality standards, and designers should consider the geological properties of the soil. Implementing these recommendations can enhance project management, reduce risks, and ensure successful bridge construction.

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