FORMULATION OF STRUCTURAL EQUATION MODEL OF MITIGATIONS AND OVERRUN FACTORS FOR THE SAUDI ARABIAN RAILWAY/METRO PROJECTS.

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Abstract

This paper presents a study on developing a structural model of Mitigation measures and overrun factors in Saudi Arabian Railway Metro construction projects. A literary review found 24 measures related to mitigations and 58 overrun factors. These factors were used as the main content of the questionnaire's development. The questionnaire was distributed among the Railway/Metro construction practitioners to evaluate each factor based on the 5-points Likert scale. The data collected from the questionnaire survey was used in the development of the structural equation model. The criteria for the selection of experts was that they should have more than five years of experience in Saudi Arabian Railway metro construction projects. The total 263 no of questionnaire survey forms distributed among experts working on the Riyadh metro project and 220 no of questionnaire were found correct to use for the analysis. The first part of the analysis was to identify the demography of the experts which describe that all the experts have substantial experience in the railway metro projects, also were qualified and have a senior role/designation in their organization that makes them suitable to answer the questions and give the researcher the confidence to fully rely on their views. After demography, the reliability of the data was checked through SPSS which found the data satisfactory and can be used further . Before final modelling through PLS SEM, an exploratory factor analysis (EFA) was performed to reduce the no. of mitigations and over-run factors and grouped them in clusters to get the required results for the model. EFA clusters 24 factors of mitigation into four groups which are Construction Planning, Construction Execution, Design Control and Commercial and identified 54 overrun factors clustered into five groups which are Financial, Design, Construction Execution, Construction Planning and Contract Administration. Based on the final form of the model, construction execution and commercial mitigation category which consists of several causative factors has significant impact on overrun factors of railway/metro construction projects. This finding is validated using advanced techniques of multivariate analysis which will benefit all parties involved in construction projects for controlling overrun factors. As a result, this study adds to the body of knowledge in the railway construction sector by offering an empirical assessment of overrun factors and mitigation strategies in Saudi Arabia.

Keywords: Construction; Overrun factors; Mitigations; Railway; PLS SEM; Management

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1. Introduction

The transportation project's infrastructure offers a pillar to the modern-day economies and is key to its social development. Various government agencies have committed significant amounts of their resources to the construction and maintenance of transportation infrastructure. For example, as compared to other public projects, developing nations have retained about 20% of the monies they have borrowed from the World Bank for transportation projects (Donaldson, 2017).

In the last decade, Saudi Arabia invested in it's public transportation projects, which is easy to sustain and makes it more accessible for existing facilities. Those projects include the railway and Transit Metro systems (Al-Malik, 2019). The railway infrastructure moves towards operating sustainably and economically, which could contribute positively to the economy. Urban project planning is always considered difficult to execute, mainly when it includes infrastructure construction — compared to similar projects around; rail projects are neither economic nor simple to realise (Al-Malik, 2019).

In Saudi Arabia, only a few railway infrastructure projects have been constructed, and all exceeded the budgeted period and cost. Since railway infrastructure is essential, the government has to execute railway infrastructure transportation projects despite the high cost and time. Hence, the government has adopted a national transport strategy to improve the transport sector in Saudi Arabia by investing more than USD 55 billion in public transport (Ellayatt, 2018). For the rail industry, successful projects completed under the approved budget and given time mostly depend on the construction methodology of the latest engineering techniques and engineers' sound judgment. This problem is generally observed in traditional public projects and remedial measures must mitigate the delays and excess cost, especially rail projects (Al Hammadi, 2016). Hence, comprehensive investigation is needed to uncover the relationship between mitigation measures on cost and time overruns factors.

Literature Review

All around the world, the most common issues recognized in the construction industry are project schedule delays and budget increases. Cost and time overruns have been persistent problems in the construction business for decades. Despite reforms, it is a well-known fact that cost overruns and time delays are significant factors that continue to affect construction projects. Various public infrastructure projects in developing countries were added with extra financial resources due to slow progress and time delays (Alaghbari et al., 2007), Amandin et al., 2016), Cunningham, T., 2017) and Heravi et al., 2017). It makes it challenging to construct a project, which is usually a complicated endeavor related to huge cost and long duration of construction, to achieve success for the project, as explained by Chidambaram (2014), Olawale, (2014), Srdic & Selih, (2015), and Ramabhadran, (2018). According to Sweis et al. (2017), the poor performance of project delivery in Saudi Arabia's construction projects is a longstanding issue and has portrayed an undesirable image. The Mahamid (2017) study looked at 55 road projects in Saudi Arabia and discovered that 58.24 percent of the projects were behind schedule, with delays ranging from a 2 percent rise to a 172 percent increase in the projected time of construction. Assaf and Al-Hejji (2006) pointed out that delays in projects increase overheads, making the contractor unable to bid for future projects. Increasing the project period and increasing overhead costs hinder the contractor from identifying different business opportunities. Flyvbjerg et al. (2013) reported that a great portion of infrastructure projects such as rail and road construction exceed the baseline budget with positive increases to the budget of 50%–100% of the estimated cost with delays in completion. Cantarelli et al. (2012) conducted a research study on Dutch rail projects and found a 90% chance of a cost overrun, with an average of 65% increase for project costs with schedule delays. Fouracre et al. (1990) studied cost overruns for 21 metro projects throughout the world and found that all of the metro systems had expenses that were higher than projected, including delays to construction schedules. In a more recent metro project, the design and build contract's construction cost for the Dubai Metro rail increased by almost 100%, from the original $4.2 billion to $8 billion with delays. In Brazil, the Rio Metro increased its planned budget by 100%, from the initial expected cost of $1.4bn to approximately $2.8bn. Harmain High-Speed Rail (Makkah-Madina 449 KM) project costs also increased by approximately 95% and are reported to have almost doubled from the initial expected cost of $1.81bn to approximately $3.49bn with a 150% increase in the scheduled duration. Construction delays and cost overruns have been discovered in earlier research, and mitigation strategies for cost and time overrun elements have been previously recommended. According to the findings (Yahya Rashid, 2019), construction delays can be reduced by implementing more than one solution at the same time. The solution applied depends on the project's nature and the factors that cause poor performance. Even though earlier studies only offered suggestions and recommendations and the recommendations did not correlate with the mitigation measures and the related variables, they were still proven to be useful. The study by Memon et al. (2012) proposed 15 mitigations to recover cost performance and 13 mitigations to reduce construction delays. However, the proposed mitigations' effectiveness was not discussed or reviewed during this study. Amlcar A and D.F. Ferreira (2020) conducted research on the Portuguese construction industry for overrun factors and their mitigations and concluded that previous research has focused on identifying the major causes of construction project delays, with mitigation methods usually given as a list that ignores the relationship between cause and effects. E. T. Banobi and W. Jung (2019) conducted research on Tanzanian power construction projects and found that the delays caused by mitigation strategies significantly varied depending on project progress performance.

2. Research Methodology

Multivariant PLS-SEM analysis was used to develop the hypothetical model between mitigation measures on overrun factors for the construction of Railway/Metro construction projects in Saudi Arabia. This research is based on both primary and secondary sources of information. The first data consists of information gathered by specialists through surveys and site visits, the questionnaire survey instrument used to collect the data from the experts. While research articles were used to collect secondary data sources. Forty-eight (48) mitigation measures were extracted from the resultant data and seventy-seven (77) overrun factors were extracted from the resultant data. Before a pilot survey with 20 professionals, the content validity analysis was done with experts to modify the description or to merge similar factors before the actual survey with the larger number of experts. In this process 24 mitigation measures and 58 overrun factors were identified and used in the final questionnaire. The first part of the instrument was in regard to the expert's demography and the second part of the instrument assessed the relevance of each aspect of the mitigations and overrun factors on a 5-point Likert scale based on how important it was to the construction of railway metro projects. Only 220 questionnaire survey forms were considered correct from the respondents out of a total of 263 questionnaire survey forms sent to the professionals which provided the input data for the model. The data reliability was tested by using statistical software of SPSS and Exploratory Factor Analyses (EFA) which were adopted to uncover the latent structure of a set of variables, this analysis reduces the number of variable from large numbers to a smaller number and as such is a non-dependent procedure. Finally, the hypothesis was formulated from the results of EFA , where it indicates four groups of mitigations measures that influence the five groups of overrun factors. The PLS-SEM was used to test the fitness of measurement model and structural model and also assess the predictive relevancy.

3. Results and Discussions

This study is based on primary and secondary data. Initial data consist of data collected by the professionals through the use of questionnaires and site visits. Secondary sources of data were obtained using research papers. Twenty-two (24) motivational factors were extracted from the resultant data, while there were fifty-eight (58) overrun factors. A total of 263 questionnaire survey forms were distributed to professionals working on construction projects and only 220 questionnaire forms were received from the respondents that were considered for the research.

Demographic of Study

The demographics of this survey are respondents including architects, engineers and surveyors. Figure 1 shows that the 51% are engineers, followed by 27% for other job titles, then 14% were architects and finally surveyors at 8%. In terms of building and construction experience, Figure 4-2 shows that 46% of respondents have from 0 to 10 years of experience, then 28% of respondents have experience ranging from 11-20 years, followed by experienced participants 21-30 years at 15% and finally 11% of participants have more than 31 years of experience. Respondents of this study are construction professionals working in the construction of the Riyadh Metro Project. The respondents' demographic profile involves designations of respondents in their companies, level of education, years of experience in Saudi's construction industry and countries of origin. Besides that, it includes the role of the respondent on the sites. Figure 2 demonstrates respondents' demographic profile from the questionnaire.

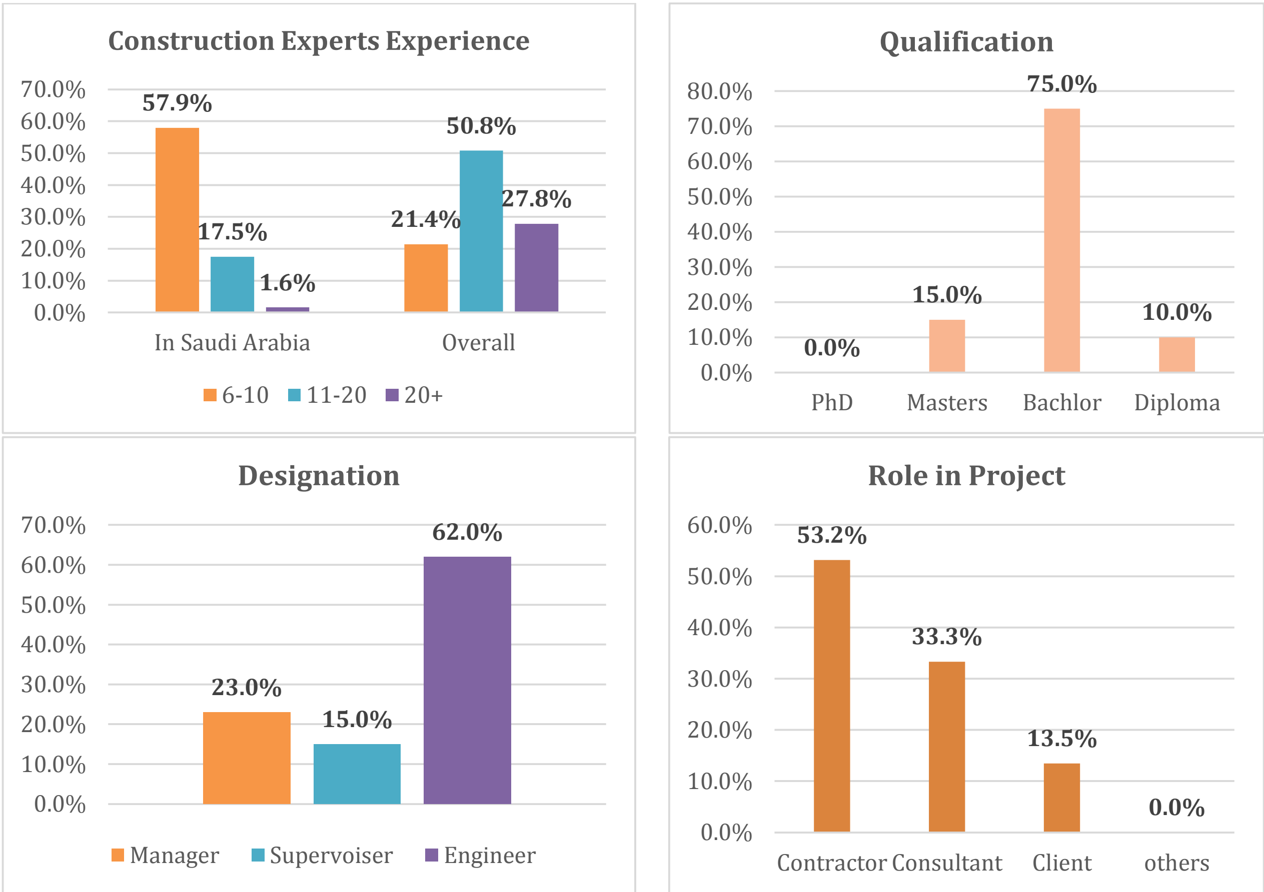

Figure 2: Respondents' demography from the actual survey

Figure 2 presents the demographic profile of respondents who participated in this study's data collection. It involves five main questions, which are: Their designation in the company, academic qualification, working experience in Saudi Arabia, years of experience in other countries, and role on the project. Respondents were questioned to specify their designations in their organization. Based on the questions the highest percentage of participants' roles belong to the engineer with a percentage value of 62%, followed by managers with a percentage value of 23% and 15% for technical staff. It also indicates that this study's participating respondents are well educated and technically competent to understand the cost and time overrun factors. Respondents' expertise was measured based on their qualifications, working experience, and the average number of workers. Referring to Figure 2, all the respondents have obtained academic qualifications of diploma, bachelor's degree, and master's degree with percentage values of 10%, 75%, and 15%, respectively. It is perceived that most respondents have bachelor's degrees and then master's degree holders; this confirms that the selected respondents are well qualified and knowledgeable for both railway construction cost and time overrun factors and also respond to the conducted survey. All the respondents have substantial working experience in Saudi's construction industry for more than five years in terms of their working experience. Besides experience in Saudi Arabia, most of the respondents had significant experience in other countries for more than ten years. Likewise, respondents include the contractor, consultant, and client of the railway project. Therefore, it can be concluded that the respondents who participated in this study are eligible and have adequate knowledge and experience of construction issues-particularly factors related to cost and time overrun and the required mitigation measures in handling factors.

Reliability of the data

The reliability analysis is primarily examined with the gathered data's internal consistency and validity. The Cronbach's Alpha is used to calculate data suitability and accuracy, and it ranges from 0 to 1 with a value of 1, suggesting perfect separation. A high value represents more homogeneous data collection (Sekaran and Bougie, 2010). Li and Wang (2007) and Pallant (2011) conclude that Cronbach's Alpha score of 0.5 is inappropriate and greater than 0.7 is acceptable, whereas 0.8 is adequate and 0.9 is outstanding. SPSS tools were used to test Cronbach's Alpha's value, and the findings were documented in Table 1.

Table 1: Reliability test results for the actual survey

Part	Title	No of Item	Cronbach Alpha
B	Overrun Factors	58	0.923
C	Mitigation Measures	24	0.890

Code	Overrun Factors – Exogenous Variables	Cluster	Definition
FF_1	Consortium /Contractor Finance Management	**Monetary Related Factors**	The process of keeping track of resources, most importantly monetary ones, and managing them in such a way as to ensure that they are being used effectively in accordance with best practices.
FF_2	Insurance bond and guarantees		
FF_3	Delay in payment/ Client financial capacity		
FF_4	Change in currency rate/Fluctuation in price		
FF_5	Warranty and liability		
FF_6	Rate of interest		
FF_7	Price Escalation of material		
FF_8	Tax rate		
FF_9	Conflict in the amount of payments		
FF_10	Unavailability of financial incentives for Contractor to finish ahead of schedule		
DF_1	Design Errors and delays	**Design Related Factors**	The procedure that involves the selection of construction design, as well as their adaptation and integration, in order to satisfies the requirements of the client
DF_2	Delay in the preparation and approval of site/shop drawings		
DF_3	Complexity of design		
DF_4	Design team experience		
DF_5	Excessive design review and changes		
DF_6	The difference in design practice and standards		
DF_7	Lack of database in estimating activity duration and resources		
DF_8	Delay in completion of planning and design		
DF_9	Issues regarding permissions/ approvals from other stakeholders (Third party)		
EF_1	Inappropriate construction methods	**Construction Implementation Related Factors**	Implementation is the process by which an idea is transformed from a concept into a reality.
EF_2	Defective work/Rework		
EF_3	Sub-contractor Issues		
EF_4	Controlling subcontractors by general contractors in the execution of work		
EF_5	Relationship between subcontractors' schedules in the execution of the projects		
EF_6	Testing and acceptance criteria of consultant		
EF_7	Social and cultural factors (Local protectionism, Language, Holidays, and deliberations)		
EF_8	Strike/disruption		
EF_9	Construction location (urban/rural)		
EF_10	Unpredicted weather (/Earthquake /Precipitation/flood)		
EF_11	Productivity of labor		
EF_12	Labor skills level		
EF_13	Labor Accidents		
EF_14	Deficiencies in coordination between parties- (Contractor, Consultant, and Owner)		
EF_15	Unavailability of professional construction management expertise		
EF_16	Poor site Management and supervision		
PF_1	Organization structure	**Integrative Management Related Factors**	Coordinate a number of project aspects including cost, schedule, and resources (among others).
PF_2	Availability of labor		
PF_3	Poor or No human resource plane		
PF_4	Poor Communication plan		
PF_5	Planning and schedule deficiencies		
PF_6	Material monopoly (Nominated vendor, production of		

	special manufacture of materials)		
PF_7	Procurement of material (Procurement method, Shortage, Delivery)		
PF_8	Equipment Issues (quality, Maintenance)		
PF_9	Non confirming materials		
PF_10	Poor procurement plan		
CF_1	Change in law & regulation	**Contract Administration Related Factors**	Perform the function of a liaison between the internal business parties and the external vendors and suppliers, making certain that the terms are accurately documented and carried out.
CF_2	Clients' decision-making process and change control procedures		
CF_3	Slowness of the client's decision-making process		
CF_4	Contractual claims, such as an extension of time with cost claims		
CF_5	Contract modifications (replacement and addition of - new work to the project and change in specifications)		
CF_6	The uncompromising attitude between parties		
CF_7	Definition of scope not clear		
CF_8	Inappropriate type of contract used		
CF_9	Mistakes and discrepancies in contract documents		
CF_10	Negotiation and obtaining contracts		
CF_11	Unpredictable or catastrophic events (War/Epidemic)		
CF_12	Land acquisition Issues		
CF_13	The owner has no priority/ urgency to complete the project		

PLS-SEM model

A hypothetical model of mitigation measures on overrun factors for Saudi Arabian railway/metro construction project. This mitigation and overrun factors were identified through rigorous literature view. 220 respondents who work in the construction sector completed a questionnaire survey, which provided the input data for the model. They assessed the relevance of each aspect on a 5-point Likert scale based on how important it was to the railway construction project. Exploratory factor analyses (EFA) were adopted by using statistical software of SPSS to uncover the latent structure of a set of variables, this analysis reduces no of variable from large no. to a smaller no. and as such is a nondependent procedure. The following table 1 depict the result of EFA that reduce the no of variables into group/cluster to use in PLS SEM modelling. This study has identified 24 mitigation measures and these factors are clustered into four groups which are Construction Planning (PM) having 7 factors, Construction Execution (EM) group having 5 factors, Design Control (DM) having 5 factors and Commercial (FM) having 3 factors. Also identified 54 overrun factors. These factors are clustered into five groups which are Financial (FF) having 10 factors, Design (DF) having 9 factors, Construction Execution (EF) having 16 factors, Construction Planning (PF) having 9 factors, and Contract Administration (CF) Related Factors having 13 factors. These factors are in table 2 and table 3.

Table -2: Mitigation Measures Clusters

Code	Mitigations – Endogenous Variables	Cluster Name	Definition
PM_1	Accurate cost estimation	**Strategic Practice Mitigations**	Preparing for successful accomplishments through planning
PM_5	Assign contingency for Time and Cost during estimates		
PM_2	Prepare and follow communication plan		
PM_6	Prepare and follow procurement plan		
PM_3	Adopt efficient construction management		
PM_4	Provide training to unskilled workers according to their trade		
PM_7	Hire experience contract administrator		
EM_3	Implement efficient sub-contractor selection process	**Effective Implementation Mitigation**	Putting strategic plans into action to attain objectives
EM_1	Plan the resource management plan efficiently		
EM_4	Plan project coordination with different stakeholders		
EM_6	Adopt project monitoring and controlling system		
EM_2	Prepare and implement Risk Management		
EM_5	Hire experienced Project Manager/Skilled Workers		

Code	Mitigations – Endogenous Variables	Cluster Name	Definition
DM_1	Appoint Experience design team	**Professional Conduct Mitigation**	The code of ethics that governs a professional's behavior
DM_4	Designing the project to a great detail		
DM_2	Acquire efficient method of design approvals		
DM_6	Ensure contingency for the time required on design changes		
DM_3	The client's scope requirement should be finalized		
DM_5	Control the design changes		
FM_1	Client should pay on time	**Agility in Commercial Issues**	Agility is the ability of an organization to adapt changes quickly.
FM_5	Must ensure the timely availability of required finance		
FM_4	Contractors make sure that it pays on time to sub-contractor		
FM_2	Adopt financial management plan		
FM_3	Prepare a comprehensive financial plan and cash flow		

Table -2: Overrun Factors Clusters

Refer to table 1, it depicts independent variables (Mitigation measures) that has 4 groups depict in all are converged to dependent variables (Overrun factors) consists 5 groups, all of which were generated using the factor analysis methodology.
The conceptual model generated was created in the SmartPLS software and used for simulation work in order to analyze the influence of mitigation measures on overrun factors to railway metro construction project. It is necessary to calculate and evaluate several parameters in order to carry out the PLS simulation of the model, which include item loading, reliability, and validity testing. According to Henseler et al. (2015), it is a two-step procedure that entails determining PLS model parameters separately by figuring out the blocks of the measurement model and then estimating the table-1, and

path coefficients of a structural model, respectively.

Evaluation of Measurement Model Fitness
Measurement model evaluation is aimed to evaluate the consistency and validity of the manifest variables. Consistency evaluations are through individual manifest and construct reliability tests. While validity of the variables is tested based on convergent and discriminant validity Hair et al. (2017). The following table 3 provide the guidelines to accept the results extracted from PLS SEM with reference from previous studies.

Table 3: Evaluation criteria for measurement model

Evaluation criteria	Guidelines	References
Indicator reliability/ factor loading	▪ Indicator with loadings of less than 0.4 or 0.5 should be deleted. ▪ Indicator outer loading > 0.5 shows good measurement. ▪ Cut-off point of 0.70.	Hulland (1999) Hair et al. (2017) Fornell and Larcker (1981)
Convergent validity	Cronbach's alpha (α) ≥ 0.7	Hair et al. (2017)
	Composite Reliability, CR ≥ 0.7 for adequate consistency.	Gefen et al., 2010; Hair et al. (2017)
	Average Variance Extracted, AVE > 0.5	Fornell and Larcker (1981); Bagozzi and Yi (1988); Henseler et al. (2016); Hair et al. (2017)
Discriminant validity (Cross loading criterion and Fornell-Larcker criterion)	▪ Cross loading criterion- an indicator's outer loadings on a construct should be higher than all its cross loadings with others constructs. ▪ Square root of the AVE of each construct > correlation values between the other exogenous constructs.	Chin (1998); Chin (2010); Hair et al. (2017)

Based on the above criteria, measurement model is evaluated by iterative process to discard the weak manifest variables from the developed model. Hence, a total of 3 iterations were involved in this study where each of the iterations was assessed based on the criteria and resulted in discarding 15 manifest variables. Table 4 summarizes the final iterations only.

Table 4- Measurement model

<table>
<tr><th>No</th><th>Assessment</th><th colspan="10">Achievements</th></tr>
<tr><td>1</td><td>Reliability of individual items</td><td colspan="10">After iteration 3, the necessary threshold values for reliability and convergent validity for all individual items are reached</td></tr>
<tr><td rowspan="11">2</td><td rowspan="11">Convergent Validity</td><td>Construct</td><td colspan="2">Cronbach's Alpha (≥ 0.7)</td><td colspan="3">Composite Reliability (CR) (≥ 0.7)</td><td colspan="4">Average Variance Extracted (AVE) (≥ 0.5)</td></tr>
<tr><td>FF</td><td colspan="2">0.897</td><td colspan="3">0.916</td><td colspan="4">0.523</td></tr>
<tr><td>EF</td><td colspan="2">0.843</td><td colspan="3">0.883</td><td colspan="4">0.521</td></tr>
<tr><td>CF</td><td colspan="2">0.89</td><td colspan="3">0.91</td><td colspan="4">0.53</td></tr>
<tr><td>DM</td><td colspan="2">0.819</td><td colspan="3">0.867</td><td colspan="4">0.523</td></tr>
<tr><td>DF</td><td colspan="2">0.883</td><td colspan="3">0.906</td><td colspan="4">0.518</td></tr>
<tr><td>FM</td><td colspan="2">0.81</td><td colspan="3">0.869</td><td colspan="4">0.572</td></tr>
<tr><td>PF</td><td colspan="2">0.803</td><td colspan="3">0.861</td><td colspan="4">0.555</td></tr>
<tr><td>PM</td><td colspan="2">0.831</td><td colspan="3">0.874</td><td colspan="4">0.5</td></tr>
<tr><td>EM</td><td colspan="2">0.851</td><td colspan="3">0.889</td><td colspan="4">0.572</td></tr>
<tr><td>Average</td><td colspan="2">0.847</td><td colspan="3">0.886</td><td colspan="4">0.535</td></tr>
<tr><td>3</td><td>Discriminant validity - cross loading</td><td colspan="10">The cross-loading findings indicate that each item/manifest vector has a higher outer loading in its relative construct/group than in other constructs/groups. It demonstrates that the model possesses discriminant validity.</td></tr>
<tr><td rowspan="10">4</td><td rowspan="10">Discriminant validity - root square of AVE</td><td></td><td>FF</td><td>EF</td><td>CF</td><td>DM</td><td>DF</td><td>FM</td><td>PF</td><td>PM</td><td>EM</td></tr>
<tr><td>FF</td><td>0.723</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>EF</td><td>0.155</td><td>0.722</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CF</td><td>0.005</td><td>0.036</td><td>0.728</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>DM</td><td>0.066</td><td>0.055</td><td>-0.015</td><td>0.723</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>DF</td><td>-0.039</td><td>0.005</td><td>0.147</td><td>0.311</td><td>0.72</td><td></td><td></td><td></td><td></td></tr>
<tr><td>FM</td><td>0.609</td><td>0.062</td><td>0.001</td><td>0.112</td><td>-0.12</td><td>0.756</td><td></td><td></td><td></td></tr>
<tr><td>PF</td><td>0.42</td><td>0.113</td><td>0.077</td><td>0.14</td><td>0.151</td><td>0.266</td><td>0.745</td><td></td><td></td></tr>
<tr><td>PM</td><td>0.144</td><td>-0.024</td><td>0.34</td><td>0.126</td><td>0.041</td><td>0.136</td><td>0.119</td><td>0.707</td><td></td></tr>
<tr><td>EM</td><td>0.142</td><td>0.519</td><td>0.172</td><td>0.11</td><td>0.032</td><td>0.093</td><td>0.144</td><td>0.178</td><td>0.757</td></tr>
</table>

Indicator reliability/ factor loading.
With reference to the Table 3 for factor loading greater than 0.5 value considered acceptable and results showed in the Table 4 that the indicator reliability/ factor loading results extracted for the measurement model shows significant loading and according to the acceptable values and considered for the significant to manifests the final output of the model

Convergent validity
The results extracted to verify the construct's convergent validity and reliability that includes Cronbach's alpha with the average value of 0.847 (≥ 0.7), composite reliability (CR) average value 0.886 (≥ 0.7), average variance extracted (AVE) value of 0.535(≥ 0.5).hence results that are extracted and are all in acceptable range as described in table 3.

Discriminant validity; (Cross loading criterion and Fornell-Larcker criterion)
The cross-loading values obtained from the final iteration, as shown in Table 5. The cross loading of all manifest variables has greater values on their corresponding latent variable when compared to other constructs. This confirms that the manifest variables in each construct correspond to the latent variable that was allocated to the construct and that

the model has discriminant validity.

Table 5: Cross loading.

	MRF	CIF	CAF	PCM	DRF	ACM	IMF	SPM	EIM
FF_1	0.835	0.193	0.037	0.024	0.009	0.501	0.336	0.113	0.197
FF_4	0.805	0.162	0.107	0.054	0.047	0.467	0.375	0.128	0.132
FF_5	0.829	0.192	0.061	0.046	-0.01	0.547	0.393	0.068	0.147
FF_6	0.79	0.152	-0.04	-0.038	-0.118	0.537	0.215	0.091	0.087
FF_9	0.792	0.191	0.09	0.003	0.005	0.456	0.351	0.1	0.124
FF_10	0.792	0.132	0.083	0.007	-0.056	0.488	0.298	0.15	0.125
EF_10	0.165	0.717	0.089	0.08	0.063	0.086	0.13	-0.027	0.348
EF_13	0.155	0.705	0.118	-0.07	-0.071	0.022	0.127	0.054	0.36
EF_16	0.228	0.727	-0.047	0.034	-0.09	0.135	0.104	0.008	0.334
EF_2	0.122	0.672	0.057	-0.01	0.072	0.036	0.124	-0.04	0.433
EF_3	0.183	0.859	0.007	-0.027	-0.091	0.091	0.061	-0.055	0.403
EF_5	0.16	0.762	-0.03	-0.016	-0.026	0.071	0.047	-0.066	0.407
EF_7	0.056	0.66	0.112	-0.066	0.013	-0.08	0.186	0.019	0.312
CF_2	0.021	0.073	0.773	-0.058	0.104	-0.024	0.074	0.278	0.186
CF_3	-0.026	-0.026	0.786	-0.019	0.194	-0.016	0.005	0.248	0.111
CF_4	0.024	-0.032	0.725	0.025	0.086	0.039	0.034	0.279	0.084
CF_5	0.048	0.016	0.772	-0.001	0.085	0.089	0.02	0.255	0.108
CF_6	0.072	0.131	0.724	0.002	0.043	0.073	0.016	0.168	0.099
CF_7	0.106	0.098	0.793	0.017	0.131	0.088	0.108	0.267	0.224
CF_8	0.103	0.038	0.742	0.012	0.093	0.014	0.049	0.299	0.117
DM_1	-0.007	0.016	-0.035	0.866	0.302	-0.001	0.107	0.053	0.086
DM_2	0.018	-0.019	-0.018	0.779	0.276	0.013	0.116	0.097	0.042
DM_4	-0.046	-0.039	0.106	0.786	0.352	0.045	0.025	0.156	0.038
DM_5	0.141	0.002	-0.108	0.652	0.15	0.137	0.215	0.042	0.054
DF_1	0.042	0.005	0.103	0.281	0.795	-0.095	0.199	0.055	0.07
DF_2	-0.142	-0.067	0.1	0.226	0.767	-0.193	0.056	0.015	-0.034
DF_3	0.003	-0.085	0.089	0.149	0.703	-0.078	0.103	0.029	0.026
DF_4	-0.001	-0.063	0.117	0.25	0.748	-0.018	0.171	0.07	0.014
DF_5	-0.1	0.051	0.155	0.295	0.745	-0.172	0.05	-0.041	0.043
DF_6	-0.007	0.009	0.1	0.311	0.755	-0.138	0.094	0.072	0.001
DF_7	-0.047	-0.006	0.016	0.268	0.649	-0.034	0.18	0.024	0.053
DF_8	0.111	-0.044	0.136	0.28	0.705	0.022	0.18	0.086	0.039
FM_1	0.573	0.088	0.026	-0.003	-0.138	0.868	0.212	0.07	0.076
FM_3	0.281	-0.071	0.053	0.117	0.013	0.634	0.245	0.186	0.031
FM_4	0.496	0.104	0.036	0.048	-0.112	0.812	0.147	0.117	0.101
FM_5	0.535	0.06	0.047	0.043	-0.115	0.814	0.191	0.066	0.113
PF_10	0.367	0.133	0.011	0.154	0.097	0.252	0.851	0.073	0.182
PF_7	0.234	0.05	0.001	0.088	0.083	0.083	0.759	0.015	0.111
PF_8	0.296	0.093	0.054	0.135	0.16	0.137	0.766	0.123	0.13
PF_9	0.33	0.157	0.135	0.016	0.206	0.225	0.731	0.083	0.082
PM_1	0.098	-0.132	0.236	0.141	0.065	0.079	0.087	0.831	0.099
PM_2	-0.058	-0.106	0.276	0.121	0.126	-0.037	0.037	0.696	0.078
PM_3	0.095	0.046	0.243	0.068	-0.015	0.111	-0.019	0.68	0.127
PM_4	0.158	-0.033	0.23	0.06	-0.027	0.193	0.069	0.71	0.109
PM_5	0.147	-0.008	0.228	0.081	0.069	0.148	0.1	0.713	0.086
PM_6	0.135	0.117	0.287	0.044	0.007	0.048	0.146	0.733	0.166
EM_1	0.049	0.326	0.111	0.094	0.055	0.085	0.128	0.138	0.758
EM_2	0.079	0.344	0.171	0.114	0.16	0.011	0.178	0.103	0.726
EM_3	0.123	0.547	0.087	0.041	0.001	0.064	0.12	0.081	0.836
EM_4	0.128	0.277	0.199	-0.012	0.051	0.063	0.154	0.132	0.743
EM_5	0.134	0.322	0.082	0.103	0.024	0.093	0.108	0.06	0.689
EM_6	0.229	0.431	0.188	0.001	-0.086	0.166	0.102	0.184	0.777

Results illustrated in Table 4 and 5 indicate that all the values of item are above the mentioned cut-off values, it successfully meets the first set of evaluation criteria. Furthermore, the measurement model achieves two discriminant validity criteria through cross-loading and Fornell and Larcker measures. Hence, it indicates that the assessment of measurement criteria is entirely fulfilled.

Evaluation of Structural Model Fitness

The structural model's evaluation assessed the inner model based on two criteria by evaluating the model's predictive capabilities and relationships among constructs. The following table 6 depicts the

Table 6 Evaluation criteria of structural model

Evaluation criteria	Fitness Guidelines	References
i. *Structural model path Coefficients (β)*	β value should be above 0.1 regardless its signage either positive or negative	Hair et al. (2017)
Coefficient of determination (R^2)	R^2 is considered substantial, moderate, and weak if R^2 is approximately around 0.26, 0.13 and 0.02 respectively.	Cohen (1988)
iii. *Effect size (f2)*	$f^2 = \frac{R^2_{included} - R^2_{excluded}}{1 - R^2_{included}}$ The f^2 values of 0.02, 0.15, and 0.35 represent small, medium, and large effects of the exogenous variables.	Cohen (1988); Hair et al. (2017)
v. *Predictive relevance (q^2)*	$q^2 = \frac{Q^2_{included} - Q^2_{excluded}}{1 - Q^2_{included}}$ The q^2 values of 0.02, 0.15 and 0.35 indicate that exogenous variable has a small, medium or large predictive relevance for a certain endogenous variable.	Hair et al. (2017)

Based on the evaluation criteria as in table 6, the followings are the evaluation results of this structural model assessments.

Structural model path Coefficients (β)

According to the Hairet al. (2017), β value should be above 0.1 regardless its signage either positive or negative. The test is achieved by performing nonparametric bootstrapping technique. However, β value has to be tested for its significance level through t-value test. Bootstrapping technique computes t-value by creating prespecified number of samples. Hair et al. [2017] suggested that acceptable t-values for a two-tailed test are 1.65. In this study, bootstrapping generated 5000 samples and these samples are used to compute t-values as presented in Table 7.

Table 7- Boot strapping (Path Coefficient (β), t Value and P Values)

Hypothesis Dependent to Independent Variable	Path Coefficient (β)	t Value	P Values
Monetary Factors -> Agility in Commercial	0.622	0.205	0.838
Construction Implementation -> Effective Implementation	0.489	0.154	0.878
Design Factors -> Professional Conduct	0.355	0.917	0.359
Contract Admiration -> Strategic Practice	0.338	3.387	0.001
Contract Admiration -> Effective Implementation	0.146	1.171	0.242
Monetary Factors -> Strategic Practice	0.107	10.354	0.00
Integrative Management -> Professional Conduct	0.078	0.512	0.609
Integrative Management -> Effective Implementation	0.077	0.728	0.467
Integrative Management -> Strategic Practice	0.047	2.111	0.035
Contract Admiration -> Agility in Commercial	0.025	3.289	0.001
Monetary Factors -> Effective Implementation	0.024	0.832	0.406
Integrative Management -> Agility in Commercial	0.018	1.98	0.048
Design Factors -> Effective Implementation	0.015	4.64	0.00
Monetary Factors -> Professional Conduct	0.005	0.288	0.773
Design Factors -> Strategic Practice	-0.003	0.826	0.409

Hypothesis Dependent to Independent Variable	Path Coefficient (β)	t Value	P Values
Construction Implementation -> Professional Conduct	-0.014	1.303	0.193
Contract Admiration -> Professional Conduct	-0.059	7.945	0.00
Construction Implementation -> Agility in Commercial	-0.063	1.669	0.096
Construction Implementation -> Strategic Practice	-0.074	0.11	0.912
Design Factors -> Agility in Commercial	-0.119	1.368	0.172

Considering the above table 7 and comparing β values among all the paths. The highest β value symbolizes the strongest effect of predictor (exogenous) latent variable towards the dependent (endogenous) latent variable and that is Financial Planning -> Commercial Factors with beta value of 0.596 while the weakest effect on the hypothesis is Project Planning -> Construction Execution with value of -0.125. Results in table 7 show that the t-value for most of the pathways was above the minimum required level. This means that most of the assumptions are supported and accepted. Thus, there are only three insignificant relations.

Coefficient of determination (R^2)

The R^2 value, or coefficient of determination, and the value, or path coefficients of the model, are used to evaluate the link between exogenous and endogenous latent variables in structural models. According to Cohen et al. [2013], the R2 of an endogenous latent variable should be more than 0.26 for a decent model .

Table 8- R^2 values

Dependent Values	R Square
Professional Conduct Mitigation	0.139
Agility in Commercial Mitigations	0.402
Strategic Practice Mitigations	0.137
Effective Implementation Mitigation	0.295
Average	**0.243**

The created model's R^2 value is 0.243, which is greater than the suggested value, indicating that the model has a significant degree of explained variation of overrun performance by inhibiting factors.

Effect size (f^2)

A variable in a structural model may be affected/influenced by several different variables. Removing an exogenous variable can affect the dependent variable. F-Square is the change in R-Square when an exogenous variable is removed from the model. f-square is effect size (>=0.02 is small; >= 0.15 is medium;>= 0.35 is large) (Cohen, 1988). The table 9 below depicts the values extracted for f^2.

Table 9- f^2 Vales and Interpretation

Independent Variables	F Square			
	Professional Conduct	Agility in Commercial	Strategic Practice	Effective Implementation
Monetary Factors	0.000	0.518	0.011	0.001
Construction Implementation Factors	0.000	0.006	0.006	0.322
Contract Admiration Factors	0.004	0.001	0.129	0.029
Design Factors	0.138	0.022	0.000	0.000
Integrative Management Factors	0.006	0.000	0.002	0.007
Average	**0.030**	**0.109**	**0.030**	**0.072**

According to table 9, the average values of an effect size of exogenous latent variables (motivation groups) on endogenous latent variables (barriers groups). The results show an average value above the effective size of 0.02 described by Hair et al., 2017.

Predictive Relevancy

The developed structural model was validated using the predictive relevance (Q2) method, which identifies the necessary motivation factors for each particular category of barries. Predictive significance (Q2) was determined in this process using SmartPLS 3.0 software by estimating cross-validated redundancy and omitting the ninth data point to predict the omitted element.

Table 5: Predictive validity (Q2)

Dependent Variables	SSO	SSE	Q^2 (=1-SSE/SSO)
Professional Conduct Mitigation	880	816.782	0.072
Agility in Commercial Mitigations	880	674.025	0.234
Strategic Practice Mitigations	1320	1231.324	0.067
Effective Implementation Mitigation	1320	1115.312	0.155

These (Q^2) values are considerably above zero, and this implies that this model has adequate ability to predict, and hence it is considered valid for further implementation.

Global Fitness

The goodness-of-fit test is a statistical hypothesis test that is used to determine how well observed data matches predicted data .According to Akter et al., (2011), criteria of GoF to check the model fitness is as GoF are less than 0.1 is considered as Not fit , GoF between 0.1 to 0.25 as Small, GoF between 0.25 to 0.36 as Medium and GoF greater than 0.36 as large. The calculation formula of GoF was adopted from Akteret al. (2011) as follow:

$$GoF = (AVE \times R^2)^{1/2}$$

Where R^2 for this study is the average R^2 for all dependent variables (3 clusters of Barriers) is 0.204, and the average of AVE for independent variables (4 groups of Motivational factors) is 0.535

$$\text{Hence, } GoF = (0.581 \times 0.243)^{1/2}$$

$$GoF = 0.376$$

As a result, the GoF value for the generated model in this study is 0.376, which falls within the range of 0.25 to 0.36 cut-off values, which is considered to be acceptable. Accordingly, the created model is somewhat effective in explaining the reduction of overrun causes in railway metro building projects in Saudi Arabia, as demonstrated.

Contribution of the Study

This research benefits and contributions to the railway/metro construction industry and academic knowledge. The benefits of this research have been outlined as the following:

- This study has identified several projects overrun factors in Saudi Arabia. The construction community in Saudi Arabia, mainly contracting companies, would take appropriate actions to resolve these factors and use these findings to complete the project with the assigned budget and time. For the executive authorities, identifying these factors will help them formulate rules and regulations to benefit railway construction projects and ensure that construction activities are productive, safe, and sustainable.
- This study has also investigated mitigation measures to the overrun factors in railway/metro construction in Saudi Arabian context and determined several significant mitigations required for construction leaders to handle construction overrun factors effectively. Hence, construction stakeholders in the whole of Saudi Arabia would use these findings as guidelines in appointing potential mitigations for their construction projects. They would be equipped with reasonable mitigation measures and able to manage railway construction project overrun factors successfully.
- Moreover, the findings of this study can provide a comprehensive understanding and ideas to the industry stakeholders about the overrun factors faced by railway/metro construction workers in Saudi Arabia and their negative impact on construction project performance.
- The developed framework model can provide a platform for Saudi's stakeholders and decision-makers in the whole of Saudi Arabia to use as a strategy for the railway/metro project to complete on time and budget without compromising the quality and litigations.

4. Conclusions

This study has examined 24 mitigation measures and 58 overrun factors to the railway/metro construction in Saudi Arabian construction industry using PLS-SEM modelling in SmartPLS software. The developed PLS-SEM path model comprised of these variables in 4 groups as independent variables (Mitigation measures) and 5 groups of dependent variables (Overrun Factors) which contribute to Saudi Arabian railway construction. This paper successfully established the relationship between the mitigation measures and overrun factors in Saudi Arabian railway construction project through the PLS-SEM modeling approach. It also presents the development and evaluation of the constructed model to ensure that the model is adequate for the determined relationship representation. Assessment on the model found that in the outer model all the manifests in the model are reliable and valid and for the inner model, it was found that the is Financial Planning -> Commercial Factors with beta value of 0.596 while the weakest effect on the hypothesis is Project Planning -> Construction Execution with value of -0.125. Finally, the overall model has largely explained power ability to generalize the model for

Saudi Arabian railway/metro construction industry representation.

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