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Assessment of the Factors Contributing to Cost and Time Overrun in Building Construction Project: A Case Study of Mauritania

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Abstract:- The paper examines the issues of cost and time overruns in the context of construction activities in Mauritania. The construction industry as the main engine of economic growth faces the worldwide problems of delays and overspending. These challenges contribute to financial losses and project delays in the Mauritanian context hence the need to understand what causes them. The primary goal of this study is to determine and understand what causes cost and time overrun in project in Mauritania. Using both quantitative and qualitative research techniques, information was gathered via questionnaires from different construction stakeholders. The study employed descriptive statistics and regression in assessing relationships and the patterns between causes of overruns. This study presents a range of issues that have significant impacts on both costs and time overruns in the projects for example weak contract management, financial constraints, and changes in the project scopes among others. However, these factors were enumerated using the RII (Relative importance index). Another approach adopted is creating predictive models that help in anticipating time delays and the impact on cost overflows. They have good predictive power showcasing complex links between time and cost overruns. The study shows how crucial are good project and contract management, effective site management, and clear communication can be for reducing time overruns. The study further demonstrates strong positive relationships between the timing losses and costs overruns highlighting significance of the correct timing for costs controlling strategies.

Keywords:- *Time overrun, Cost overrun, impact, construction project, predictive models, Mauritania, Project management.*

I. INTRODUCTION

The economy relies significantly on the construction industry, which greatly affects the productivity of other sectors. Infrastructure facilities are necessary for substantial investments in manufacturing, agriculture, or services. One of the main objectives and policies of any public or private sectors dealing with the execution of projects is to upgrade project performance through minimization of costs, completion of projects within their assigned budget and time limits and improve quality.

The aim of project control is to ensure the projects finish on time, within budget and achieve other project objectives. However, current practices in the construction industry reveal that achieving project timelines, staying within budget, and maintaining desired quality are rare occurrences. Unfortunately, the construction industry in Mauritania faces similar challenges, withfrequent instances of cost and time overruns.

Construction projects face challenges in meeting budget and deadline requirements, which can lead to cost and time overruns. The lack of understanding about the factors influencing cost and time is a significant reason for these overruns. Consequently, overruns affect project objectives such as cost, time, quality, and productivity, and can even result in bankruptcy for construction companies. Therefore, it is crucial to comprehend the causes of delays and cost overruns to ensure effective project management and prevent potential financial losses for the project and the construction companies involved.

Developing countries are the most prone for such problem which often causes the delay of construction and other services, increased costs and lost revenue due to inefficient execution. Mauritanian construction activities often result in budget and schedule blowouts leading to higher spending, late deliverables, and low production. The overruns are caused by varied issues, which includes mis conceptualization of the factors affecting cost and time. The situation brings up more disagreements hence aggravating the problem.

Therefore, this study will determine the reasons for cost and time overruns during project construction in Mauritius, with a view towards identifying feasible solutions that could be put into practice to address such problems, hence facilitating successful project completion in line with the stipulated budgetary and temporal limits. Although much attention has been focused on the issue of cost and time overruns in the construction sector, the studies conducted are hardly specific to Mauritania. The absence of this information prevents devising of proper interventions towards preventing time-and-cost overruns during construction projects in Mauritania. As discussed above, Mauritanian environment necessitates carrying out investigation on costs and time overruns as predictive tools for their occurrence in order to help manage construction industry in the country.

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The main objective of this research was to assess the actors contributing to cost and time overruns in construction projects in Mauritania. This research aimed to identify factors contributing to cost and time overruns in Mauritanian construction projects, develop predictors model, and propose mitigation measures.

Construction projects aim at maximizing quality while minimizing costs and time. As such, it's justified that the study will identify the major causes of cost and time overruns, design a model used in prediction of overruns, and proffer useful mitigating actions. It also enhances projects success by reducing cases of cost and time overlaps.

Cost and time overrun issues in construction projects are not confined to Mauritius; they affect building projects in most developing countries all over the world. However, detailed studies on what exactly were leading to these cost overruns are lacking.There is a problem of high costs and delayed completion of construction projects in Mauritania as it results in negative impact on objectives, profit of the contracting party, client, and other parties having interests in the project. It has been noted that effective management of cost and time overruns is essential and a central concern for construction projects worldwide, according to earlier research.

Not with standing, some limitations exist in previous research such as out dated investigations, etc..

II. LITERATURE REVIEW

Construction industry makes vital contribution in nation's progress although has adverse effects due to cost and time-over runs. As of now, the construction sector in Africa has witnessed unprecedented development. The gross domestic product (GDP) of the nation has been highly contributed by the construction industry. (Gashahun, 2020). It made up approximately 7% in Kenya, 11.9% in Nigeria and on average for Sub-saharan Africa was 21.3%. (Gashahun, 2020). Generally, the tertiary sector comprising construction industry takes away 32.9% of the total GDP in Mauritania (Ministry of Economic Affairs and Development, March 2023).

Completing projects within the time is an indicator of an efficient construction industry, Chan and Kumaraswamy (1997). The completion of a project does not solely determine its success from the perspective of the project owner. The success of a project, as perceived by the client or owner, is influenced by various critical factors. These factors include the ability to complete the project within the allocated budget, adhering to the scheduled timeline without delays, ensuring a high standard of work quality, and prioritizing health and safety considerations. These key factors serve as fundamental indicators of a project's success, as they ensure that the project meets the client's expectations, delivers value for the investment, and maintains a safe working environment. Effectively managing and addressing these factors, project owners can enhance their overall project outcomes and increase the likelihood of achieving success. Adhering to the scheduled closing date without delays allows for timely project completion and avoids any potential negative consequences, such as contractual penalties or missed business opportunities. Maintaining a high standard of work quality guarantees the delivery of a project that meets the client's requirements and expectations, enhancing overall satisfaction. Lastly, prioritizing health and safety considerations safeguards the well-being of the project's workers and stakeholders, minimizing the risk of accidents or legal issues.

Mezher & Tawil (1998), however noted that time overrun in Lebanon construction industry are costing the country a lot of money and that there is a need to find more effective methods to overcome the problem. Construction project is a mission, undertaken to create a unique facility, product or service within the specified scope, quality, time, and cost (Chiittkara, 2004). Cost overrun, poor quality workmanship and delay of construction projects require an in-depth investigation to improve the outputs of the construction industry.

Time and cost overruns are the most severe issues in the construction sector. In any construction, project time and cost overruns exist and the severity of these varies considerably from project to project, one country to another etc.....

Time overrun is a most common incident, which occurs nearly in all the projects related to the construction industry. Time delay is critical in developing countries where it exceeds its 100 % of estimated time while constructing a project.(Uroosa M., 2017)

Mansfield et. al. (1994), carried out a questionnaire survey amongst 50 contractors, consultants and client organizations in Nigeria and found out that the most important variables causing construction delays are poor contract management, financing and payment of completed works, changes in site conditions, shortage of materials, imported materials and plant items, design changes, subcontractors and nominated suppliers. (Kodwo & Seth, 2014).

(Gupta & Kumar, 2020)identified that poor climatic planning and scheduling, lack of proper site management, fluctuations in the material rate, monitoring and controlling, improper management of resources in construction project and poor financial control in site can yield to cost overruns.

Time overrun (delay) based on the two methods one is the Inexcusable delay (Non - Excusable delay and second is the Excusable delay shown in the bellow (Uroosa M., 2017)

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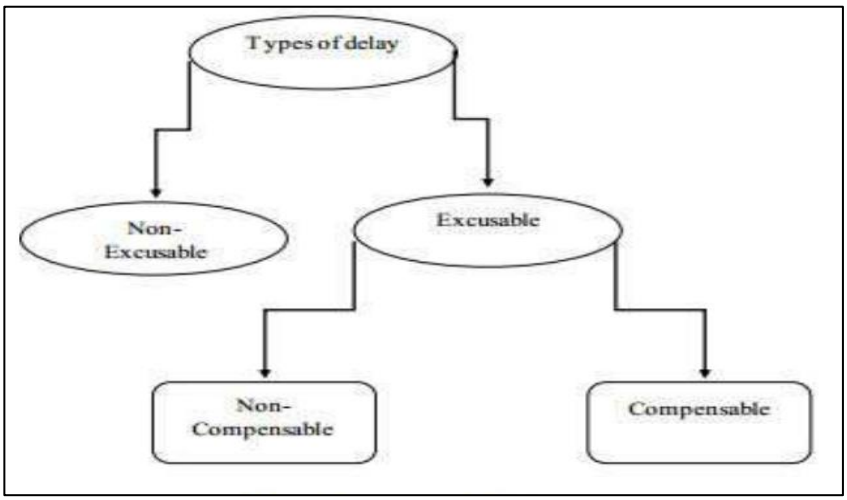

Fig. 1: Type of delay

Cost overrun is the difference between the original cost estimate of the project and actual construction cost on completion of the work.

Cost overrun is a major problem in the construction industry where 9 of 10 projects are faced by these overruns which commonly range between 50 to 100%.(Albtoush & Doh, 2019). Cost overrun is common in infrastructure and building construction projects. Researches on construction projects in some developing countries indicate that by the time a project is completed, the actual cost exceeds the original contract price by about 30 % . (Oynaka, 2020).

Construction cost that is out of control adds investment pressure, increases construction cost, affect investment decision making. Hence, it is important to identify the factors that contribute to cost overrun to avoid and reduce the problems (Ali, A. & Kamaruzzaman, 2010).

Angelo and Reina (2002), stated that cost overrun is a major problem in both developed and developing countries. Several studies of major projects show that cost overrun is common. The causes of cost overrun in construction projects are varied, some are not only hard to predict but also difficult to manage.

Shaqour, (2014); Khodeir and Hamdy, (2015) and Yakoub, (2016) mentioned that the majors factors cause of cost overrun in Egypt are changes in project scope, material prices, poor estimation of project cost, additional works at owner's request, donor policy in bidding to the lowest price, fluctuations in the cost of building materials, delay in project completion time, fraudulent practices, kickbacks, corruption and economic instability, political insecurity, Unsupportive governmental policies and Governmental control and regulations.

Danso and Antwi (2012) identified price fluctuations, poor planning andcontrol, lack of coordination at design phase,ineffective cost control systems, design scopechanges as the major causes of cost overruns in the construction projects in Ghana. The study also found clients' delay ofpayment certificates, unrealistic clients' requirements, delays in design work, design information and contract modifications, and lack of tower materials in the local markets as the causes of time overruns in Ghana.

III. METHODOLOGY

A. Data collection

This research adopted a combination of quantitative and qualitative methods. The data were collected through developed questionnaire based on literature review and through semi-structured interviews and fromproject managers, contractors, and other stakeholders involved in the selected construction projects in Mauritania.

The questionnaire was divided into four sections, each focusing on specific areas of investigation. Both closed-ended and open-ended questions were included to capture both quantitative and qualitative data….

The questionnaires were distributed to the identified study sample (150 persons), including project managers, architect, builders, quantity surveyors, contractors, engineers, clients, and other relevant stakeholders involved in construction projects in Mauritania. 130 were responded and the 19 reminded questionnaire were not responded.

A five-point scale of 1 to 5 was considered for evaluating each factor, these numerical impact and likelihood values will be assigned to the respondents' rating: (1: Not significant; 2: Slightly significant; 3: Moderate; 4: Very significant; 5: Extremely significant).

B. Data Analysis

Both quantitative and qualitative data analysis techniques were employed. Quantitative data was analysed using statistical methods: descriptive statistics, relative importance index for ranking and regression analysis to identify correlations and patterns and to short out a model. Qualitative data from interviews and open-ended questions in the questionnaires were analysed through thematic analysis to identify recurring themes and extract meaningful insights.

ISSN No:-2456-2165

Relative Importance Index **RII:**

For ranking in this research, Relative Important Index RII was used. (RII) technique is a method used to assess the relative importance or significance of different factors or variables in a research study. It is commonly employed in survey-based research where respondents are asked to rate or rank the importance of various factors.

$$RII = \Sigma\, ai * ni / N * A$$

Where:

- ai = assigned weight to ith response,
- ni = frequency of ith response,
- N = total number of respondents,
- A = highest weight

Ranking the factors based on their RII values was done in descending order. The factor with the highest RII is considered the most important, while the one with the lowest RII was considered the least important. It was useful for identifying the most influential factors. It provided a quantitative measure of relative importance and helped prioritize factors for further analysis or decision-making.

C. Regression:

Conducting regression analysis helped to examine the relationship between variables and madpredictions. Regression analysis is a statistical technique that investigates the relationship between a dependent variable and one or more independent variables.
The equation form of regression model is as follows:

$$Y = \beta 0 + \beta 1X1 + \beta 2X2 + \ldots + \beta nXn + \varepsilon$$

Where:

- **Y** represents dependent variable (Cost overrun or Time overrun predicted)
- **X1, X2, …, Xn** represent the various factors that contribute to the cost and time overruns.
- **β1, β2, …, βn**are Coefficients (The relationship between the independent variables and the dependent variable)
- **β0** represents the intercept.
- **ε** = Error term

The study adhered to ethical principles, including obtaining informed consent from the study participants, ensuring the confidentiality of the participants' data, and ensuring that the research does not harm the participants or the community in any way.

IV. RESULTS AND DISCUSSION

A. Response rate

A total of 150 questions were distributed, and 130 were returned. As can be seen in table 1, the response rate was 87%. This indicates that nonresponse bias was about 13%. Based on Richardson, (2005), a response rate of more than 50 % is considered acceptable and therefore the obtained response rate of 87% indicates that the returned rate was acceptable and sufficiently representative.

Table 1: Returned rate

Distributed	Returned	Rate
150	130	87%

B. Respondents profile

➢ *Profession/position of respondents*

Based on the respondents' professions or positions: most respondents were Technicians, constituting 42.3% of the sample. Engineers make up a significant portion of the respondents at 28.5%. Project Managers account for 20.8% of the sample. Architects represent the smallest group, with only 8.5% of respondents. These results provide insight into the professional backgrounds of the respondents in the study. It is important to consider how the different professions within the construction industry may have varying perspectives on factors contributing to cost and time overruns. See Figure 2.

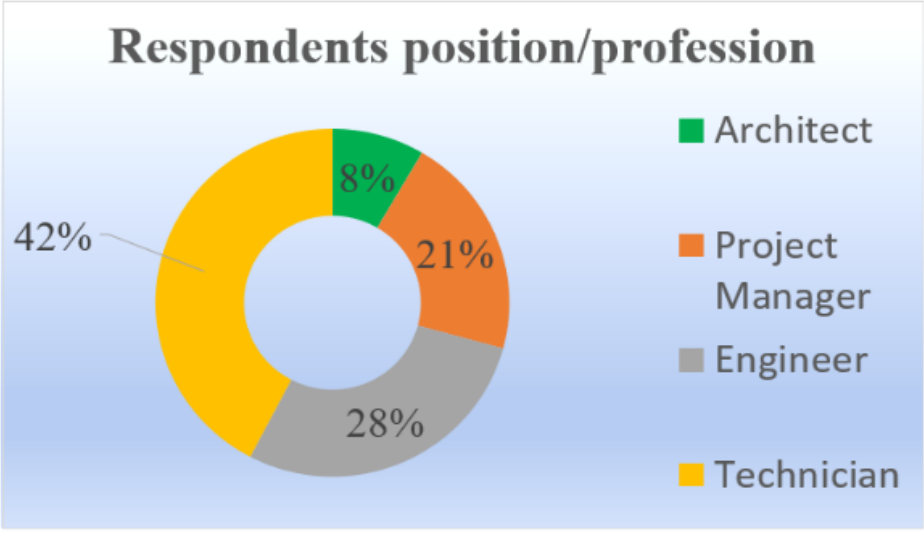

Fig. 2: Respondents profession/position

ISSN No:-2456-2165

➢ *Education level*

Based on the respondents' levels of education, majority of respondents had a bachelor's degree (Licence), comprising 52.3% of the sample. The second most common educational level was master's degree, with 34.6% of respondents holding this qualification. A smaller percentage of respondents (12.3%) had achieved a PhD (Doctorate), indicating a highly educated subset of the sample. Only one respondent (0.8%) reported having a Diploma (BTS or other). As shown in Figure 3.

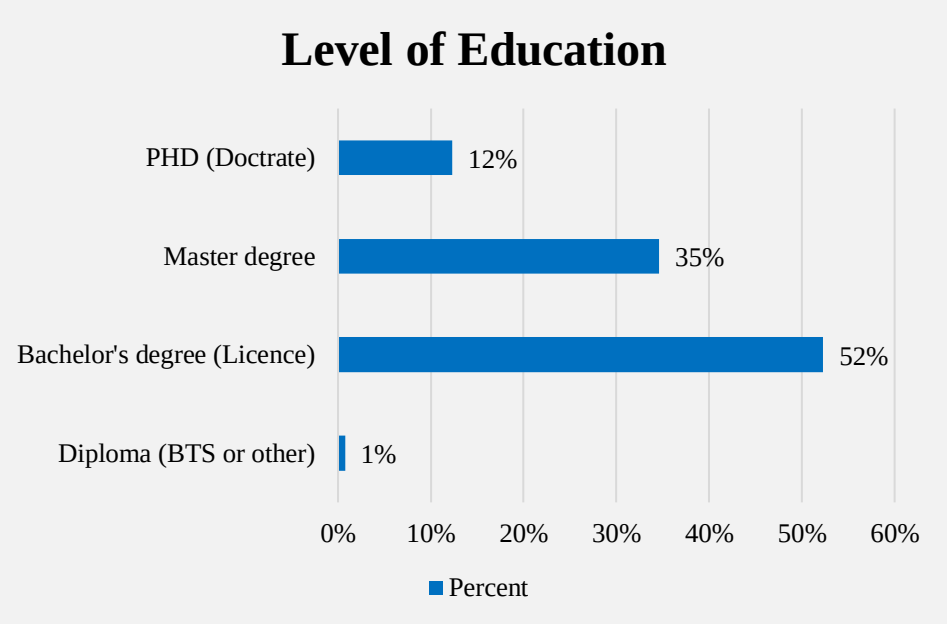

Fig. 3: Level of education

➢ *Experience*

The largest group of respondents, 46.9%, had 1-5 years of experience in the industry. The second largest group, 28.5%, had 6-10 years of experience. A significant portion, 24.6%, have more than 10 years of experience. As shown in Figure 4.

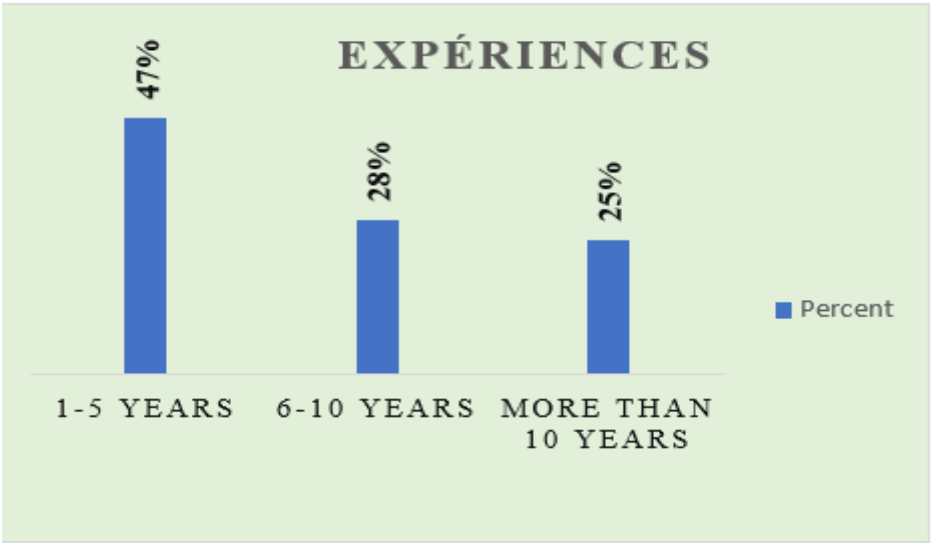

Fig. 4: Respondents experiences

C. Ranking of factors: RII

➢ *Factors contributing to time overrun.*
VS = very significant, S = significant, M = moderate, SS = slightly significant, NS = not significant

Table 2: Ranking of factors contributing to time overrun

Factors	**Code**	**VS**	**S**	**M**	**SS**	**NS**	**Total weightage**	**Ranking**
Inadequate contractor's experience	FTOV17	33	66	24	7	0	0.7923	1
Lack of coordination with project participants	FTOV15	24	64	22	7	13	0.7215	2
Poor construction site management and supervision	FTOV19	34	58	10	3	25	0.7123	3
Financial difficulties encountered by contractor	FTOV16	31	36	36	25	2	0.7062	4
Improper construction method / techniques	FTOV26	12	78	18	8	14	0.7015	5
Poor communication with project parties	FTOV28	45	35	14	6	30	0.6908	6
Inadequate experience of the consultant	FTOV09	34	44	10	28	14	0.6862	7
Late provision of instructions	FTOV07	25	37	36	30	2	0.6815	8
Late payments during works progress	FTOV01	18	38	60	6	8	0.68	9
Late issuance and incomplete information	FTOV13	16	48	47	7	12	0.6754	10
Use of low productive equipment	FTOV30	42	18	28	31	11	0.6754	10
Variation and change requirements during execution stage	FTOV03	41	30	9	27	23	0.66	12
Delay in site mobilization	FTOV25	9	62	28	16	15	0.6523	13
Late procurement of materials and delivery by contractor	FTOV29	30	36	11	41	12	0.6477	14
Unclear delegation of responsibilities	FTOV12	21	40	33	18	18	0.6431	15
Late approval of tests and site inspections	FTOV14	29	25	36	20	20	0.6354	16
Ineffective scheduling of the project	FTOV24	26	34	26	17	27	0.6231	17
Late preparation of Request for Information (RFIs) by contractor	FTOV20	20	32	28	39	11	0.6169	18
Suspension of work by client	FTOV08	15	39	26	41	9	0.6154	19
Late payment to subcontractors by main contractor.	FTOV23	9	39	27	54	1	0.6015	20
Inadequate technical study during bidding	FTOV21	13	48	24	15	30	0.5985	21
Rework due to mistakes and errors	FTOV18	18	20	46	29	17	0.5892	22
Specific expertise that cannot be gotten within locally available labor, which forces client to employ labor from outside the country.	FTOV37	28	13	38	26	25	0.5892	22
Delay in subcontractor's works	FTOV27	10	26	55	19	20	0.58	24
Delay in receiving clearances through Customs of the imported materials.	FTOV04	9	36	22	50	13	0.5662	25
Fluctuation materials price	FTOV36	9	20	58	26	17	0.5662	25
Ambiguities, mistakes, inconsistency and discrepancies in drawings and specifications.	FTOV10	15	21	44	22	28	0.5585	27
Late inspection of imported material at the ports	FTOV35	8	27	28	64	3	0.5585	27
Late approval of shop drawings	FTOV11	8	44	18	30	30	0.5538	29
Client's interference in contractual duties	FTOV05	4	23	60	23	20	0.5508	30
Unfavorable Weather conditions	FTOV32	21	11	33	44	21	0.5492	31
Frequent change of subcontractors	FTOV22	10	24	29	53	14	0.5431	32
Slowness in decision making by owner	FTOV06	4	30	43	22	31	0.5292	33
Unrealistic contact period imposed by owner	FTOV02	3	24	46	35	22	0.5246	34
Unexpected government regulations	FTOV33	16	28	8	46	32	0.5231	35
Construction materials cannot be procured on local market and have to be imported.	FTOV34	10	19	24	58	19	0.5123	36
Delay in preparation of shop drawings and materials samples.	FTOV31	6	16	41	46	21	0.5077	37

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In Table 2, these ranking provide a comprehensive view of the factors contributing to time overruns in construction projects, allowing to prioritize and address the most critical issues effectively. There were 32 selected factors for but just 20 are the most critical according to the ranking (relative importance index RII). Higher RII values indicate greater significance.

Factors ranked from 1 to 5 are considered "Very Significant" contributors to time overruns and should be prioritized for mitigation. These include inadequate contractor experience, lack of coordination with project participants, poor construction site management and supervision, financial difficulties encountered by the contractor, and improper construction methods/techniques.

Factors ranked from 6 to 10 are "Significant" contributors and include poor communication with project parties, inadequate experience of the consultant, late provision of instructions, late payments during works progress, and late issuance of incomplete information.

Factors ranked from 11 to 20 are "Moderate" contributors to time overruns and include issues such as the use of low-productivity equipment, variation and change requirements during execution, delay in site mobilization, late procurement of materials, unclear delegation of responsibilities, late approval of tests and site inspections, ineffective scheduling of the project, late preparation of Request for Information (RFIs) by the contractor, suspension of work by the client, late payment to subcontractors by the main contractor, inadequate technical study during bidding, rework due to mistakes and errors, and the need for specific expertise not locally available.

- *Inadequate Contractor's Experience (RII = 0.7923):*

The fact that inadequate contractor experience ranked as the most significant factor contributing to project delays indicates that respondents view the skills and expertise of contractors as a crucial determinant of project success. Inexperienced contractors may struggle to effectively manage projects, leading to delays, cost overruns, and quality issues. The high ranking of inadequate contractor experience suggests that a lack of expertise and knowledge among contractors is a significant issue in Mauritania. It is essential to invest in the development of skilled and knowledgeable contractors to enhance project management and execution.

- *Lack of Coordination with Project Participants (RII = 0.7215):*

Poor coordination among project participants, including owners, contractors, and subcontractors, is a recurring challenge in construction. This finding emphasizes the importance of efficient communication and collaboration to prevent misunderstandings and disputes that can lead to project delays.

Strategies for improving coordination and communication need to be implemented. This may involve the use of project management tools, regular meetings, and clear roles and responsibilities for all project participants.

- *Poor Construction Site Management and Supervision (RII = 0.7123):*

This factor underscores the significance of effective site management and supervision. Inadequate supervision can result in safety issues, quality problems, and inefficient work processes, all of which contribute to project delays. Proper training and resource allocation for site managers and supervisors are crucial. It is essential to ensure that construction sites are efficiently managed to maintain progress and quality.

- *Financial Difficulties Encountered by Contractor (RII = 0.7062):*

Financial constraints can disrupt project cash flows and lead to payment disputes. This ranking reflects the economic challenges that contractors in Mauritania may face, which can impede project progress. Facilitating access to project financing, improving payment mechanisms, and assisting contractors in financial planning can address this issue.

- *Improper Construction Method / Techniques (RII = 0.7015):*

Using inappropriate construction methods can result in rework, delays, and inefficiencies. The high ranking of this factor highlights the importance of adopting best practices in construction processes.

Promoting proper training, education, and adherence to industry best practices can enhance project efficiency and reduce delays.

- *Poor Communication with Project Parties (RII = 0.6908):*

Poor communication among project stakeholders results in misunderstandings, disputes, and delays. Emphasizing transparent and efficient communication processes improves project collaboration and can mitigate this challenge.

- *Late Provision of Instructions (RII = 0.6815):*

Delays caused by late provision of instructions can lead to project disruptions. Contractors and project participants rely on timely guidance to make informed decisions and maintain progress. Streamlining the instruction process and ensuring prompt communication between project stakeholders is essential for preventing this delay factor.

- *Late Payments During Works Progress (RII = 0.680):*

Late payments during works progress can strain cash flows and disrupt project timelines. Timely payment is essential for maintaining contractor motivation and project progress. Developing clear payment schedules and mechanisms can help ensure that contractors receive payments promptly, mitigating this factor's impact on project delays.

- *Late Issuance and Incomplete Information (RII = 0.6754):*

Delays caused by late issuance of critical documents and incomplete information can result in project inefficiencies and rework. Implementing efficient document

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management systems and emphasizing the importance of complete and accurate information can prevent this issue.

- *Use of Low Productive Equipment (RII = 0.6754):*

The use of low-productivity equipment can significantly impact project efficiency and timelines. Employing suitable machinery and tools is essential for productivity. Encouraging the use of efficient equipment and regular maintenance can minimize delays caused by inadequate machinery.

- *Variation and Change Requirements During Execution Stage (RII = 0.66):*

Changes in project requirements during the execution stage can lead to delays, rework, and additional costs. This factor emphasizes the importance of effective change management. Efficient change management processes and clear communication with all project stakeholders are crucial for addressing this challenge.

- *Delay in Site Mobilization (RII = 0.6523):*

Delays in mobilizing resources and initiating work on the construction site can significantly impact project schedules. Effective project planning and resource mobilization strategies help to prevent delays at this stage.

- *Late Procurement of Materials and Delivery by Contractor (RII = 0.6477):*

Delays in procuring materials and their delivery can result in construction hold-ups. Timely procurement is essential for maintaining progress. Efficient supply chain management and clear procurement schedules are essential for preventing this delay factor.

- *Unclear Delegation of Responsibilities (RII = 0.6431):*

Unclear delegation of responsibilities can lead to confusion and inefficiencies in project execution. Clearly defining roles and responsibilities for all project participants help eliminate misunderstandings and prevent this factor from causing delays.

- *Late Approval of Tests and Site Inspections (RII = 0.6354):*

Delays in approving tests and site inspections can affect project quality and schedules. Timely approvals are crucial for maintaining progress. Streamlining the approval process and establishing clear deadlines for inspections can mitigate this challenge.

- *Ineffective Scheduling of the Project (RII = 0.6231):*

Ineffective project scheduling can lead to mismanagement, resource shortages, and delays in project execution. Developing comprehensive and realistic project schedules and ensuring adherence to them are essential for minimizing project delays.

V. DISCUSSION

In comparing these findings to existing literature, we see a consistent alignment with global trends in construction project management. However, these results provide unique insights into the specific challenges faced in the construction industry in Mauritania.

These findings suggest that targeted strategies should be implemented to improve contractor expertise, enhance coordination among project participants, ensure proper site management, address financial challenges, and promote the use of appropriate construction methods. By focusing on these areas, the construction industry in Mauritania can work to minimize project delays and improve project outcomes.

The ranking of factors in this study corresponds with much of the existing literature on construction project delays. Inadequate contractor experience, poor coordination, and financial difficulties are recognized as significant contributors to project delays in many studies. These factors reflect fundamental issues that can affect project timelines and are consistent with the challenges faced in the construction industry worldwide.

However, there might be some variations or surprises in the rankings when compared to existing literature, especially in the specific context of Mauritania. Factors like "Improper construction method / techniques" ranking high could be indicative of unique challenges or practices in the local construction industry.

The implications of these findings suggest that efforts should be directed towards improving contractor expertise, enhancing coordination among project participants, addressing financial constraints, and ensuring the use of appropriate construction methods to mitigate project delays in Mauritania.

A. Factors of cost overrun.

VS = very significant, S = significant, M = moderate, SS = slightly significant, NS = not significant.

ISSN No:-2456-2165

Table 3: Ranking of factors contributing to cost overrun

Factors	Code	VS	S	M	SS	NS	Total weightage	Ranking
Poor site financial control	FCOV11	40	38	28	24	0	0.7446	1
Poor contract management	FCOV07	42	32	29	17	10	0.7215	2
Government's Unstable economic conditions.	FCOV06	23	22	44	45	18	0.6815	3
Fluctuation in the cost of building materials.	FCOV03	7	69	15	31	8	0.6554	4
Lack of local skilled labor	FCOV09	28	39	27	8	28	0.6477	5
Frequent design changes	FCOV02	25	33	31	27	14	0.6431	6
High cost of transport	FCOV08	13	50	21	38	8	0.6338	7
Omissions and errors in the bills of quantities	FCOV05	12	48	26	31	13	0.6231	8
Political interference	FCOV10	17	26	26	57	4	0.5923	9
Construction materials cannot be procured on local market and have to be imported.	FCOV15	24	12	39	45	10	0.5923	9
Lack of updated cost data on specifications	FCOV01	9	28	44	46	3	0.5908	11
Duration of Contract period	FCOV12	25	21	26	34	24	0.5831	12
Adjustment of prime cost and provisional sums.	FCOV13	4	22	63	40	1	0.5815	13
Inadequate review of drawings and others contract documents.	FCOV04	21	18	37	31	23	0.5738	14
Unexpected government regulations	FCOV14	17	31	10	43	29	0.5446	15

Factors ranked from 1 to 3 are the most significant contributors to cost overruns and should be given high priority for mitigation. These include "Poor Site Financial Control," "Poor Contract Management," and "Government's Unstable Economic Conditions." These top-ranked factors highlight the pivotal roles of effective financial management, efficient contract administration, and proactive management of external economic influences in preventing cost overruns.

Factors ranked from 4 to 6 are "Highly Significant" contributors to cost overruns and should be prioritized for mitigation. These include "Fluctuation in the Cost of Building Materials," "Lack of Local Skilled Labor," and "Frequent Design Changes." These factors underline the importance of stabilizing material costs, developing local labor, and managing design changes effectively to control project budgets.

Factors ranked from 7 to 12 are "Significant" contributors, including "High Cost of Transport," "Omissions and Errors in the Bills of Quantities," "Political Interference," "Construction Materials Cannot Be Procured Locally," "Lack of Updated Cost Data on Specifications," and "Duration of Contract Period." Addressing these issues, such as optimizing logistics, improving bill of quantities accuracy, and adhering to legal frameworks, can help mitigate cost overruns.

Factors ranked from 13 to 15 are "Moderate" contributors to cost overruns and should also be considered for mitigation. These include "Adjustment of Prime Cost and Provisional Sums," "Inadequate Review of Drawings and Contract Documents," and "Unexpected Government Regulations." These factors emphasize the need for clear contract definitions, thorough document reviews, and adaptation to changing government regulations to prevent cost overruns.

These rankings provide a comprehensive view of the factors contributing to cost overruns in construction projects, allowing project stakeholders to prioritize and address the most critical issues effectively.

B. Poor Site Financial Control (RII = 0.7446):

Poor financial control on the construction site is the top-ranked factor contributing to cost overruns. It indicates that inefficient financial management can lead to budget overruns and disruptions in project cost control. Implementing robust financial management practices, budget monitoring, and cost control mechanisms are essential for addressing this factor.

C. Poor Contract Management (RII = 0.7215):

Ineffective contract management can lead to cost overruns. It suggests that issues related to contracts, such as variations and disputes, are common in construction projects. It highlights the importance of comprehensive contract administration. Emphasizing effective contract management, dispute resolution mechanisms, and robust change order processes can help mitigate this challenge.

D. Government's Unstable Economic Conditions (RII = 0.6815):

The unstable economic conditions in Mauritania can lead to cost overruns due to factors beyond the control of project stakeholders, such as inflation and exchange rate fluctuations. Implementing robust risk management strategies, economic forecasting, and contingency planning can help address this challenge.

E. Fluctuation in the Cost of Building Materials (RII = 0.6554):

Fluctuations in the cost of building materials can disrupt budget planning and lead to cost overruns. This factor highlights the vulnerability of construction projects to market price changes. Implementing strategies such as fixed-price contracts, long-term procurement agreements, or local material sourcing can help stabilize costs.

ISSN No:-2456-2165

F. Lack of Local Skilled Labor (RII = 0.6477):

The shortage of skilled labor is a common challenge that can lead to higher labor costs and inefficiencies in construction projects. Focus on training and developing local labor to meet the demands of construction projects.

G. Frequent Design Changes (RII = 0.6431):

Frequent design changes can lead to extra costs, delays, and rework in construction projects. Effective design management, clear documentation, and a robust change management process can help minimize this factor's impact.

H. High Cost of Transport (RII = 0.6338):

High transportation costs can inflate project budgets, especially in remote areas. Exploring alternative transportation options, optimizing logistics, and local sourcing can help control transportation expenses.

I. Omissions and Errors in the Bills of Quantities (RII = 0.6231):

Errors in quantity estimations can lead to underestimation of project costs, resulting in budget overruns. Ensuring accurate and comprehensive bills of quantities and thorough cost estimation processes is vital to prevent cost overruns.

J. Political Interference (RII = 0.5923):

Political interference can disrupt projects by imposing unexpected changes, affecting procurement, or introducing inefficiencies. Clear governance, adherence to legal frameworks, and political stability are key factors in managing this issue.

K. Construction Materials Cannot Be Procured Locally (RII = 0.5923):

When construction materials cannot be sourced locally and must be imported, project costs can rise due to import duties, shipping, and supply chain challenges. Encouraging the use of local materials and exploring alternative sourcing options can help manage these challenges.

L. Lack of Updated Cost Data on Specifications (RII = 0.5908):

The absence of updated cost data on project specifications can lead to inaccurate budgeting and cost overruns. Maintaining updated cost databases and utilizing cost estimation software can help address this challenge.

M. Duration of Contract Period (RII = 0.5831):

Lengthy contract periods can lead to increased project costs, especially if the duration is underestimated. Ensuring realistic contract periods and proper project scheduling can help mitigate this factor.

N. Adjustment of Prime Cost and Provisional Sums (RII = 0.5815):

Frequent adjustments to prime cost and provisional sums can lead to budget uncertainties and cost overruns. Careful assessment and clear definitions of these cost components in contracts can help prevent adjustments.

O. Inadequate Review of Drawings and Contract Documents (RII = 0.5738):

Inadequate review of drawings and contract documents can lead to misunderstandings, scope changes, and cost overruns. Emphasizing thorough document review processes and technical evaluations is crucial to prevent this factor from causing cost overruns.

P. Unexpected Government Regulations (RII = 0.5446):

Unexpected government regulations can disrupt construction projects, leading to additional compliance costs. Staying informed about regulatory changes and adapting project plans accordingly is essential to address this issue.

VI. DISCUSSION

In comparing these findings to existing literature on construction cost overruns, we observe a consistent alignment with global trends in construction project management. However, these results provide unique insights into the specific challenges faced in the construction industry in Mauritania.

These findings suggest that targeted strategies should be implemented to address the primary factors contributing to cost overruns in the region. To align with global best practices, the construction industry in Mauritania should focus on enhancing financial control, improving contract management, and effectively managing economic instability. The top-ranked factors in this study correspond with many of the recognized contributors to cost overruns worldwide, emphasizing the need for proactive measures to prevent these issues.

However, there might be some variations or surprises in the rankings when compared to existing literature, particularly in the local context of Mauritania. For instance, the high ranking of factors like "Fluctuation in the Cost of Building Materials" and "Lack of Local Skilled Labor" may indicate unique challenges or practices specific to the construction industry in Mauritania.

The implications of these findings suggest that efforts should be directed towards implementing robust financial management practices, strengthening contract administration, and effectively managing external economic conditions. Additionally, stabilizing material costs, developing local labour, and addressing design changes are essential strategies to mitigate cost overruns in the construction industry in Mauritania. By focusing on these areas, the industry can work towards minimizing budget overruns and improving project outcomes.

A. Regrouped factors into main groups

The factors influencing construction project cost and time overruns can be broadly categorized into several key groups. See table 4 "Contractor's Site Management" encapsulates issues such as poor supervision, improper construction methods, and delays in site mobilization, which can lead to inefficiencies and disruptions. The "Information/Communication" group emphasizes the significance of effective coordination and communication,

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with late issuance of critical information and requests for information potentially causing project delays. The quality of project design and documentation is vital within the "Design/Documentation" category, as inadequate technical studies and late approvals can result in errors and delays. Access to both human and non-human resources is essential, with a shortage of skilled local labor or difficulties in procuring construction materials potentially increasing costs. The "Financial Management" section addresses financial control, material cost fluctuations, and errors in cost estimations. "External Factors" include material price fluctuations, adverse weather conditions, and government regulations, while "Project and Contract Management" encompasses a broad spectrum of issues like inadequate experience, payment delays, unclear responsibilities, and changes to project requirements. Recognizing these groupings aids in identifying potential risk areas, emphasizing the need for effective planning, communication, and risk management to prevent cost and time overruns in construction projects.

Table 4: Main groups / Regrouped factors

Groups	Factors
Contractor's Site management	Poor construction site management and supervision
	Improper construction method / techniques
	Use of low productive equipment
	execution stage
	Delay in site mobilization
	Late procurement of materials and delivery by contractor
	Late approval of tests and site inspections
	Ineffective scheduling of the project
	Rework due to mistakes and errors
	Delay in subcontractor’s works
	Delay in receiving clearances through Customs of the imported materials.
Information/communication	Lack of coordination with project participants
	Poor communication with project parties
	Late provision of instructions
	Late issuance and incomplete information
	Late preparation of Request for Information (RFIs) by contractor
Design/Documentation/	Inadequate technical study during bidding
	Late approval of shop drawings
	Delay in preparation of shop drawings and materials samples.
	Inadequate review of drawings and others contract documents.
Human and non-Human Resources	Specific expertise that cannot be gotten within locally available labor, which forces client to employ labor from outside the country.
	Construction materials cannot be procured on local market and have to be imported.
	Lack of local skilled labor
	Construction materials cannot be procured on local market and have to be imported.
Financial management	Poor site financial control
	Fluctuation in the cost of building materials.
	Omissions and errors in the bills of quantities
	Lack of updated cost data on specifications
	Adjustment of prime cost and provisional sums.
External factors	Fluctuation materials price
	Unfavorable Weather conditions
	Unexpected government regulations
	Government’s Unstable economic conditions.
	Political interference
	Unexpected government regulations
Project and contract management	Inadequate contractor’s experience
	Financial difficulties encountered by contractor
	Inadequate experience of the consultant
	Late payments during works progress
	Variation and change requirements during
	Unclear delegation of responsibilities
	Suspension of work by client
	Late payment to subcontractors by main contractor.
	Late inspection of imported material at the ports
	Client’s interference in contractual duties
	Frequent change of subcontractors

	Slowness in decision making by owner
	Unrealistic contact period imposed by owner
	Poor contract management
	Frequent design changes
	High cost of transport
	Duration of Contract period

B. Predictors Models

➢ *Time overruns.*

- Model 1

Table 5: Model 1

Model Summary[b]									
					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.993[a]	0.985	0.985	0.07145	0.985	1179.665	7	122	0.000
b. Dependent Variable: TimeOverrun									

The model summary as shown in Table 5 for time overruns presents a regression model that attempts to explain the variations in time overruns based on several factors related to different aspects of construction projects. The key takeaway from this analysis is that the model exhibits a remarkably high level of explanatory power, as indicated by an R Square value of 0.985. This means that approximately 98.5% of the variability in time overruns can be accounted for by the chosen factors. In practical terms, this indicates that these factors collectively hold substantial predictive value for understanding and managing time overruns in construction projects.

The Adjusted R Square, which is also 0.985, suggests that the model remains reliable even when accounting for the number of predictors. This means that the inclusion of these specific factors significantly contributes to the model's accuracy in predicting time overruns.

Additionally, the very low p-value (Sig. F Change < 0.001) associated with the F-statistic of 1179.665 reinforces the statistical significance of the entire model. It underscores that the combination of these factors is highly effective in enhancing our understanding of time overruns.

The extremely low standard error of the estimate (0.07145) further bolsters the model's reliability by indicating a tight fit between the predicted values and the actual data, strengthening its accuracy in forecasting time overruns.

- **ANOVA**

Table 6: ANOVA model 1

ANOVA[a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	42.156	7	6.022	1179.665	.000[b]
	Residual	0.623	122	0.005		
	Total	42.779	129			
a. Dependent Variable: TimeOverrun						

The ANOVA result as shown in Table 6 supports the conclusion drawn from the model summary that the combination of these predictor categories is highly effective in explaining and predicting time overruns in construction projects. The model is statistically significant, and its low residual sum of squares suggests a strong fit to the data.

- **Coefficients and the equation of the model**

The coefficients as presented in Table 7 provides valuable insights into the relationships between various categories of factors and time overruns in construction projects. It is evident that several factors play a significant role in influencing time overruns, while others have a relatively minor impact.

First and foremost, the category of "Project and Contract Management" stands out as the most influential predictor of time overruns. With a substantial coefficient of 0.362, it indicates a strong positive relationship. This means that effective project and contract management practices are crucial for minimizing time overruns. Construction projects that are well-managed and where responsibilities are clearly defined tend to experience fewer time delays.

"Contractor's Site Management Related Factors" and "Information/Communication" are also important predictors with coefficients of 0.241 and 0.198, respectively. These results emphasize the significance of

efficient site management and clear communication among project stakeholders. Problems in these areas can lead to delays and, subsequently, time overruns.

"Design/Documentation" is another significant predictor with a coefficient of 0.113. This highlights the importance of having comprehensive and accurate design and documentation. Incomplete or incorrect design documents can lead to delays during the construction process.

On the other hand, "Human and Non-Human Resources" and "Financial Management" have coefficients of 0.009 and 0.012, respectively, indicating that these factors have only a minor impact on time overruns. While they should not be overlooked, it suggests that improvements in these areas might have a limited effect on reducing time delays.

"External Factors" also have a positive impact on time overruns, with a coefficient of 0.071. These external factors, such as economic conditions and government regulations, can influence project timelines, but their effect is less significant compared to internal management practices.

Effective project and contract management, contractor's site management, communication, and comprehensive design and documentation are key areas to focus on when addressing time overruns. While external factors play a role, they are less influential, and human and non-human resources as well as financial management have a relatively minor impact.

Table 7: Coefficients of model 1

Coefficients[a]											
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	-0.071	0.053		-1.353	0.178	-0.176	0.033			
	Contractor's site management related factors	0.241	0.020	0.273	12.144	0.000	0.201	0.280	0.912	0.740	0.133
	Information/communication	0.198	0.017	0.220	11.931	0.000	0.166	0.231	0.756	0.734	0.130
	Design/Documentation	0.113	0.015	0.193	7.733	0.000	0.084	0.142	0.885	0.574	0.084
	Human and non-Human Resources	0.009	0.016	0.011	0.585	0.560	-0.022	0.041	0.651	0.053	0.006
	Financial management	0.012	0.016	0.013	0.771	0.442	-0.019	0.044	0.673	0.070	0.008
	External factors	0.071	0.013	0.113	5.428	0.000	0.045	0.097	0.531	0.441	0.059
	Project and contract management	0.362	0.029	0.341	12.288	0.000	0.304	0.420	0.950	0.744	0.134
a. Dependent Variable: TimeOverrun											

Here we have the equation of the model.

*Time Overrun = -0.071 + (0.241 * Contractor's Site Management Related Factors) + (0.198 * Information/Communication) + (0.113 * Design/Documentation) + (0.009 * Human and Non-Human Resources) + (0.012 * Financial Management) + (0.071 * External Factors) + (0.362 * Project and Contract Management).*

➢ *Effect of time overrun on cost overrun.*

- **Correlation**

Table 8: Correlation of Model 2

Correlations			
		Cost Overrun	TimeOverrun
Pearson Correlation	Cost Overrun	1.000	.734
	Time Overrun	.734	1.000
Sig. (1-tailed)	Cost Overrun	.	.000
	Time Overrun	.000	.
N	Cost Overrun	130	130
	Time Overrun	130	130

The results (from Table 8) demonstrates that the relationship between "CostOverrun" and "TimeOverrun" is substantial and positive. That means when "TimeOverrun" goes up, it also causes an upward trend of "CostOverrun". Therefore, such findings imply that an increased lag time in a construction project is accompanied by cost escalations as an important issue that any project manager must remember.

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➢ *Model 2*

The model summary as shown in Table 9 gives vital comprehension into the association between the independent variable, "CostOverrun" and the predicted one, "TimeOverrun." The R value of 0.734 shows strong positive linear relationships and it indicates the high positive correlation between the two variables. Additionally, R Square of 0.539 means that around 53.9% of difference in "CostOverrun" can be explained by "TimeOverrun" which signifies its high level of predicting power as well as significant ability to explain more than half of variation. With just a single predictor, it guarantees that the model's goodness fits will remain reliable since Adjusted R Square is slightly lower at 0.535. An estimate deviation is expressed as "Standard error of the Estimate", and for this case it is 0.42226 which implies a remaining "unexplained cost overrun" variation. The smaller this value, the better the fit of the model to data. The R Square change of 0.539 shows that an extra "cost overrun" is accounted by introducing "time overrun." The striking F-statistic of 149.686 proves an overall high statistical and predictive reliability of the model. Degrees of freedom are linked to predictors and sample points as indicated by the symbol –df1 and –df2. In particular, a very small significance level (Sig.). Furthermore, low F=change!<0.001 signifies an immense improvement made in the model's forecast potential by "Timeoverrun." Overall, "Timeoverrun" alone as the predictor has demonstrated a considerable proportion of variance in "costoverrun." Additionally, high In addition, the model shows strong statistical significance, which is essential for good project management and cost control.

Table 9: Model 2

Model Summary[b]									
					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.734[a]	.539	.535	.42226	.539	149.686	1	128	.000
a. Predictors: (Constant), TimeOverrun									
b. Dependent Variable: CostOverrun									

➢ *ANOVA*

Table 10: ANOVA of model 2

ANOVA[a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	26.690	1	26.690	149.686	.000[b]
	Residual	22.823	128	.178		
	Total	49.513	129			
a. Dependent Variable: CostOverrun						
b. Predictors: (Constant), TimeOverrun						

The ANOVA results as shown in Table 10 confirm the statistical significance of the regression model with "TimeOverrun" as the predictor. The high F-statistic and very low significance level underscore the model's capability to effectively predict "CostOverrun" based on "TimeOverrun." These results provide strong support for the importance of time management in mitigating cost overruns in construction projects.

➢ *The coefficients and equation*

This coefficients as shown in Table 11 demonstrates that "TimeOverrun" has a significant positive effect on "CostOverrun." A one-unit increase in "TimeOverrun" corresponds to an increase of approximately 0.790 units in "CostOverrun." The strong correlation and low multicollinearity indicate that "TimeOverrun" is a valuable predictor for explaining cost overruns in construction projects.

The equation: *Cost Overrun = 0.650 + 0.790 * Time Overrun*

Table 11: Coefficients of model 2

Coefficients[a]													
		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
Model		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
2	(Constant)	0.650	0.202		3.210	0.002	0.249	1.051					
	Time Overrun	0.790	0.065	0.734	12.235	0.000	0.662	0.918	0.734	0.734	0.734	1.000	1.000
a. Dependent Variable: CostOverrun													

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VII. CONCLUSION AND RECOMMENDATION

A. *Conclusion*

In conclusion, this research has explored the critical aspects of construction project cost and time overruns in the context of Mauritania. The study has dissected the contributing factors, developed predictive models, and extracted meaningful insights that can significantly benefit the construction industry in the region. The journey through this investigation unveiled several key findings and their implications, shaping the way forward for more successful and efficient construction projects in Mauritania.

The research began by identifying and categorizing factors contributing to cost and time overruns in construction projects. These factors spanned various domains, including contractor's site management, information and communication, design and documentation, human and non-human resources, financial management, external factors, and project and contract management. These categories represent a comprehensive framework that encapsulates the multifaceted nature of challenges faced by construction projects in Mauritania.

The study ventured into the development of predictive models to understand and manage time overruns. The first model demonstrated an exceptional level of explanatory power, with an R Square of 0.985, indicating that 98.5% of the variability in time overruns can be accounted for by the chosen factors. The second model uncovered a strong positive correlation between times overruns and cost overruns, emphasizing the pivotal role of time management in controlling project costs.

B. *Recommendations:*

Based on the study's findings, the following recommendations are proposed to help mitigate construction project cost and time overruns in Mauritania an d in the region:

- **Enhance Project and Contract Management:** Project stakeholders should prioritize effective contract administration, clear definition of responsibilities, and efficient project management practices. This can significantly reduce time and cost overruns.
- **Improve Contractor's Site Management:** Implement robust site management practices, including proper supervision, construction methods, and timely site mobilization to minimize delays.
- **Strengthen Information and Communication:** Promote efficient communication and coordination among project participants. Timely provision of instructions and complete information can prevent project delays.
- **Comprehensive Design and Documentation:** Ensure that technical studies, shop drawings, and materials samples are prepared and approved on time. Accurate and complete design documents are crucial for preventing delays.
- **Develop Local Skilled Labor:** Address the shortage of skilled labor by investing in training and development programs for the local workforce.
- **Financial Management:** Implement sound financial control practices to track budgets and costs effectively, and address fluctuations in material costs and bill of quantities errors.
- **Monitor External Factors:** Stay informed about external factors such as economic conditions, government regulations, and fluctuating material prices. Develop risk management strategies to mitigate their impact.
- **Address Time Overruns:** Given the strong positive correlation between time overruns and cost overruns, a primary focus should be on time management and adherence to project schedules.
- **Regularly Update Cost Data:** Maintain up-to-date cost data on project specifications to ensure accurate budgeting and prevent cost overruns.
- **Optimize Contract Period:** Ensure that contract periods are realistic and well-scheduled to prevent time overruns.
- **Mitigate Political Interference:** Advocate for stable political environments that do not interfere with contractual duties.

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