Received 24 July 2024
Revised 9 December 2024
Accepted 16 December 2024

Application of structural equation modelling (SEM) to evaluate reworks in sustainable buildings

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Abstract

Purpose – Sustainable buildings are designed to minimise the adverse impacts of buildings on users, occupants, communities and the environment while enhancing client investment, contractors' productivity and profit margins. However, sustainable buildings often experience significant rework. This research aims to evaluate the complex interrelationships among the causes of rework in sustainable buildings using structural equation modeling (SEM) techniques. By testing the theory and validating a framework addressing the causes of rework in sustainable buildings, the construction sector can make a meaningful contribution towards a sustainable future.

Design/methodology/approach – The study developed a questionnaire comprising 24 identified causes of rework in sustainable buildings, derived from an extensive literature review and field observations. The causes were evaluated using a 4-point Likert scale, ranging from less occurrence to very high occurrence. The survey was administered to construction professionals via online platforms and direct hand delivery.

Findings – The identified causes of rework were grouped into four components through exploratory factor analysis (EFA) and subsequently validated using SEM. These components are competency, information, framework and plan. While the measurement model demonstrated robustness, the structural model indicated the need for further refinement. The study provides actionable strategies to mitigate rework, supporting the advancement of sustainable practices within the construction sector.

Originality/value – The findings of this research carry substantial theoretical and practical significance for advancing knowledge and practices in the sustainable buildings market. Theoretically, the study enriches the understanding of rework causes and their interrelationships, providing a foundation for future research. Practically, the results serve as a vital resource for stakeholders in the construction sector and offer actionable insights to enhance decision-making, improve project outcomes and foster sustainable building practices.

Keywords Root causes analysis, Claims, Productivity, Site operatives, Malaysia

Paper type Research paper

1. Introduction

The construction sector plays a pivotal role in driving economic development, growth, and urbanisation, contributing up to 10% of GDP in many economies and employing approximately 10% of the global workforce. Despite its significance, the sector faces persistent challenges in delivering projects on time, within budget, and to the required quality. The increasing focus on sustainability has introduced additional complexities to these challenges. Unlike traditional buildings, which prioritise cost, time, and quality, sustainable buildings aim to minimise environmental impact, optimise resource efficiency, and enhance occupant health and well-being, while also improving construction company productivity (Olanrewaju *et al.*, 2024). However, these goals are frequently undermined by the pervasive issue of rework (Olanrewaju, 2022; Hwang *et al.*, 2017a), which escalates costs, prolongs timelines, and compromises sustainability. Rework consumes additional resources, generates excessive waste, increases accident risks, and leads to claims, disputes, and litigation—contradicting the principles of sustainable construction. Recent studies reveal that rework in

Frontiers in Engineering and Built Environment
Vol. 5 No. 1, 2025
pp. 86-108
Emerald Publishing Limited
e-ISSN: 2634-2502
p-ISSN: 2634-2499
DOI 10.1108/FEBE-07-2024-0033

sustainable buildings can account for up to 30% of project costs (Olanrewaju, 2022), making its mitigation critical for advancing sustainable practices. Despite the growing interest in rework due to its impact on sustainability, specific causes of rework in sustainable building projects, particularly in the Malaysian context, remain underexplored. To address this gap, this research employs SEM to analyse the causes of rework in sustainable buildings. SEM integrates factor analysis and multiple regression to assess hypotheses, identify causal relationships, and examine both measurement and structural models, offering a robust framework for understanding and addressing rework in sustainable construction.

2. Background and theoretical framework

Building defects are defined as deficiencies in a building's functionality, compliance with statutory regulations, or ability to meet user expectations (Olanrewaju and Lee, 2022). These shortcomings are often the result of human errors and flawed work processes. Such defects negatively impact occupant and client satisfaction and frequently lead to disputes and litigation among clients, developers, and maintenance organisations (Jonsson and Gunnelin, 2019). Manifesting in various components of a building—including its structure, fabric, services, and facilities—defects compromise functionality, longevity, and overall performance. Effectively addressing these issues is vital to maintaining building integrity and ensuring user satisfaction. Building defects may be rectified during the construction phase, the defect liability period, or after this period has elapsed. Rework refers to the rectification of defects during the construction phase (Mills *et al.*, 2009) and is described as the avoidable effort required to correct a function that was improperly executed initially. Rework is a persistent issue in the global construction sector, resulting in cost overruns, delays, accidents, claims, disputes, reduced productivity, and compromised quality (Love *et al*., 2019). In sustainable construction, the consequences of rework are particularly detrimental, as it undermines sustainability objectives through inefficiencies and negative environmental impacts. Rework generates excessive material waste, depleting natural resources and posing disposal challenges. It also contributes to higher pollution levels, including increased carbon emissions and other environmental contaminants, due to repeated transportation, demolition, and reconstruction activities. These processes further elevate energy consumption, intensifying the ecological footprint of the project. Additionally, rework heightens the risk of workplace accidents, with extended project durations and repeated hazardous tasks endangering worker safety. These compounded effects not only detract from a project's sustainability goals but also challenge the broader aims of sustainable construction practices (Olanrewaju, 2022). Consequently, identifying and mitigating the root causes of rework is imperative for improving the sustainability of construction projects, fostering efficiency, and ensuring compliance with environmental and social objectives.

2.1 Rework in construction projects

The extent of rework in construction projects is considerable and rising across various countries. In Iran, Heravi and Jafari (2014) found that poor-quality costs accounted for 7.4% of the total project cost. In Australia, rework represented more than 10% of project costs (Love *et al*., 2019). In the USA, data from 359 construction projects revealed that rework made up 5% of the total construction costs (Hwang *et al*., 2018). In Singapore, rework contributed to 24.94% of construction delays (Hwang and Yang, 2014). In Spain, rework costs amounted to 2.75% of the original contract value (Forcada *et al*., 2017). In Malaysia, rework costs ranged between 3% and 6% (Yap *et al*., 2017), while in Portugal, they reached as high as 7% (dos Reis Almeida, 2011). A South African study indicated that the average total rework cost accounted for 5.12% of the original contract value, and when rework costs reached this percentage, there was a 76% likelihood of the project exceeding its budget (Simpeh *et al*., 2015). Numerous studies have identified various causes of rework in construction projects. For instance, Hwang *et al*. (2018) noted that design changes were one of the primary causes of rework in construction projects in Singapore. In New Zealand, Asadi *et al.* (2023) identified several causes, including errors in design, drawings, and specifications, incomplete designs, omissions in the design or construction process, poor project documents, unclear instructions, poor contract documentation, conflicting and incomplete information, and design or construction changes. Balouchi *et al.* (2019) found that poor site supervision and inspection, as well as an unclear project management process, were significant contributors to rework in Iran. A study in China by Ye *et al.* (2015) analysed 39 causes of rework, grouping them into categories such as contractor field management, external environment, contract management, subcontractor management, design management, project communication management, project plan changes, active rework for quality improvement, owner capability, project scope management, and project process management. Finally, based on SEM, Garg and Misra (2021) identified coordination issues, poor execution, supervision issues, consultant issues, aberrant events, worker issues, client issues, and site issues as the main causes of rework in the Indian building industry. These findings highlight the pervasive and varied nature of rework across global construction projects, underscoring the need for targeted interventions to mitigate its occurrence and impact.

2.2 Profile of rework in sustainable building projects

Similar to conventional buildings, sustainable buildings are also susceptible to rework. While the causes of rework in traditional construction projects are well-documented, the unique characteristics of sustainable building projects introduce additional factors that contribute to the need for rework. For example, sustainable buildings often incorporate advanced technologies, such as renewable energy systems, energy-efficient HVAC systems, and sustainable materials. The complexity of these systems can result in installation errors, leading to rework. Furthermore, the use of innovative but unproven technologies in sustainable construction can give rise to unforeseen issues that necessitate corrective actions.

The lack of familiarity with new technologies among construction teams can also lead to implementation mistakes, exacerbating the risk of rework. In addition to technological challenges, sustainable building projects must comply with stringent sustainability standards and certification requirements, such as LEED or BREEAM. Meeting these standards requires adherence to specific criteria, and any deviations from these criteria can result in the need for rework (Olanrewaju, 2022). Moreover, sustainable construction projects typically involve a diverse range of stakeholders, each with their own interests and expectations. This diversity can lead to conflicting requirements and, consequently, rework. Clients of sustainable buildings often have high expectations, which can result in frequent changes to the project scope or design. These changes, while aimed at meeting client needs, can trigger rework. Sustainable construction also tends to favour agile management principles over deterministic approaches. As Love *et al.* (2019) pointed out, managing client expectations is crucial to minimising rework. Furthermore, the availability and consistency of sustainable materials can pose significant challenges (Emmanuel Eze *et al.*, 2021). Supply chain disruptions or variations in material quality can result in rework if materials do not meet project specifications, as explained by Olanrewaju *et al.* (2024). Ensuring that materials comply with sustainability criteria requires thorough sourcing and verification processes, and any lapses in these processes can lead to rework when materials are found to be non-compliant after installation. These unique challenges in sustainable construction highlight the importance of addressing rework proactively to maintain the efficiency, sustainability, and cost-effectiveness of building projects.

The objectives of sustainable buildings are profound and essential in addressing the shortcomings of conventional construction practices. Sustainable construction seeks to mitigate the harmful effects of traditional building activities, contributing to economic growth and development in a more environmentally responsible way (Olanrewaju *et al.*, 2024). At its core, sustainable construction aims to create a harmonious relationship between human activities and the natural world, ensuring a healthy planet and an equitable society for the long term. The impact of buildings on sustainable development goals is immense. For example, buildings consume more than 40% of the world's energy, use 25% of harvested wood, release 50% of fluorocarbons, produce 40% of landfill materials, account for 45% of energy consumption in operations, discharge 40% of Sustainable House Emissions, and consume 15% of global freshwater (Wood, 2009; United Nations Environment Programme, 2020). In the United States, the building sector uses 50% of the mined, harvested, and dredged raw materials (Spiegel and Meadows, 2010). When considering additional CO2 emissions from the manufacturing, transportation of building materials, and urban sprawl, the impact on sustainable development goals becomes even larger. To address these issues, sustainable construction has been conceived and, in some areas, mandated. Sustainable building techniques enable buildings to use fewer resources such as energy, materials, water, labour, and gas, while improving indoor environmental quality and ventilation, reducing life-cycle costs, and increasing user satisfaction and productivity (Olanrewaju *et al*., 2019). Sustainable buildings incorporate non-toxic and natural materials, generate less waste, and are energy- and water-efficient, often utilizing recycled materials to a significant extent. These buildings are designed to be recyclable when necessary, contributing to a circular economy. Sustainable construction practices are less harmful and do not pose significant threats to site operations. However, despite the promising prospects and benefits of sustainable buildings, challenges persist. A major issue is the prevalence of rework in sustainable building projects (Tollin, 2011; Hwang *et al*., 2017b; Olanrewaju *et al*., 2019; Lu *et al*., 2017; Seyis *et al*., 2016). Rework in sustainable buildings can undermine the very objectives of sustainability by increasing resource consumption, generating waste, and contributing to delays. It significantly affects project timelines, budgets, and the ability to meet sustainability goals. Addressing the causes of rework is crucial for realizing the full potential of sustainable construction practices and ensuring that they deliver on their promise of a greener, more efficient, and socially responsible built environment.

3. Research design

To place the research in a philosophical context, it is epistemological in nature, as it concerns the nature of knowledge. The study aims to understand how we know and interpret the causes of rework in sustainable buildings. Using SEM implies examining the relationships between variables to develop or validate knowledge. SEM is a statistical technique, aligning with the epistemological focus on methods and tools for acquiring and validating knowledge. However, ontological considerations underpin the foundational assumptions about the existence and nature of the causes of rework. The study assumes that the causes of rework exist as real phenomena within sustainable building projects. This assumption reflects an ontological stance regarding the existence and structure of reality. While we acknowledge the subjective influences (constructivism) of stakeholders on reworks in sustainable buildings, an objective stance (positivism) is taken, which necessitates the use of surveys for data collection. The primary data were collected through convenience sampling, a method in which the survey is administered to available, accessible, and willing respondents (Olanrewaju and Idrus, 2020). This approach is suitable where sufficient information on the population size and sample frame is lacking. However, the technique is inherently prone to biases, such as over-representation or under-representation of certain groups, which can limit the ability to draw conclusions applicable to the wider population. While the findings derived from convenience sampling may lack generalisability due to the non-random selection of participants, they can still offer valuable insights if the sample size is sufficiently large and diverse (Sekaran and Bougie, 2016). A larger respondent pool increases the likelihood of capturing a broader range of the required perspectives, which can enhance the representativeness of the results. The main postulation is that the results will be representative of the population if enough data are gathered and objectivity is upheld. In addition, if the survey respondents have relevant work experience, the possibility that the findings will have high validity and reliability is greater.

The survey questionnaires were administered to the respondents through online techniques (i.e. from 5 September 2022 to 23 October 2023). Respondents were asked, based on their evidence, to evaluate the degree to which each of the causal factors would lead to the occurrence of reworks in sustainable buildings. In order to quantify the respondents' measurement of the degree of occurrence of rework, a 4-point scale was used. The questionnaire was piloted twice before the final version. Table 1 contains the explanation of the scale. The causes are positively worded, and a higher score indicates a higher possibility of leading to rework occurrence. The causes were developed from an extensive literature review (Hwang *et al*., 2016; Olanrewaju, 2022; Raouf and Al-Ghamdi, 2020, 2023; Khalesi *et al*., 2020; Ismail *et al*., 2019; Mohammad *et al*., 2014; Cao *et al*., 2022; Ghannadpour *et al*., 2018) and discussions with construction professionals involved in sustainable construction.

The analyses are divided into two main sections. The first section involves an analytical examination of the causal factors. The second phase involves conducting EFA (Exploratory Factor Analysis) and SEM. The purpose of the EFA is to identify the latent variables by clustering the measurement or observed variables. While SEM may be suitable for exploratory data analysis, it is more of a confirmatory technique. SEM was employed to examine the previously conceived notions about the causes of rework in sustainable buildings. SEM is a statistical technique that combines factor analysis and multiple regression analysis to examine complex relationships among observed and latent variables (Kline, 2023; Hair *et al*., 2021). SEM provides illustrations of the relationships among the dependent and independent latent constructs (Mueller and Hancock, 2018; Hair *et al*., 2021). In SEM, two models are involved: the measurement model and the structural model. JASP was used for the data analysis.

4. Findings of the research

The findings of 75 valid responses are presented in the tables and figures.

4.1 Analyses of the respondents' profile

The results of the respondents' profiles are contained in Tables 2 and 3 and Figures 1–4. The average work experience of the respondents is 12.5 years (Table 2), and most of the respondents work in the downstream segment of the construction sector (Table 3). All the

Table 1. Explanation of the survey scale

	Impact	Description	Example
1	Less occurrence	The factor is unlikely to cause rework. Any impact on the project is negligible, and it rarely results in the need for corrections or adjustments	A minor, easily correctable discrepancy in a non-critical area of the project
2	Moderate occurrence	The factor occasionally causes rework, but its effects are limited. It results in minor adjustments that do not significantly affect the overall project timeline or budget	Small errors in specifications that require minor changes to materials or processes
3	High occurrence	The factor frequently causes rework, leading to noticeable disruptions. It results in moderate adjustments that can affect the project timeline or budget to a certain extent	Incomplete drawings that necessitate multiple corrections and affect the sequencing of certain tasks
4	Very high occurrence	The factor consistently causes significant rework, leading to major disruptions. It results in substantial adjustments that heavily impact the project timeline, budget, and overall quality	Major design flaws or inadequate funding leading to significant delays, cost overruns, and extensive rework

Source(s): Table by author

Table 2. Respondent's work experience (year) in the construction sector

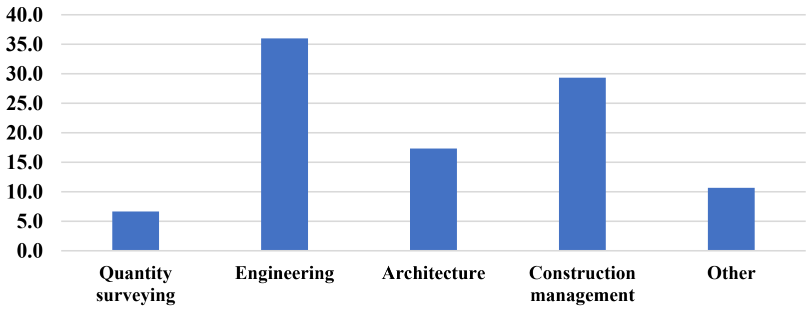
Year	Less than 5 years	5–10 years	11–15 years	16–20 years	More than 20 years
Percentage	30.7	13.3	30.7	10.7	14.7

Source(s): Table by author

Table 3. Respondent's organisatiom

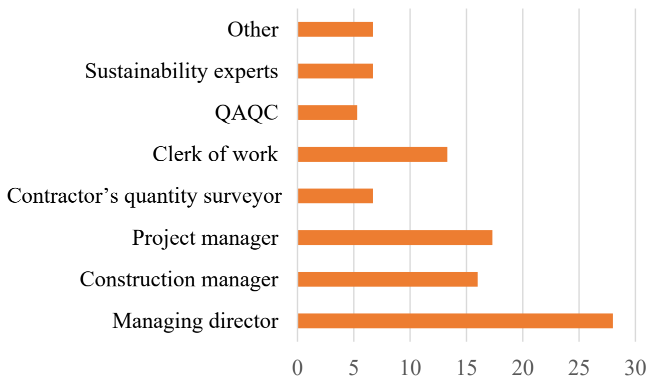
Organisation	Constructor organisation	Maintenance	Manufacturing	Other
Percentage	65.3	5.3	1.3	28.0

Source(s): Table by author



Source(s): Figure by author

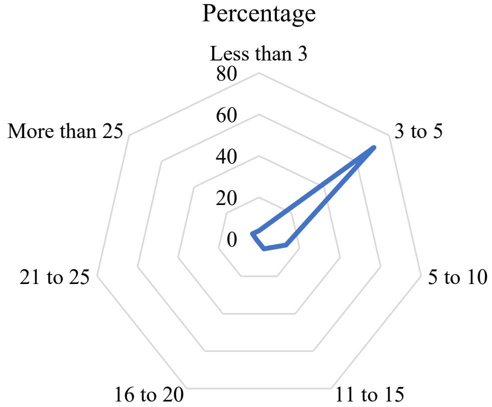
Figure 1. Respondent's academic qualification



Source(s): Figure by author

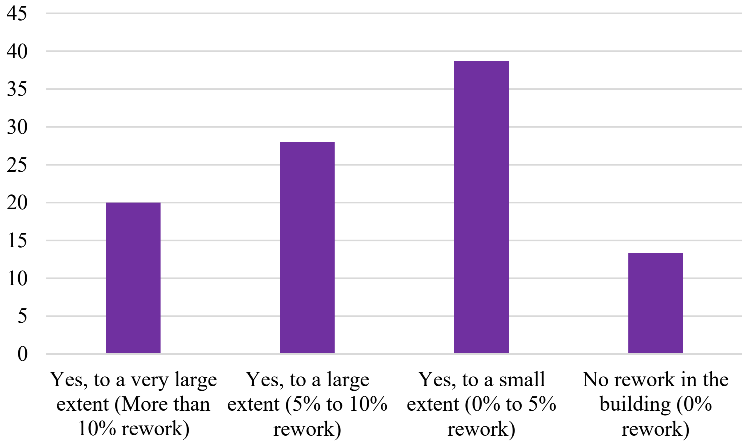
Figure 2. Respondent's position in the company (%)

respondents have expertise in various construction processes and stages (Figure 1). The respondents held key and diverse roles in building projects (Figure 2). The respondents have participated in the design, construction, development, and operations or maintenance of 145



Source(s): Figure by author

Figure 3. Number of green building projects that the respondents have completed in the last five years (%)



Source(s): Figure by author

Figure 4. Measurement of size of rework in typical sustainable building the respondent was involved

sustainable buildings, with the average number of sustainable buildings completed by each respondent in the last 5 years being 10 buildings (Figure 3). The data also revealed that rework occurred 184 times. On average, rework occurred to a large extent (5%–10%) in most of the projects the respondents have participated in delivering (Figure 4). The data on the respondents' profiles shows that the respondents have adequate knowledge and competencies to provide unbiased and valid information on sustainable construction processes and delivery. The data revealed that rework had increased project costs by between 11% and 20%, and rework has delayed projects by similar amounts. Rework occurred in about 90% of the sustainable building projects surveyed.

4.2 Goodness of fits of data

Goodness-of-fit indices are crucial in evaluating the appropriateness of a statistical model. They help determine whether a model adequately represents the underlying data structure and supports the theoretical framework. For instance, in the context of SEM, goodness-of-fit indices are used to assess how well the proposed model fits the actual data. Table 4 presents the results of *t*-tests conducted to evaluate the significance of the various causes of rework in sustainable building projects. All factors, except one, have *p*-values less than 0.05, indicating that they significantly contribute to rework in sustainable buildings. The non-significance of the one factor may be due to the lack of agreement among the respondents on the measurement

Table 4. One sample *T*-test

Causes	*t*	*p*	Cohen's d	SE Cohen's d	95% CI for Cohen's d Lower	Upper
Competency of the workers on the site	−2.436	0.017	−0.281	0.118	−0.511	−0.05
Negligence of the workers on the site	−3.036	0.003	−0.351	0.119	−0.583	−0.116
Negligence of site supervisors	−3.236	0.002	−0.374	0.119	−0.607	−0.138
Competence of site supervisor	−3.119	0.003	−0.36	0.119	−0.593	−0.125
Competence of the clerk of work	−3.556	<0.001	−0.411	0.120	−0.645	−0.174
Incomplete drawings	−1.768	0.081	−0.204	0.117	−0.432	0.025
Inadequate specifications	−2.069	0.042	−0.239	0.117	−0.468	−0.009
Poor construction schedule	−3.677	<0.001	−0.425	0.121	−0.66	−0.187
Poor quality of materials	−4.700	<0.001	−0.543	0.124	−0.784	−0.299
Poor coordination of contract documents	−3.760	<0.001	−0.434	0.121	−0.670	−0.196
Incomplete documents	−3.412	0.001	−0.394	0.120	−0.628	−0.158
Variation order	−2.069	0.042	−0.239	0.117	−0.468	−0.009
Lack of sustainability plan	−3.424	0.001	−0.395	0.120	−0.629	−0.159
Poor payment plan	−5.653	<0.001	−0.653	0.127	−0.900	−0.401
Poor weather	−6.912	<0.001	−0.798	0.133	−1.056	−0.536
Non-adherence of green/sustainable rating tools	−3.153	0.002	−0.364	0.119	−0.597	−0.129
Complexity of designs	−5.301	<0.001	−0.612	0.126	−0.857	−0.364
Poor communication on the site	−3.926	<0.001	−0.453	0.121	−0.690	−0.214
Lack of information on the nature of the site	−4.558	<0.001	−0.526	0.123	−0.766	−0.283
The high workload of the site workers	−5.372	<0.001	−0.62	0.126	−0.866	−0.371
Poor quality management framework	−3.25	0.002	−0.375	0.119	−0.608	−0.14
Poor health and safety frameworks	−6.519	<0.001	−0.753	0.131	−1.007	−0.494
Competency of the construction manager	−2.778	0.007	−0.321	0.118	−0.552	−0.088
Competency of the project manager	−2.901	0.005	−0.335	0.119	−0.567	−0.101
Competency of the construction company	−2.613	0.011	−0.302	0.118	−0.532	−0.069
Poor communication between the site and the company's office	−2.883	0.005	−0.333	0.119	−0.564	−0.099
Poor procurement management plan	−4.585	<0.001	−0.529	0.123	−0.77	−0.286
The lack of adequate plants and equipment	−4.064	<0.001	−0.469	0.122	−0.706	−0.229
Poor supply chain management plan	−3.207	0.002	−0.370	0.119	−0.603	−0.135
Poor site management plan	−3.874	<0.001	−0.447	0.121	−0.683	−0.208
Inadequate funding	−2.196	0.031	−0.254	0.117	−0.483	−0.023
Inadequate funding by the client	−3.482	<0.001	−0.402	0.120	−0.636	−0.165
Insufficient information government policy	−4.503	<0.001	−0.520	0.123	−0.760	−0.277
The problems of contractor's cash flow	−3.512	<0.001	−0.406	0.120	−0.640	−0.169

Source(s): Table by author

of the cause of rework, or it may be related to the sample size. Meanwhile, the 95% confidence intervals for Cohen's d provide a range within which we can be 95% confident the true effect size lies. None of the intervals for significant factors cross zero, further confirming their statistical significance. Table 5 indicates that the scale demonstrates excellent internal consistency, suggesting that the causal factors are well-aligned in measuring the same underlying objectives.

4.3 Analysis of the taxonomy of the occurrence of rework in sustainable buildings
Table 6 indicates the extent to which the various factors contribute to rework in sustainable buildings. The ratings of seven of the causes exceed the cumulative average. The data revealed that 9% of the respondents assessed the extent to which the causes lead to rework as low, while 24% considered the extent to be moderate. A further 33% believed the extent to be high, and an equal percentage measured it as very high. In terms of prioritisation, none of the causes scored below 60%. The cumulative index is 78.4%. To interpret, the rework causes identified are the main contributors to rework in sustainable buildings.

4.4 Results of the SEM
The results of the SEM are presented in the following subsections.

4.4.1 Result of the EFA model. Previous studies have indicated that χ^2, the RMSEA, CFI, AGFI, VIF, TLI, and NFI should be reported to measure the reliability, validity, multicollinearity, and statistical significance of the data, as well as the relationship between the variables. The data revealed that all the test results were within the recommended thresholds (see Hair *et al.*, 2021). However, the chi-square statistic for the model suggests that the model does not perfectly reproduce the observed covariance matrix. This is common in SEM with small samples, as the chi-square test is sensitive to sample size and often yields significant results in smaller samples (Table 7). Even with a significant chi-square, the model may still be practically useful if other fit indices suggest an acceptable fit. Therefore, other fit indices such as CFI, TLI, RMSEA, and SRMR are typically considered alongside the chi-square tests. Table 8 contains the fit indices for the data, which clearly indicate that, overall, these indices suggest the model fits the data excellently. The fitness can also be verified by the results of other indices shown in Table 9. Collectively, the fit indices indicate that the model fits the data exceptionally well. The high values for Hoelter's critical *N* suggest that the model remains stable, even with larger sample sizes.

4.4.2 Structural model. The structural model illustrates the associations among latent variables and errors, providing information on the estimates of the relationships between the latent variables. To examine the structural model, the significance of the structural model, the R^2, and variances were assessed. From the results (Tables 10 and 11), it is clear that the structural model does not meet the statistical requirement of <0.05. However, with *p*-values >0.05, hypotheses 1, 2, 3, and 4 are not substantiated. The R^2, representing the variance explained by the model, is high (Hair *et al.*, 2021).

Table 5. Frequentist scale reliability statistics

Estimate	McDonald's ω
Point estimate	0.981
95% CI lower bound	0.973
95% CI upper bound	0.986

Source(s): Table by author

Table 6. Descriptive statistics of the causes of rework in sustainable buildings

Cause	Std. deviation	Index
Incomplete drawings	22.9	81.7
Inadequate specifications	21.8	81.0
Variation order	24.0	80.3
Inadequate funding	22.6	80.3
Competency of the site operatives	24.2	79.0
Poor communication between the site and the company's office	21.2	78.7
Competency of the construction manager	22.9	78.3
Competency of the project manager	21.9	78.3
Poor supply chain management plan	20.5	78.0
Non-adherence to green/sustainable rating tools	22.3	77.3
Lack of sustainability plan	21.2	77.0
Poor quality management framework	23.1	76.7
Poor site management plan	20.0	76.3
Poor construction schedule	21.7	76.0
Poor coordination of contract documents	21.8	75.7
Poor procurement management plan	18.9	75.0
The lack of adequate plants and equipment	21.3	75.0
Lack of information on the nature of the site	21.0	73.7
Poor quality of materials	20.9	73.3
Insufficient information on government policy	22.8	72.7
Complexity of designs	20.3	72.0
Poor payment plan	20.6	70.7
Poor health and safety frameworks	18.6	70.0
Poor weather	20.9	66.7

Source(s): Table by author

Table 7. Model fit

				Baseline test			Difference test		
	AIC	BIC	n	χ^2	df	p	$\Delta\chi^2$	Δdf	p
Model 1			75	400.632	290	<0.001	400.632	290	<0.001

Source(s): Table by author

Table 8. Fit indices

Index	Value
Comparative fit index (CFI)	1.00
Tucker-Lewis index (TLI)	1.065
Bentler-Bonett non-normed fit index (NNFI)	1.065
Bentler-Bonett normed fit index (NFI)	0.989
Parsimony normed fit index (PNFI)	0.882
Bollen's relative fit index (RFI)	0.987
Bollen's incremental fit index (IFI)	1.058
Relative noncentrality index (RNI)	1.058

Source(s): Table by author

The factor loadings suggest that the model has strong explanatory power for the latent variables, with most indicators showing strong relationships with their respective latent

Table 9. Other fit measures

Metric	Value
Root mean square error of approximation (RMSEA)	0.000
RMSEA 90% CI lower bound	0.000
RMSEA 90% CI upper bound	0.000
RMSEA *p*-value	1.000
Standardized root mean square residual (SRMR)	0.057
Hoelter's critical N ($\alpha = 0.05$)	482.306
Hoelter's critical N ($\alpha = 0.01$)	508.838
Goodness of fit index (GFI)	0.997
McDonald fit index (MFI)	5.032

Source(s): Table by author

Table 10. *R*-squared

	Cause	R^2
D1	Competency of the project manager	0.601
D2	Competence of site supervisor	0.730
D3	Competency of the construction manager	0.701
D4	Poor procurement management plan	0.751
D5	Poor site management plan	0.685
D6	Competency of the site operatives	0.350
D7	Poor communication between the site and the company's office	0.626
D8	Lack of information on the nature of the site	0.722
D9	Poor weather	0.454
C1	Poor quality management framework	0.697
C2	The lack of adequate plants and equipment	0.657
C3	Poor health and safety frameworks	0.658
C4	Poor supply chain management plan	0.682
C5	Poor quality of materials	0.704
C6	Incomplete drawings	0.754
C7	Inadequate specifications	0.772
C8	Variation order	0.708
F1	Poor payment plan	0.547
F2	Lack of sustainability plan	0.765
F3	Poor coordination of contract documents	0.644
F4	Poor construction schedule	0.616
F5	Non-adherence to green/sustainable rating tools	0.728
F6	Complexity of designs	0.701
P1	Insufficient information of government policy	0.922
P2	Inadequate funding	0.542

Source(s): Table by author

variables. For instance, with regard to competency, the factor loadings indicate strong relationships with all indicators except C6, which has a moderate loading. For the framework, the factor loadings indicate strong relationships with all indicators, with F1 being slightly lower but still within an acceptable range. In terms of information, the factor loadings indicate strong relationships with all indicators, with D4 being slightly lower but still reasonable. For the plan, the factor loadings indicate strong relationships with both indicators, with P1 being particularly strong. These results highlight the robust connections between the latent variables and their respective indicators, reinforcing the model's validity.

Table 11. Factor loadings

Latent	Indicator	Estimate	Std. error	z-value	*p*	95% confidence interval Lower	Upper	Standardized All	LV	Endo
Competency	C1	1.00	0.00			1.00	1.00	0.775	0.843	0.775
	C2	1.137	0.087	13.056	<0.001	0.966	1.308	0.854	0.958	0.854
	C3	1.128	0.088	12.802	<0.001	0.955	1.301	0.837	0.951	0.837
	C4	0.965	0.072	13.317	<0.001	0.823	1.107	0.867	0.813	0.867
	C5	0.974	0.073	13.364	<0.001	0.831	1.117	0.827	0.821	0.827
	C6	0.843	0.072	11.695	<0.001	0.701	0.984	0.592	0.71	0.592
	C7	0.99	0.077	12.816	<0.001	0.839	1.142	0.791	0.835	0.791
	C8	1.052	0.08	13.133	<0.001	0.895	1.21	0.849	0.887	0.849
Framework	F1	1.00	0.00			1.00	1.00	0.674	0.698	0.674
	F2	1.371	0.113	12.103	<0.001	1.149	1.593	0.835	0.957	0.835
	F3	1.228	0.101	12.214	<0.001	1.031	1.425	0.811	0.858	0.811
	F4	1.073	0.086	12.445	<0.001	0.904	1.242	0.811	0.749	0.811
	F5	1.205	0.097	12.43	<0.001	1.015	1.395	0.826	0.842	0.826
	F6	1.246	0.10	12.482	<0.001	1.05	1.441	0.839	0.87	0.839
Information	D1	1.00	0.00			1.00	1.00	0.868	0.986	0.868
	D2	0.964	0.072	13.311	<0.001	0.822	1.106	0.879	0.95	0.879
	D3	1.018	0.079	12.949	<0.001	0.864	1.172	0.841	1.003	0.841
	D4	0.769	0.059	12.998	<0.001	0.653	0.885	0.74	0.758	0.74
	D5	0.936	0.07	13.439	<0.001	0.8	1.073	0.874	0.923	0.874
	D6	0.882	0.068	12.987	<0.001	0.749	1.015	0.803	0.869	0.803
	D7	0.857	0.067	12.872	<0.001	0.727	0.988	0.785	0.845	0.785
	D8	0.96	0.075	12.828	<0.001	0.814	1.107	0.853	0.947	0.853
	D9	0.855	0.064	13.327	<0.001	0.729	0.98	0.837	0.842	0.837
Plan	P1	1.00	0.00			1.00	1.00	0.96	1.078	0.96
	P2	0.774	0.064	12.004	<0.001	0.648	0.90	0.736	0.835	0.736

Source(s): Table by author

Tables 12–14 contain the results of the regression, variances, and covariances. The results revealed that none of the predictors have statistically significant effects on the outcome variable (extent), as all *p*-values are greater than 0.05. While Information shows a moderate positive standardised effect, and the other predictors show weak negative effects, the lack of significance suggests that these relationships should be interpreted with caution. This means there is insufficient evidence to assert that these predictors have a meaningful impact on the extent of rework, indicating limited practical impact on the outcome variable. The non-significant results could arise due to sampling variability, insufficient sample size, or noise in the data, leading to a higher chance of Type II error (failing to detect an effect when one exists). Alternatively, there may genuinely be no relationship between the predictors and the outcome. In context, overstating these findings could lead to misleading conclusions about the influence of the predictors on the outcome. Meanwhile, the results reveal strong internal consistency and significant interrelationships among the latent variables. This indicates that these constructs are well-defined and reliably measured within the context of the study. Each latent variable demonstrates strong factor loadings, suggesting that the indicators used are highly representative of their respective constructs. The high factor variances further confirm the robustness of the model, showing that these latent variables capture a significant proportion of the variance in the data. Figure 5 displays the path diagram for the structural model.

Table 12. Regression coefficients

						95% confidence interval		Standardized		
Predictor	Outcome	Estimate	Std. error	z-value	*p*	Lower	Upper	All	LV	Endo
Information	extent	0.326	0.387	0.843	0.399	−0.432	1.084	0.321	0.321	0.321
Plan	extent	−0.177	0.348	−0.509	0.611	−0.860	0.505	−0.191	−0.191	−0.191
Competency	extent	−0.204	0.497	−0.410	0.682	−1.178	0.771	−0.172	−0.172	−0.172
Framework	extent	−0.092	0.696	−0.133	0.894	−1.456	1.271	−0.064	−0.064	−0.064

Source(s): Table by author

Table 13. Factor variances

Variable	Estimate	Std. error	z-value	*p*	95% confidence interval Lower	Upper	Standardized All	LV	Endo
Competency	0.71	0.081	8.756	<0.001	0.551	0.869	1	1	1
Framework	0.488	0.063	7.767	<0.001	0.365	0.611	1	1	1
Information	0.971	0.106	9.142	<0.001	0.763	1.18	1	1	1
Plan	1.163	0.302	3.849	<0.001	0.571	1.755	1	1	1

Source(s): Table by author

Table 14. Factor covariances

Variables	Estimate	Std. error	z-value	*p*	95% confidence interval Lower	Upper	Standardized All	LV	Endo
Competency – Framework	0.519	0.044	11.857	<0.001	0.433	0.605	0.882	0.882	0.882
Competency – Information	0.734	0.058	12.759	<0.001	0.621	0.846	0.883	0.883	0.883
Competency – Plan	0.70	0.066	10.677	<0.001	0.572	0.829	0.77	0.77	0.77
Framework – Information	0.601	0.05	11.934	<0.001	0.502	0.7	0.873	0.873	0.873
Framework – Plan	0.609	0.062	9.828	<0.001	0.487	0.73	0.808	0.808	0.808
Information – Plan	0.821	0.074	11.071	<0.001	0.676	0.967	0.773	0.773	0.773

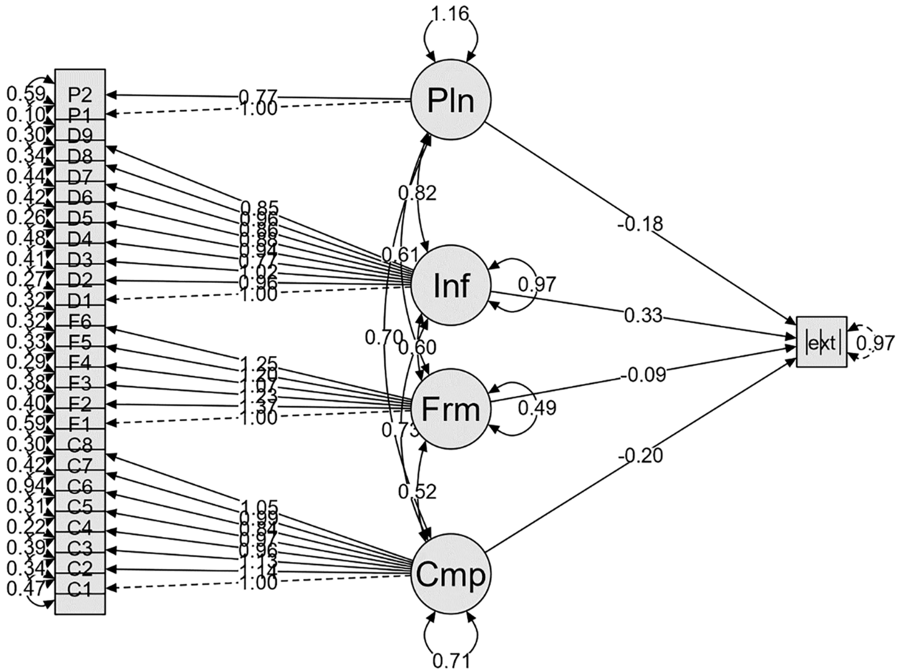
Source(s): Table by author

5. Discussions of the results

The findings are discussed in two parts. First, the analytical findings for each of the causal factors are presented. The discussion then shifts to the SEM results, where the relationships between the latent variables are explored in depth.

5.1 Discussion of the analytical findings

Incomplete drawings are ranked highest in causing rework in sustainable buildings. This makes practical sense, as construction projects heavily rely on detailed and accurate drawings to guide the construction process. Given the complexity of sustainable building, the need for precise and comprehensive drawings is even more critical to ensure that the sustainability objectives are achieved and to avoid rework. Inadequate specifications are ranked second, reflecting their critical role in construction quality and compliance. Specifications provide detailed information on materials, workmanship, and performance standards. In sustainable building projects, stringent specifications are essential to achieve energy efficiency, maintainability, decarbonisation, and other sustainability criteria, making this a significant cause of rework. Variation orders are changes made to the original construction plan after the project has commenced. The frequent need for variation orders indicates poor initial planning or unforeseen problems, both of which are common in sustainable building projects where innovative materials and techniques are used. Inadequate funding is ranked third and reflects its impact on project continuity and quality. Cash flow issues may lead to disruption, mistakes, and errors. Sustainable buildings often require higher upfront investments in sustainable



Source(s): Figure by author

Figure 5. Path diagram

practices, making adequate funding crucial to prevent rework and to achieve other sustainability objectives in the buildings.

The competency of site operatives is a critical factor, as skilled workers are essential for executing construction tasks correctly; failure to do so may lead to rework. This is especially important in sustainable buildings, where specialised knowledge and skills are required to implement sustainable building practices effectively. However, there are several skill shortages in sustainable construction practices. Effective communication ensures that any problems are promptly addressed and that everyone is well-informed and updated on the project's performance. In sustainable buildings, where precise coordination is required to meet sustainable standards, poor communication can lead to significant errors and rework. An incompetent manager can fail to identify problems that affect sustainable objectives early, leading to mistakes that require rework. In sustainable construction, the manager's role is even more pivotal due to the complexity and high standards involved, making this ranking practically justified. Similarly, the project manager's competency is vital for the overall success of the project. The project manager ensures that the project stays on schedule, within budget, and meets all specifications. The technical and managerial demands of sustainable projects necessitate a high level of project management competence. However, sustainable construction management seeks a product management perspective that extends beyond just design and construction issues. A poor supply chain management plan ranks significantly because it affects the timely delivery of materials and equipment, which is crucial for maintaining project schedules and quality. Sustainable building projects often require specific, high-quality materials, making effective supply chain management essential to avoid rework. Non-adherence to sustainable rating tools indicates a failure to meet predefined sustainable objectives. Deviations from these objectives often result in the need for rework to align with the objectives.

The lack of a sustainability plan ranks highly due to its importance in guiding the construction process towards sustainable objectives. To avoid rework, a well-defined sustainability plan ensures that all sustainable objectives and standards are met throughout the project. A poor-quality management framework ranks highly because it directly impacts the standard of work produced on site. In sustainable buildings, ensuring high-quality standards is essential to achieve the desired sustainable performance, and any lapses can lead to significant rework. Poor site management impacts the organisation of construction activities. Effective site management ensures that tasks are performed in the correct sequence and to the required standards. In sustainable construction, where adherence to specific sustainable practices is crucial, poor site management can lead to errors and inefficiencies, resulting in rework. A poorly managed construction schedule ranks significantly. An effective schedule is crucial to ensure that all activities are completed on time and in the correct sequence. In sustainable projects, where timing is critical for integrating sustainable technologies and materials, a poorly managed schedule can lead to rework.

Poor coordination of contract documents can lead to discrepancies and misunderstandings about project requirements and specifications. This is particularly important in sustainable construction, where precise documentation is necessary to meet sustainable standards. Poor coordination can result in errors that require rework to correct. Effective procurement management ensures that the specified resources are available at the right time and meet the required quality standards. Moreover, for sustainable building projects, where specific high-quality materials are needed, poor procurement practices can lead to rework. The lack of adequate plant and equipment can significantly impede the progress and quality of construction. In sustainable projects, specialised equipment is necessary to implement sustainable building practices, making this factor critical for avoiding rework. The lack of information on the nature of the site ranks highly because site-specific information is crucial for planning and executing construction activities. Understanding site conditions is essential for implementing appropriate sustainable measures. Inadequate information can lead to errors and rework to correct problems that arise from unforeseen site conditions. Poor quality of materials impacts the durability and performance of the building. Using substandard materials can lead to structural problems and failure to meet sustainability standards, necessitating rework.

Insufficient information on government policy can lead to non-compliance with regulations and standards, resulting in rework to meet legal requirements. Sustainable building projects must adhere to sustainable regulations and policies, making it crucial to have accurate and comprehensive information on relevant government policies. Complexities in designs can lead to misunderstandings and errors during construction, requiring rework to meet design specifications. Sustainable buildings feature innovative and complex designs to achieve sustainable performance, making this factor particularly relevant in causing rework due to the high level of detail and precision required. A poor payment plan can disrupt cash flow and affect productivity. Poor health and safety frameworks can lead to accidents and interruptions on the construction site, causing delays, mistakes, errors, and rework to address safety violations and injuries. Sustainable construction projects are required to adhere to stringent health and safety standards to protect workers and ensure project continuity. Vulnerable workers are more prone to making mistakes and sustaining injuries. Poor weather conditions can disrupt construction activities and cause damage that requires rework. While weather is an uncontrollable factor, its impact can be mitigated through effective planning and scheduling. Sustainable building projects must consider weather-related risks and incorporate measures to minimise their impact on construction progress.

5.2 Discussion of the results of the SEM model

The factor analysis structured the 24 causal factors into four components. The total variance explained by the four components is 76.1%. Each component contains a minimum of two factors, with the factor loadings for each component exceeding 0.5. Consequently, the results of the exploratory factor analysis (EFA) serve as the basis for theorising the SEM. Therefore, the four components derived from the factor analysis and used for the SEM represent the latent variables (independent variables) in the SEM model. The discussion in this section is tentative due to the limited research on this topic. For instance, while there is some research on the application of SEM to rework in conventional construction projects (e.g. Garg and Misra, 2021; Elseufy *et al*., 2022; Puspita *et al*., 2019; Elseufy *et al*., 2024; Susetyo *et al*., 2021; Budinata and Susetyo, 2022), studies focusing on its application in the context of sustainable buildings remain notably scarce. This gap highlights the need for further exploration of rework causes and their complex interrelationships in sustainable construction using SEM techniques. The results affirm the internal consistency and strong interrelationships among the latent variables, which are crucial for theorising research on sustainable construction management. These findings underscore the importance of a solid theoretical foundation, providing a reliable basis for future studies to build upon. This affirmation of internal consistency supports the development of comprehensive models that can better capture the intricate dynamics of sustainable construction projects, paving the way for more effective strategies and interventions. The validated interrelationships among these key constructs emphasise the need to address various dimensions simultaneously, rather than in isolation, to achieve optimal project outcomes. Furthermore, the strong internal consistency observed suggests that the measures used are reliable and can be effectively applied in future research.

However, the analysis did not identify significant direct effects of these latent variables on the extent of rework in the building. This absence of direct significance raises several important considerations. Firstly, it may suggest that the extent of rework is influenced by additional causes not included in the current model. Alternatively, the lack of significant direct effects could indicate that the relationship between the latent variables and the extent of rework is more complex than initially anticipated. The interplay between these variables may involve mediating or moderating processes not captured in the model. For example, the impact of "competency" on the extent of rework might be mediated by the quality of the framework, or the influence of the plan might be moderated by the level of information. The second and third reasons may apply to this research. To address these possibilities, future research could benefit from several approaches. Investigating potential mediating variables could provide insights into how these latent variables indirectly influence the outcome. Additionally, incorporating interaction terms in the model might help uncover conditional relationships that explain how different levels of the causes impact the relationship between other causes and the extent of rework. Exploring these complex relationships through further modelling techniques could offer a more nuanced understanding of the dynamics at play and identify additional factors contributing to the observed extent of rework. The discussion of each component predictor is presented in the following subsections.

5.2.1 Competency. The findings emphasise that the competency of key personnel and robust management practices are vital for reducing rework. These factors contribute to rework in sustainable buildings by leading to mismanagement, errors, and delays. Insufficient competency in key roles results in poor decision-making and oversight. A lack of competency can lead to poor decision-making, misalignment of goals, and the need for rework. Among other purposes, the procurement plan specifies the skill requirements of the parties involved. Similarly, the competence of the site supervisor and construction manager is crucial in overseeing daily activities and ensuring that sustainable practices are implemented correctly. Their inadequacies can result in errors that require rework. A poor procurement management plan can delay material deliveries, affecting project timelines and causing delays or mistakes that necessitate rework. Likewise, a poor site management plan can lead to disorganisation, inefficiencies, and improper execution of tasks, increasing the likelihood of rework. The competency of site operatives directly impacts the quality of work, and insufficient skills can lead to mistakes that require corrections. With poor communication, errors and rework would be high and expensive. A lack of information on the nature of the site may lead to miscalculations or improper handling of site-specific challenges, contributing to rework. Poor weather conditions can disrupt the construction process, leading to delays and forcing rework to meet deadlines and quality standards, especially when projects are not managed competently and there is inadequate planning and communication breakdowns.

5.2.2 Information plan. This cause suggests that effective information management is crucial for addressing rework and improving project outcomes. Poor quality management, inadequate equipment, and unsafe practices lead to mistakes and delays, requiring rework. Substandard materials, incomplete drawings, and unclear specifications create execution errors. Poor supply chain management and frequent variation orders disrupt the construction flow, resulting in corrections. These problems increase costs, delays, and waste in sustainable buildings. If a poor-quality management framework fails to detect problems early, it leads to defects that require correction. Inadequate equipment and poor site management hinder work efficiency, causing errors that necessitate rework. The competency of the project manager and construction manager is crucial; their lack of skills can lead to mismanagement, resulting in mistakes that need rectifying. Incomplete drawings and inadequate specifications leave room for misinterpretation, leading to faulty execution. Variation orders alter the scope, often creating conflicts and errors in implementation. Additionally, poor communication between the site and the company's office, along with insufficient information about the site, can lead to misunderstandings, which necessitate rework to resolve issues. These factors collectively hinder the construction of sustainable buildings.

5.2.3 Framework. The Framework latent variable emphasises the importance of structural and procedural elements in construction management. High factor loadings indicate that poor weather significantly impacts the quality of the framework, highlighting environmental factors as a major consideration. In sustainable buildings, poor payment plans can delay construction, leading to labour shortages, slow progress, and the need for rework due to missed deadlines. Poor payment may also affect sustainable objectives. The lack of a sustainability plan impedes the integration of sustainable practices, causing design and construction errors that require correction. Without a sustainability plan or payment plan, productivity may be affected. Poor coordination of contract documents creates confusion and discrepancies, resulting in miscommunication among stakeholders and mistakes during construction that require rework. These issues may lead to a poor schedule of works. A poor construction schedule hampers the timely completion of tasks, leading to rushed work or missed steps, both of which can necessitate corrections. Non-adherence to green/sustainable rating tools compromises the sustainable objectives of the project, resulting in non-compliant features that must be redone to meet sustainability standards. The complexity of designs can increase the likelihood of errors in interpretation or execution, particularly when sustainable features are involved. These issues ultimately lead to rework, increasing costs, extending timelines, and affecting the building's sustainability.

5.2.4 Plan. The Plan latent variable addresses critical aspects related to strategic and financial planning in a project, revealing significant factors that influence its effectiveness. This component highlights the importance of having comprehensive and up-to-date information on regulatory requirements, guidelines, and policies that impact the project. Insufficient information about government policy can lead to non-compliance with sustainability regulations and green building standards, requiring rework to meet legal and environmental requirements. When project teams are unaware of updated or specific policies, errors may arise during construction, causing delays and the need for corrections. Inadequate funding can lead to compromises in quality and delays in the procurement of sustainable materials or equipment. This may result in incomplete or substandard work, requiring rework to achieve the desired sustainability outcomes. Insufficient financial resources can also hinder the implementation of essential green building strategies, necessitating further adjustments.

5.2.5 Implications and actionable strategies. 5.2.5.1 The findings hold several key implications. *Policy implications* The findings underline the critical need for policymakers to establish more stringent guidelines and quality standards for sustainable building projects. Regulatory frameworks should mandate the use of comprehensive design and planning processes, emphasising the importance of complete drawings and specifications. Policies should also promote continuous training for construction companies to enhance competency and mitigate the occurrence of rework. Additionally, incentives for adopting robust product management practices and ensuring adequate funding allocation should be incorporated into national sustainability policies.

Theoretical implications The study contributes to the theoretical understanding of rework in sustainable construction by clustering causes into four latent variables using EFA and validating them with SEM. The rigorous measurement model enhances the reliability of future studies in this area, providing a robust foundation for examining rework phenomena. The results suggest avenues for further research, including the exploration of moderating and mediating variables, as well as a re-evaluation of dependent variables to improve alignment. Theoretical advancements can foster a deeper understanding of how rework affects sustainability outcomes and project success.

Practical implications and actionable strategies for practitioners Practitioners in the construction sector can adopt the following strategies to mitigate rework:

(1) *Improve design processes:* Ensure complete and detailed drawings and specifications before construction begins. Implement digital tools to minimize design-related problems.

(2) *Enhance Competency:* Provide targeted training and certifications for construction professionals, focusing on sustainable building practices and quality control.

(3) *Streamline Communication:* Establish clear communication channels among stakeholders to reduce errors from variation orders and enhance collaboration.

(4) *Adequate Funding:* Allocate sufficient budgets during the planning stage to address potential issues that could lead to rework.

(5) *Quality Assurance Programmes:* Introduce stringent quality checks and review systems at each project phase to ensure compliance with sustainability objectives.

6. Conclusion and recommendations

The research has investigated the causes of rework in sustainable buildings in Malaysia. The results from the factor loadings, regression coefficients, and covariances highlight the significant role of various latent variables, such as competency, framework, information, and planning, in influencing rework in sustainable construction projects. Factor loadings suggest that poor management frameworks, inadequate specifications, incomplete drawings, and poor supply chain management are critical drivers of rework. These factors align with competency-related issues, such as the competence of project managers and supervisors, which are integral to the effective execution of sustainable building projects. Information variables, including a lack of site-specific data and poor communication, were also found to be significantly correlated with rework, emphasising the importance of effective information flow and management. Furthermore, the study revealed that poor planning, including insufficient funding, poor payment plans, and the lack of a sustainability plan, leads to delays and issues that may necessitate rework. The research indicates that while some relationships, such as those between competency and information, were moderately strong, others, like plan and framework, showed weaker effects, suggesting areas where improvement could help reduce rework risks. The research underscores the complex interplay of factors that contribute to rework in sustainable building projects. By confirming the robust connections between the latent variables, this research highlights the necessity of considering complex, multifaceted relationships in sustainable construction management. Ultimately, these results enhance our understanding of sustainable construction management, promoting the development of more holistic and integrated approaches to tackle the challenges within this domain. While the measurement model is rigorous and robust, the structural model requires further investigation. Moderating and mediating variables may be reintroduced to the model, and the dependent variable may be reconsidered for better alignment and understanding. The research offers valuable insights into rework in sustainable buildings and its implications for construction management practices. However, the findings are constrained by the limited dataset. Although the respondents' profiles indicate adequate skills and knowledge in sustainable construction, a larger sample size could enhance the generalisability and robustness of future studies. Increasing the sample size would improve the statistical power of the analyses, reducing the likelihood of Type II errors and allowing for more precise estimation of relationships between variables. Larger sample sizes could also enable subgroup analyses to uncover nuanced effects that may not be apparent in smaller datasets. Additionally, expanding the range of determinants examined could provide a more comprehensive understanding of the factors contributing to rework. Future research should also focus on identifying and evaluating specific strategies to mitigate rework in sustainable buildings. Refining the measurement model could improve the accuracy and reliability of the model. This could involve incorporating additional indicators for each latent variable, ensuring that they comprehensively capture the underlying dimensions being measured. Researchers could also consider employing advanced techniques, such as confirmatory factor analysis (CFA), to further validate the measurement model. Furthermore, exploring the various types of rework in detail could yield nuanced insights, enabling targeted interventions to improve sustainability outcomes in construction projects.

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