



INTERNAL FACTOR AFFECTING THE CONSTRUCTION MANAGEMENT OF LARGE – SCALE AIRPORT BUILDINGS

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ABSTRACT

This research investigates the internal factors specifically Personal Factors, Construction Contract Management Factors, and Project Resource Factors—that are perceived to impact the construction management of Large-Scale Airport Building Projects across three dimensions: Work Delays, Cost Management, and Work Quality. Conducted using a quantitative survey of $N = 73$ experienced professionals involved in the SAT-1 project, the study findings are structured as follows: 1) Descriptive Ratings: Internal factors overall were perceived as having a high impact on construction management dimensions, with Work Delays receiving the highest average impact rating ($\bar{X} = 3.89$), where Contract Management emerged as the highest-ranked internal variable. 2) Group Comparisons (ANOVA): A One-Way ANOVA revealed no statistically significant differences in perceptions across educational backgrounds and stakeholder groups ($p > 0.05$). However, professional experience revealed a statistically significant difference regarding how personal factors affect work delays and cost management ($p = 0.050$). 3) Correlation Analysis (Pearson's, r): Correlation analyses demonstrated strong positive associations among the internal factors across the outcome dimensions, most notably between Cost Management and Work Quality ($r = 0.850, p < 0.001$), Work Delays and Work Quality ($r = 0.810, p < 0.001$). The findings provide an empirical baseline of perceived associations within a multi-contract Mega-Project context, offering actionable risk-management recommendations for future aviation infrastructure expansions.

KEYWORDS: Internal Factors; Construction Contract Management; Project Resources; Large-Scale Airport Buildings; Work Delays; Cost Management; Work Quality

1. Introduction

The aviation industry in Thailand plays a pivotal role in driving the national economy. Beyond generating direct revenue from air transportation, it serves as a foundational cornerstone for the tourism industry – the primary catalyst for the country's

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economic growth. The prosperity and operational strength of the aviation sector rely on four key components: airlines, aircraft, airports, and aviation facilities.

Between 2008 and 2017, Thailand's aviation sector experienced rapid growth, primarily catalyzed by the expansion of Low-Cost Carriers (LCCs). This structural shift democratized air travel, lowered overall passenger travel expenses, and led to a surge in passenger volumes. According to the *Report on the State of the Aviation Industry in Thailand* by the Civil Aviation Authority of Thailand (CAAT), both passenger traffic and flight frequencies doubled by 2015 relative to 2010 levels, significantly outpacing global and Asia-Pacific regional growth averages [1].

This continuous expansion highlighted the urgent need to expand airport infrastructure to prevent operational bottlenecks. Suvarnabhumi Airport, which opened in 2006 with an initial designed capacity of 45 million passengers per year, exceeded its threshold as early as 2007 by accommodating 46 million passengers [2]. Passenger traffic continued to escalate annually, demonstrating a direct correlation between aviation business growth and the necessity for airport facility expansion [2]. To address severe congestion, the Cabinet passed a resolution on August 24, 2010, approving the Suvarnabhumi Airport Development Project (Fiscal Years 2011–2016) with a total budget of 62,503.21 million Baht, aiming to increase total passenger handling capacity from 45 million to 60 million passengers per year [3]. A central element of this expansion plan was the construction of the Midfield Satellite 1 Building (SAT-1). Under the primary construction contract (Contract CC1/1), the project encompassed a 216,000-square-meter satellite terminal building, 28 contact gates, connecting tunnels, and an Automated People Mover (APM) transit system designed to connect SAT-1 seamlessly with the main passenger terminal [4].

It is evident that internal project factors – specifically personal factors, construction contract management, and project resources – play a critical role in the construction management of such Large-Scale Airport facilities. These factors directly influence project performance in terms of Work Delays, Cost Management, and Work Quality.

2. Conceptual Framework

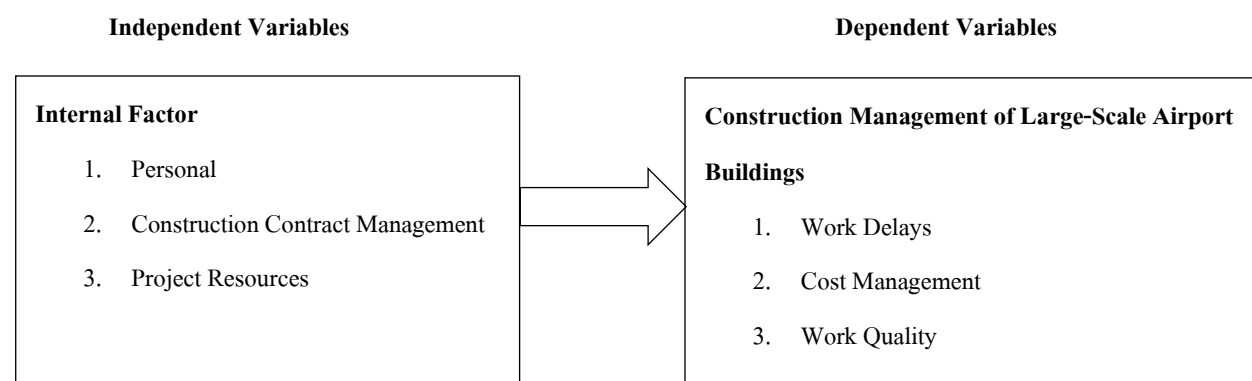


Figure 1 Conceptual framework of Internal Factor affecting the Construction Management of Large – Scale Airport Buildings

3. Objectives

1. To conduct a comparative analysis between the general profiles of the respondents and the perceived impacts on the construction management of Large – Scale Airport Buildings.
2. To investigate the relationship between internal project factors and their impact on the construction management of Large – Scale Airport Buildings, specifically regarding Work Delays.
3. To investigate the relationship between internal project factors and their impact on the construction management of Large – Scale Airport Buildings, specifically regarding Cost Management.
4. To investigate the relationship between internal project factors and their impact on the construction management of Large – Scale Airport Buildings, specifically regarding Work Quality.

4. Literature Review and Research Gap

This study grounds its independent variables Personal Factors, Construction Contract Management, and Project Resources Factors—in the Resource-Based View (RBV) [5], which posits that internal capabilities and resource allocations drive organizational performance. Furthermore, the dependent dimensions of Work Delays, Cost Management, and Work Quality are aligned with the Project Management Institute's triple-constraint framework. It is hypothesized that internal micro-level vulnerabilities directly influence these triple-constraint outcomes in Mega-Airport Projects. [6].

Within Large-Scale Airport construction management, internal factors represent controllable micro-level variables categorized into three domains:

1. Personal Factors: Competence, technical experience, and decision-making efficiency among key stakeholders (Employer, Designer, Project Consultant, Construction Supervisor and Contractors), where human errors directly risk procedural delays and rework [7].
2. Construction Contract Management Factors: Ambiguity in contractual terms, slow Variation Order (VO) approvals, and claims administration, which dictate project baseline adherence [8].
3. Project Resources Factors: Availability and logistical management of specialized materials, high-tech equipment, labor productivity, and liquidity [9].

In Mega-Airport Projects, failures in these internal dimensions trigger severe performance issues—manifesting as schedule overruns from approval bottlenecks, cost overruns from extended overheads, and quality compromises under schedule pressure.

4.1 Research Gap and Novelty

While existing literature extensively addresses construction delays in general civil infrastructure (e.g., highways or residential buildings), significant scholarly gaps remain regarding Mega-Airport Terminals:

1. Internal and External Focus: Prior studies heavily emphasize uncontrollable external macro-environment factors (e.g., political instability or weather) while under-exploring internal micro-level dynamics across multi-stakeholder coalitions [7,9].

2. Lack of Multi-Dimensional Correlation: Most empirical research evaluates Work Delays, Cost Management, and Work Quality as isolated metrics rather than analyzing cross-correlations among internal sub-factors and triple-constraint outcomes simultaneously.

3. Contextual Specificity: Specialized Satellite Terminals (such as SAT-1) involve unique architectural and system complexities (e.g., Automated People Movers and Baggage Handling System) that differ fundamentally from routine building projects.

To bridge these gaps, this study offers significant novel contributions: (1) It provides a 360-degree empirical evaluation across five key stakeholder groups (Employer, Designer, Project Consultant, Construction Supervisor and Contractors; $N = 73$); (2) It establishes holistic statistical evidence proving strong internal-factor correlations—most notably between Cost Management and Work Quality ($r = 0.850$) and Work Delays and Work Quality ($r = 0.810$); and (3) It identifies Contract Management as the single primary driver of Work Delays ($\bar{X} = 4.11$), delivering an actionable risk-mitigation framework for future aviation infrastructure expansions.

5. Research Methodology

This research was conducted using a quantitative survey research methodology supported by documentary synthesis (field data and contract extension documents) to investigate the internal factors affecting the construction management of Large-Scale Airport Terminal Buildings—focusing on Work Delays, Cost Management, and Work Quality [10,11]. While preliminary insights from expert consultations (semi-structured discussions with senior executives, $n = 19$) were utilized to frame the questionnaire context and enrich the practical discussion, the core empirical findings are derived from statistical analyses of survey data.

5.1 Population and Sampling Method

1. Target Population: Key professional stakeholders directly involved in the construction and supervision of the Midfield Satellite 1 Building (SAT-1) project at Suvarnabhumi Airport.

2. Sampling Technique and Size: A Purposive Sampling method was employed to select $N = 73$ senior key personnel who possess critical decision-making roles and operational expertise across five core project stakeholder groups:

1. Employer Group ($n = 11$, 15.1%)
2. Designer Groups ($n = 2$, 2.7%)
3. Project Consultant Groups ($n = 9$, 12.3%)

4. Construction Supervision Groups (n = 11, 15.1%)

5. Contractors (CC1/1 – CC5) Group (n = 40, 54.8%)

All respondents (100%) possessed direct experience in Airport Building Construction, with 76.7% having over 20 years of professional work experience [11][12].

Ethical Considerations and Informed Consent: This research involving human participants (questionnaire surveys and semi-structured interviews with senior professionals, N = 73) was conducted in accordance with ethical research standards. Prior to data collection, informed consent was obtained from all participants. Participation was entirely voluntary, and respondents were assured that their responses would remain strictly confidential and reported only in aggregate format to protect organizational and individual anonymity.

5.2 Research Instrument, Validity, and Reliability

1. Instrument Structure: The structured questionnaire consisted of 3 key parts:

1.1 Part 1: Demographic background.

1.2 Part 2: 5-point Rating Scale evaluating internal factors (Personal, Contract Management, Project Resources) across Work Delays, Cost Management, and Work Quality.

1.3 Part 3: Semi-structured qualitative interview guidelines for senior executives (n = 19).

2. Content Validity (IOC): The questionnaire items were validated by an expert panel of 3 scholars and practitioners in Large-Scale Construction Management and Engineering Law. The Index of Item-Objective Congruence (IOC) for all retained items ranged between 0.67 and 1.00, meeting the acceptable threshold of ≥ 0.50 [13][14]. Items with IOC scores below this threshold were either revised or eliminated.

3. Reliability Testing (Cronbach's Alpha): The instrument was pre-tested (Try-Out) with 30 non-sample professionals sharing similar characteristics. Internal consistency reliability was evaluated using Cronbach's Alpha Coefficient (α) calculated separately for each specific subscale and dimension [14][15]. The reliability coefficients for the quantitative subscales demonstrated acceptable to high internal consistency:

3.1 Personal Factors Scale: $\alpha = 0.85$

3.2 Construction Contract Management Scale: $\alpha = 0.89$

3.3 Project Resources Factors Scale: $\alpha = 0.86$

3.4 Overall Questionnaire Reliability: $\alpha = 0.88$

4. Qualitative Rigor and Credibility: Regarding the qualitative component, the semi-structured interview guidelines (n = 19) were validated for dependability and credibility through expert peer examination and member-checking with senior industry practitioners, rather than statistical internal consistency tests, ensuring qualitative research trustworthiness [10][11].

5.3 Measurement Scale and Score Interpretation Criteria

Part 2 measured respondents' perceptions using a 5-point Likert Scale [16]: 5 = Very High Impact, 4 = High Impact, 3 = Moderate Impact, 2 = Low Impact, 1 = No Impact.

To interpret the calculated mean scores ($\bar{X}$) and classify the level of impact, the study applied the Standard Class Interval Formula [11], [14], [17]:

$$\text{Class Interval} = \frac{\text{Maximum Score} - \text{Minimum Score}}{\text{Number of Levels}} = \frac{5 - 1}{5} = 0.80$$

The mean values ($\bar{X}$) are categorized and translated into operational impact levels as presented in Table 1

Table 1 Interpretation Criteria for Internal Factor Impact Levels

Mean Range ($\bar{X}$)	Impact Level (EN)	Scholarly Citation
4.21 – 5.00	Very High Impact	Best (1977) [17]
3.41 – 4.20	High Impact	Best (1977) [17]
2.61 – 3.40	Moderate Impact	Best (1977) [17]
1.81 – 2.60	Low Impact	Best (1977) [17]
1.00 – 1.80	Very Low / No Impact	Best (1977) [17]

5.4 Statistical Data Analysis Methods

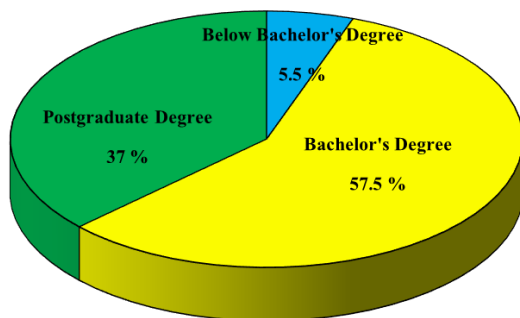
Data processing was executed using statistical packages (SPSS/R) applying both descriptive and inferential statistics:

1. Descriptive Statistics: Mean ($\bar{X}$), Standard Deviation (SD), and Variance (σ^2) to analyze central tendencies [18].
2. Descriptive Statistics for Priority Ranking: Mean ($\bar{X}$), Standard Deviation (SD), and ranking analysis were employed to evaluate the impact levels of internal factors affecting work delays, cost management, and work quality, based on 5-point Likert scale ratings [18]. The calculated mean scores were interpreted using established standard class intervals to determine priority rankings [17].
3. One-Way ANOVA (F-test): Applied to test parametric hypotheses regarding differences in mean impact scores across demographic groups (Education, Experience, Stakeholder Role). Homogeneity of variance was verified, with statistical significance set at $\alpha = 0.05$ ($p < 0.05$ to accept H_1) [18].
4. Pearson Correlation Coefficient (r): Evaluated linear inter-relationships between independent internal factors and dependent outcome dimensions (Work Delays, Cost Management, Work Quality). The coefficient values (r) were interpreted using standard strength thresholds [11][19]:

0.801 - 0.999: Very High level
0.601 - 0.800: High level
0.401 - 0.600: Moderate level
0.201 - 0.400: Low level
0.100 - 0.200: Very Low level

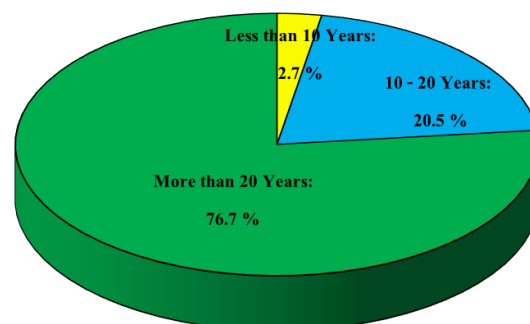
6. Analysis of Respondent's General Information

Based on a sample size of N = 73 respondents, the general information categorized by stakeholder status is as follows:
Contractor Groups: 54.8% (n = 40), Employer Groups: 15.1% (n = 11), Construction Supervisor Groups: 15.1%(n=11), Project Consultant Groups: 12.3% (n = 9), and Designer Groups: 2.7% (n = 2).



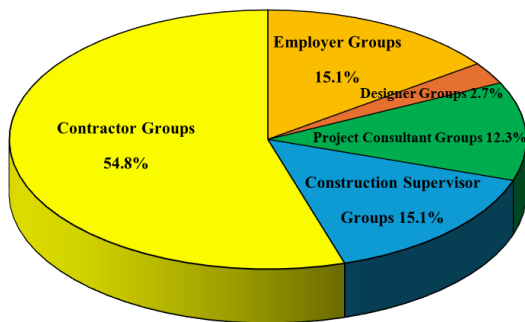
Bachelor's Degree: 57.5%
Postgraduate Degree: 37.0%
Below Bachelor's Degree: 5.5%

Figure 2 Education Background



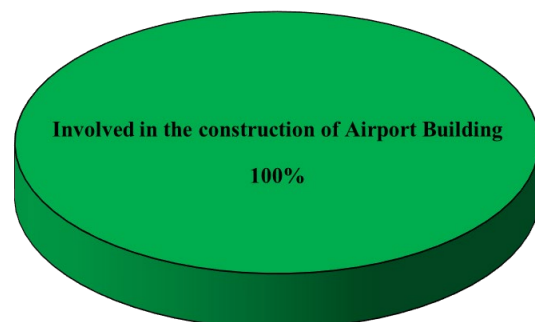
More than 20 years: 76.7%
10 – 20 years: 20.5%
Less than 10 years: 2.7%

Figure 3 Work Experience



Contractor Groups (CC1/1-CC5): 54.8%
Employer Groups: 15.1%
Construction Supervisor Groups: 15.1%
Project Consultant Groups: 12.3%
Designer Groups: 2.7%

Figure 4 Project Stakeholder Groups



Involved in the Construction of Airport Building: 100%

Figure 5 Project Involvement in Airport Construction

7. Results

7.1 Analyses of the Importance Index Affecting Large – Scale Airport Building Construction Management

From the analysis of the mean values ($\bar{X}$) and standard deviations (SD), the impact levels and priority rankings of each internal factor affecting the Construction Management of Large – Scale Airport Buildings were determined. The results are categorized and presented in Tables 2 – 4.

Furthermore, when analyzing specific sub-variables within the internal factors, the results indicated that the sub-variables with the highest mean impact scores regarding construction contract management were slow decision-making processes ($\bar{X}$ = 4.51) and work site handover delays ($\bar{X}$ = 4.49). For project resources factors, variation orders (VOs) represented the highest cost-escalating factor ($\bar{X}$ = 4.23). Regarding personal factors, the qualifications of engineers and managers ($\bar{X}$ = 4.00) and specialized skilled labor ($\bar{X}$ = 3.99) ranked highest in influencing work quality.

Table 2 Impact of Internal Factors on Work Delays in Large – Scale Airport Construction Management

Item	Impact of Internal Factors on Work Delays	$\bar{X}$	SD	Results
1	Construction Contract Management Factors	4.11	0.638	High
2	Project Resources Factors	3.89	0.862	High
3	Personal Factors	3.69	0.761	High
Summarize Impact of Internal Factors on Work Delays in		3.89	0.659	High

Large – Scale Airport Construction Management

According to Table 2, the ranking of internal factors affecting the management of Large – Scale Airport Projects regarding work delays, ranked as follows:

- Rank 1: Construction Contract Management Factors, with a mean score at a high level ($\bar{X} = 4.11$)
- Rank 2: Project Resources Factors, with a mean score at a high level ($\bar{X} = 3.89$)
- Rank 3: Personnel Factors, with a mean score at a high level ($\bar{X} = 3.69$)

In conclusion, the internal factors overall have a high-level impact on the Construction Management of Large – Scale Airport Projects in terms of Work Delays, with an overall mean score of 3.89.

Table 3 Internal Factors Affecting the Cost Management of Large – Scale Airport Projects

Item	Internal Factors Affecting the Cost Management of Large – Scale Airport Projects	$\bar{X}$	SD	Results
1	Project Resources Factors	3.82	0.915	High
2	Construction Contract Management Factors	3.81	0.679	High
3	Personal Factors	3.50	0.826	High
Summary of Internal Factors Affecting the Cost Management of Large – Scale Airport Projects		3.71	0.708	High

According to Table 3, the ranking of internal factors affecting the Cost Management of Large – Scale Airport Projects are ranked as follows:

- Rank 1: Project Resources Factors, with a high impact level ($\bar{X} = 3.82$)
- Rank 2: Construction Contract Management Factors, also at a high level ($\bar{X} = 3.81$)
- Rank 3: Personal Factors, which are at a high level as well ($\bar{X} = 3.50$)

In conclusion, internal factors overall exert a high – level impact on the Cost Management of Large – Scale Airport Projects, with an aggregate mean of 3.71.

Table 4 Internal Factors Affecting the Work Quality of Large – Scale Airport Projects

Item	Internal Factors Affecting the Work Quality of Large – Scale Airport Projects	$\bar{X}$	SD	Results
1	Personal Factors	3.72	0.816	High
2	Project Resources Factors	3.58	1.000	High
3	Construction Contract Management Factors	3.33	0.849	Moderate
Summary of Internal Factors Affecting the Work Quality		3.54	0.793	High

of Large – Scale Airport Projects

According to Table 4, the ranking of internal factors affecting the Work Quality of Large – Scale Airport Projects is as follows:

- Rank 1: Personal Factors, with a high impact level ($\bar{X} = 3.72$)
- Rank 2: Project Resources Factors, also at a high level ($\bar{X} = 3.58$)
- Rank 3: Construction Contract Management Factors, which are at a moderate level ($\bar{X} = 3.33$)

In summary, internal factors overall have a high – level impact on the Work Quality of Large – Scale Airport Projects, with an average mean of 3.54.

7.2 Analysis of Variance (One-Way ANOVA: F-test)

A One-Way Analysis of Variance (One-Way ANOVA) was conducted to examine whether perceptions of internal factors affecting construction management differed significantly across educational backgrounds, professional experiences, and project stakeholder groups. Prior to analysis, homogeneity of variance was tested using Levene's test.

The results revealed that most comparisons across education levels and stakeholder groups showed no statistically significant differences ($p > 0.05$). However, when categorized by professional experience, a statistically significant difference was found regarding the impact of Personal Factors on Work Delays ($F(2, 70) = 3.12, p = 0.050, \eta^2 = 0.082$) and Cost Management ($F(2, 70) = 3.08, p = 0.050, \eta^2 = 0.081$).

Table 5 Analysis of Internal Factors Categorized by Educational Background, Professional Experience, and Project Stakeholder Groups Affecting the Construction Management of Large – Scale Airport Terminals in Terms of Work Delays, Cost Management, and Work Quality.

Categorized by	Impact of Large – Scale Airport Construction Management		
	Work Delays	Cost Management	Work Quality
	F (df ₁ , df ₂) / p	F (df ₁ , df ₂) / p	F (df ₁ , df ₂) / p
Educational Background			
Personal	1.82 (2, 70) / 0.168	1.04 (2, 70) / 0.359	1.61 (2, 70) / 0.208
Construction Contract Management	2.55 (2, 70) / 0.085	0.76 (2, 70) / 0.470	0.43 (2, 70) / 0.651
Project Resources	2.78 (2, 70) / 0.069	2.47 (2, 70) / 0.092	2.59 (2, 70) / 0.084
Internal Factors Summary	3.01 (2, 70) / 0.057	1.71 (2, 70) / 0.190	1.66 (2, 70) / 0.199
Professional Experience			
Personal Factors	3.12 (2, 70) / 0.050*	3.08 (2, 70) / 0.050*	2.08 (2, 70) / 0.130
Construction Contract Management	0.89 (2, 70) / 0.415	2.22 (2, 70) / 0.114	1.08 (2, 70) / 0.345
Project Resources	0.39 (2, 70) / 0.674	0.67 (2, 70) / 0.514	2.73 (2, 70) / 0.071
Internal Factors Summary	1.41 (2, 70) / 0.250	1.93 (2, 70) / 0.154	2.37 (2, 70) / 0.100
Project Stakeholder Groups			

Personal Factors	1.08 (4, 68) / 0.364	0.39 (4, 68) / 0.814	0.93 (4, 68) / 0.455
Construction Contract Management	0.81 (4, 68) / 0.522	0.18 (4, 68) / 0.947	0.74 (4, 68) / 0.569
Project Resources	1.78 (4, 68) / 0.151	0.67 (4, 68) / 0.620	1.88 (4, 68) / 0.117
Internal Factors Summary	1.59 (4, 68) / 0.192	0.33 (4, 68) / 0.859	1.32 (4, 68) / 0.273

* Statistical Significance Level (Sig.) 0.05

Based on the statistical analysis presented in Table 5 (One-Way ANOVA), values presented indicate the F-statistic, with degrees of freedom in parentheses, and the exact p -value. Statistical significance is evaluated at the 0.05 level. An asterisk (*) denotes a statistically significant difference ($p \leq 0.05$). Non-significant results indicate no statistically significant difference across the tested subgroups ($p > 0.05$).

7.3 Correlation Analysis Results

The analysis of survey data regarding internal factors affecting the construction management of Large – Scale Airport Projects – specifically in terms of Work delays, Cost Management, and Work Quality – revealed significant correlations. Based on a sample size of 73 respondents, the data was subjected to Correlation Analysis, the results of which are presented in Tables 6 through 9 as follows:

Table 6 Correlation between internal factors affecting Large – Scale Airport Construction Management in terms of Work Delays and Cost Management.

Internal factors affecting Work delays	Internal factors affecting Cost Management			
	Personal	Construction Contract Management	Project Resources	Summary of Internal factors impacting Cost Management
Personal	R=0.814** Sig 0.000 <i>r</i>	R=0.506** Sig 0.000 <i>r</i>	R=0.608** Sig 0.000 <i>r</i>	R=0.740** Sig 0.000 <i>r</i>
Construction Contract Management	R=0.603** Sig 0.000 <i>r</i>	R=0.703** Sig 0.000 <i>r</i>	R=0.539** Sig 0.000 <i>r</i>	R=0.691** Sig 0.000 <i>r</i>
Project Resources	R=0.510** Sig 0.000 <i>r</i>	R=0.433** Sig 0.000 <i>r</i>	R=0.711** Sig 0.000 <i>r</i>	R=0.643** Sig 0.000 <i>r</i>
Summary of Internal factors impacting Work Delays	R=0.731** Sig 0.000 <i>r</i>	R=0.611** Sig 0.000 <i>r</i>	R=0.718** Sig 0.000 <i>r</i>	R=0.789** Sig 0.000 <i>r</i>

* Statistical Significance Level 0.05 ** Statistical Significance Level 0.01

From the results in Table 6, it can be concluded that internal factors affecting the construction management of Large – Scale Airport Projects in terms of “Overall Work Delays” have a significant correlation with “Overall Cost Management”. The correlation analysis yielded a coefficient of 0.789 (High Level), indicating a strong positive relationship; thus, the research hypothesis was accepted.

In detail, the internal factor – comprising Personal Factors, Construction Contract Management Factors, and Project Resources factors – as they relate to Work Delays, correlate with the Cost Management impacts. The breakdown of these internal sub – factors are as follows:

Personal Factors impacting Construction Contract Management in terms of Work Delays were correlated with; Personal Factors impacting Construction Management in terms of Cost Management at 0.814 (Very High Level), Construction Contract Management factors impacting Construction Management in terms of Cost Management at 0.506 (Moderate Level), and Project Resources Factors impacting Construction Management in terms of Cost Management at 0.608 (High Level).

Construction Contract Management Factors impacting Construction Management in terms of Work Delays were correlated with; Personal Factors impacting Construction Management in terms of Cost Management at 0.603 (High Level), Construction Contract Management Factors impacting Construction Management in terms of Cost Management at 0.703 (High Level), and Project Resources Factors impacting Construction Management in terms of Cost Management at 0.539 (Moderate Level).

Project Resources Factors impacting Construction Management in terms of Work Delays were correlated with; Personal factors impacting Construction Management in terms of Cost Management at 0.510 (Moderate Level), Construction Contract Management factors impacting Construction Management in terms of Cost Management at 0.433 (Moderate Level), and Project Resources Factors impacting Construction Management in terms of Cost Management at 0.711 (High Level).

Table 7 Correlation between Internal Factors affecting Large – Scale Airport Construction Management in terms of Work Delays and Work Quality.

Internal factors affecting Work delays	Internal factors affecting Work Quality			
	Personal	Construction Contract Management	Project Resources	Summary of Internal factors impacting Work Quality
Personal	R=0.891** Sig 0.000 <i>r</i>	R=0.542** Sig 0.000 <i>r</i>	R=0.694** Sig 0.000 <i>r</i>	R=0.791** Sig 0.000 <i>r</i>
Construction Contract Management	R=0.715** Sig 0.000	R=0.603** Sig 0.000	R=0.641** Sig 0.000	R=0.730** Sig 0.000

Internal factors affecting Work delays	Internal factors affecting Work Quality			
	Personal	Construction Contract Management	Project Resources	Summary of Internal factors impacting Work Quality
	<i>r</i>	<i>r</i>	<i>r</i>	<i>r</i>
Project Resources	R=0.592** Sig 0.000	R=0.399** Sig 0.000	R=0.645** Sig 0.000	R=0.617** Sig 0.000
Summary of Internal factors affecting Work delays	R=0.832** Sig 0.000	R=0.577** Sig 0.000	R=0.756** Sig 0.000	R=0.810** Sig 0.000

* Statistical Significance Level 0.05 ** Statistical Significance Level 0.01

According to Table 7, it can be concluded that Internal Factors affecting the Construction Management of Large – Scale Airport Projects in terms of 'Overall Work Delays' showed a strong positive correlation with overall Work Quality ($r = 0.810, p < 0.001$). Therefore, we failed to reject the alternative hypothesis.

The Internal Factors – comprising Personnel Factors, Construction Contract Management Factors, and Project Resources Factors – demonstrate a correlation between their impact on Work Delays and their impact on Work Quality in Large – Scale Airport Construction Management. The details for each sub – factor are as follows:

Personnel Factors impacting construction management in terms of Work Delays were correlated with; Personnel Factors impacting construction management in terms of Work Quality at 0.891 (Very High level), Construction Contract Management Factors impacting construction management in terms of Work Quality at 0.542 (Moderate level), and Project Resources Factors impacting construction management in terms of Work Quality at 0.694 (High level).

Construction Contract Management Factors impacting construction management in terms of Work Delays were correlated with; Personnel Factors impacting construction management in terms of Work Quality at 0.715 (High level), Construction Contract Management Factors impacting construction management in terms of Work Quality at 0.603 (High level), and Project Resources Factors impacting construction management in terms of Work Quality at 0.641 (High level).

Project Resources factors impacting construction management in terms of Work Delays were correlated with; Personnel Factors impacting construction management in terms of Work Quality at 0.592 (Moderate level), Construction Contract Management Factors impacting construction management in terms of Work Quality at 0.399 (Low level), and Project Resources factors impacting construction management in terms of Work Quality at 0.645 (High level).

Table 8 Correlation between Internal Factors affecting Large – Scale Airport Construction Management in terms of Cost Management and Work Quality.

Internal factors affecting Cost Management	Internal factors affecting Work Quality			
	Personal	Construction Contract Management	Project Resources	Summary of Internal factors impacting Work Quality
Personal	R=0.790** Sig 0.000 <i>r</i>	R=0.699** Sig 0.000 <i>r</i>	R=0.714** Sig 0.000 <i>r</i>	R=0.821** Sig 0.000 <i>r</i>
Construction Contract Management	R=0.543** Sig 0.000 <i>r</i>	R=0.789** Sig 0.000 <i>r</i>	R=0.620** Sig 0.000 <i>r</i>	R=0.729** Sig 0.000 <i>r</i>
Project Resources	R=0.573** Sig 0.000 <i>r</i>	R=0.490** Sig 0.000 <i>r</i>	R=0.758** Sig 0.000 <i>r</i>	R=0.691** Sig 0.000 <i>r</i>
Summary of Internal factors impacting Cost Management	R=0.728** Sig 0.000 <i>r</i>	R=0.735** Sig 0.000 <i>r</i>	R=0.802** Sig 0.000 <i>r</i>	R=0.850** Sig 0.000 <i>r</i>

* Statistical Significance Level 0.05 ** Statistical Significance Level 0.01

According to Table 8, it can be concluded that Internal Factors affecting the Construction Management of Large – Scale Airport Projects in terms of 'Overall Cost Management' showed a strong positive correlation with overall Work Quality ($r = 0.850, p < 0.001$). Therefore, we failed to reject the alternative hypothesis

The Internal Factors – comprising Personnel Factors, Construction Contract Management Factors, and Project Resources Factors – demonstrate a correlation between their impact on Cost Management and their impact on Work Quality in Large – Scale Airport Construction Management. The details for each sub – factor are as follows

Personnel Factors impacting construction management in terms of Cost Management were correlated with: Personnel Factors impacting construction management in terms of Work Quality at 0.790 (High level); Construction Contract Management Factors impacting construction management in terms of Work Quality at 0.699 (High level); and Project Resources Factors impacting construction management in terms of Work Quality at 0.714 (High level).

Construction Contract Management Factors impacting construction management in terms of Cost Management were correlated with: Personnel Factors impacting construction management in terms of Work Quality at 0.543 (Moderate level); Construction Contract Management Factors impacting construction management in terms of Work Quality at 0.789 (High level); and Project Resource Factors impacting construction management in terms of Work Quality at 0.620 (High level).

Project Resource factors impacting construction management in terms of Cost Management were correlated with: Personnel Factors impacting construction management in terms of Work Quality at 0.573 (Moderate level); Construction Contract Management Factors impacting construction management in terms of Work Quality at 0.490 (Moderate level); and Project Resources factors impacting construction management in terms of Work Quality at 0.758 (High level).

Table 9 Correlations between Internal Factors affecting Work Delays, Cost Management, and Work Quality in Large – Scale Airport Construction Management.

Internal Factors Affecting Construction Management	Internal Factors Affecting Construction Management		
	Work delays	Cost Management	Work Quality
Work delays	1	0.789**	0.810**
		Sig 0.000	Sig 0.000
		<i>r</i>	<i>r</i>
Cost Management	0.789**	1	0.850**
	Sig 0.000		Sig 0.000
	<i>r</i>		<i>r</i>
Work Quality	0.810**	0.850**	1
	Sig 0.000	Sig 0.000	
	<i>r</i>	<i>r</i>	

* Statistical Significance Level 0.05 ** Statistical Significance Level 0.01

Based on the results in Table 9, the study found significant correlations among Internal Factors affecting Large – Scale Airport Construction Management as follows:

The impact on “Overall Work Delays” showed a strong correlation with “Overall Cost Management” at 0.789 (High Level), leading to the acceptance of the research hypothesis.

The impact on “Overall Work Delays” exhibited a very strong correlation with “Overall Work Quality” at 0.810 (Very High Level), hence the research hypothesis was accepted.

The impact on “Overall Cost Management” demonstrated a very strong correlation with “Overall Work Quality” at 0.850 (Very High Level). Therefore, we failed to reject the alternative hypothesis

8. Discussion

8.1 Analysis of Statistical Findings and Internal Constraint Dynamics

The empirical findings reveal how internal factors govern the construction management triple constraints in Large-Scale Airport Terminal construction

1. Work Delays ($\bar{X}=3.89$): Primary Impact of Contract Management ($\bar{X}=4.11$)

The dominant impact of Construction Contract Management on schedule overruns stems directly from the multi-contract interface complexity of the SAT-1 project comprising 5 main package contracts (CC1/1, CC1/2, CC3, CC4, and CC5). The sub variables causing the highest delay were identified by respondents as critical administrative bottlenecks, specifically slow decision-making processes among project stakeholders and work site handover delays between contracts, demonstrating that contractual interdependencies create severe ripple effects. A delay in one contract's Key Date (KD) directly halts successor contractors, confirming Pooworakulchai [20] and Gorampai et al. [24], who identified multi-party administrative bottlenecks as the primary trigger for public construction extensions.

2. Cost Management ($\bar{X}=3.71$): Primary Impact of Project Resources ($\bar{X}=3.82$)

Project Resources emerged as the primary driver of cost overruns, closely followed by Construction Contract Management ($\bar{X}=3.81$). This reflects the capital-intensive nature of specialized aviation systems, such as Automated People Movers (APM) and Baggage Handling Systems (BHS). Cash flow liquidity, material price inflation, and extended administrative overheads during project extensions directly inflate budgets. Furthermore, Variation Orders (VOs) ($\bar{X}=4.23$) represent the highest cost-escalating factor, proving that incomplete tender designs force contractual scope adjustments during execution, in line with findings by Mohammed and Hasan [21] on budget deviations in complex engineering projects.

3. Work Quality ($\bar{X}=3.54$): Primary Impact of Personal Factors ($\bar{X}=3.72$)

Unlike time and cost, Work Quality is fundamentally anchored in human competency. Sub-variables such as Qualifications of Engineers and Managers ($\bar{X}=4.00$) and Specialized Skilled Labor ($\bar{X}=3.99$) ranked highest. In Mega-Airport Projects bound by strict international aviation safety standards (ICAO/FAA), quality non-conformances arise primarily from human error, deficient supervision, or a lack of certified technical experts in electro-mechanical installations, supporting Mehta et al. [22] regarding workforce skills as critical efficiency drivers.

4. ANOVA Insights: Work Experience as a Perception Differentiator

The One-Way ANOVA indicated consensus across educational levels and stakeholder groups ($p > 0.05$). A statistically significant variance was observed only in professional experience regarding Personal Factors influencing Work Delays and Cost Management ($p \leq 0.050$). Senior professionals with over 20 years of experience placed higher emphasis on managerial and human competence. Nonetheless, readers should interpret subgroup comparisons involving junior experience tiers with caution due to smaller subgroup sample sizes, which limit statistical power in those specific strata.

5. Pearson Correlation Analysis: Triple-Constraint Inter-relationships

The Pearson correlation analysis evaluates linear associations (co-variations) among performance dimensions rather than direct causal relationships:

5.1 Cost Management vs. Work Quality ($r = 0.850, p < 0.01$): Demonstrates the highest statistical association (85.0%). This strong co-variation indicates that project perceptions of financial stability and quality standards move in the same direction where higher cost management challenges strongly co-occur with lower quality outcomes, without assuming direct causality.

5.2 Work Delays vs. Work Quality ($r = 0.810, p < 0.01$): Reveals a strong positive association (81.0%). This reflects a strong statistical pattern where schedule overrun concerns closely align with Work Quality challenges during Mega-Airport Construction Projects.

5.3 Work Delays vs. Cost Management ($r = 0.789, p < 0.01$): Indicates a strong positive relationship (78.9%), showing that Work Delays and Cost Management difficulties tend to co-exist significantly across the multi-contract life cycle, reinforcing Obondi [23] regarding the inter-connected nature of project constraint indicators.

8.2 Comparative Discussion with Prior Literature and Academic Novelty

Comparing these empirical findings with prior national and international literature illustrates key alignments, divergences, and the scholarly contribution of this study

1. Alignment with Classic Infrastructure Studies:

The conclusion that Construction Contract Management and Decision-Making Bottlenecks drive Work Delays aligns with global findings by Assaf and Al-Hejji [7] in Saudi Arabia and Sambasivan and Soon [8] in Malaysia, who cited slow approvals and client-contractor communication gaps as main delay drivers.

2. Divergence in Cost Management Overrun Determinants

While general civil construction studies (e.g., Mohammed and Hasan [21] in Iraqi civil works) attribute Cost Management deviation primarily to external macroeconomic inflation, this study proves that in Mega-Airport Buildings, Variation Orders (VOs) and Internal Resource Liquidity carry greater weight ($\bar{X} = 3.82$ and $\bar{X} = 3.81$). This divergence highlights the technological complexity of Satellite Terminals, where design modifications in specialized systems trigger exponential cost increases compared to routine building projects.

3. Scientific Novelty and Academic Contribution

Existing literature predominantly evaluates Work delays, Cost Management, and Work Quality as isolated performance metrics. The primary scientific contribution of this study is providing quantitative empirical proof of the high inter-correlation ($r = 0.789 - 0.850$) among internal factors across all three triple-constraint dimensions within a multi-contract Mega-Airport Framework. It demonstrates that internal contractual and managerial failures create a compound risk cascade throughout the project life cycle.

8.3 Actionable Practical Strategies for Industry Stakeholders

To mitigate internal risks in future aviation infrastructure developments, based on empirical findings and supporting literature, the following practical strategies are recommended for industry stakeholders

1. For Project Owners and Airport Authorities (e.g., AOT)

1.1 Establish an Integrated Program Management Office (PMO): Implement a centralized PMO utilizing real-time Building Information Modeling (BIM) and digital interface management tools to streamline Key Date (KD) site handovers between civil and architectural (CC1/1 & CC1/2), systems (CC4/CC5), and utility (CC3) contractors.

1.2 Streamline Variation Order (VO) Governance: Establish fast-track decision-making protocols with predefined monetary authorization thresholds to prevent approval delays ($\bar{X} = 4.51$) from stalling progress.

2. For Construction Supervision Consultants (CSC)

Enforce Technical Credential Audits: Because Personal Factors drive Work Quality ($\bar{X} = 3.72$), consultants must strictly verify the qualifications of specialized sub-contractors and systems integration engineers prior to site deployment.

3. For Main Construction Contractors (CC)

Proactive Cash Flow and Supply Chain Management: Maintain dedicated contingency funds and advance supply-chain agreements for specialized high-tech equipment to buffer against resource-driven cost and timeline overruns ($\bar{X} = 3.82$).

9. Novelty and Academic Contribution

This study extends the existing body of knowledge in Construction Management and Engineering Law in four fundamental ways:

1. Bridging the Domain Gap from Routine Civil Works to Specialized Aviation Infrastructure:

While prior construction management literature heavily focuses on general civil infrastructure (highways, housing, and commercial buildings), this research extends the theoretical framework specifically to Mega-Airport Satellite Terminal developments. It captures the unique technical complexity, stringent aviation security standards (ICAO/FAA), and multi-contract interface dynamics inherent in aviation Mega-Projects.

2. Advancing from Isolated Constraint Analysis to Empirical Inter-Constraint Co-variation:

Traditional project management studies predominantly evaluate Work Delay, Cost Management, and Work Quality defects as isolated, independent variables [19][21]. This study contributes a novel empirical baseline by establishing statistically proven high co-variations ($r = 0.789 - 0.850$) among all three triple-constraint dimensions [8]. It provides concrete evidence that internal managerial and contractual vulnerabilities generate compound risks across the entire project life cycle.

3. Providing a 360-Degree Multi-Stakeholder Empirical Matrix:

Existing research frequently captures the perspective of a single party (either Contractors or Employer) [20][24]. This study advances methodology by integrating a balanced 360-degree empirical matrix across five distinct core stakeholder coalitions (Employer, Designer, Project Consultants, Construction Supervisor, and Contractors; $N = 73$). The high ANOVA consensus ($p > 0.05$) validates a unified multi-party understanding of internal project risks.

4. Quantifying Contract Interface Management as the Primary Delay Determinant:

This research delivers actionable empirical evidence proving that Construction Contract Management Factors ($\bar{X} = 4.11$)—specifically approval bottlenecks ($\bar{X} = 4.51$) and interface handover delays ($\bar{X} = 4.49$) serve as the primary drivers of schedule overruns in multi-package developments [8]. This offers a benchmark framework for future project management office (PMO) structures and contract administration practices in international aviation expansions.

10. Conclusion

This study empirically investigated the internal factors specifically Personal Factors, Construction Contract Management Factors, and Project Resources Factors affecting the construction management of Large-Scale Airport Terminal Buildings (focusing on the SAT-1 Project) across Work Delays, Cost Management, and Work Quality.

Summary of Main Findings: The empirical results indicate that internal factors overall exert a high impact on construction management dimensions, with Work Delays receiving the highest average impact rating ($\bar{X} = 3.89$). Construction Contract Management emerged as the primary driver of Work Delays ($\bar{X} = 4.11$), driven heavily by slow decision-making and interface handover bottlenecks. Furthermore, correlation analyses established strong co-variations among the triple constraints, most notably a very high positive correlation between Cost Management and Work Quality ($r = 0.850$), Work Delays and Work Quality ($r = 0.810$).

Practical Implications: To mitigate internal risks in future aviation infrastructure projects, industry stakeholders should establish a centralized Integrated Program Management Office (PMO) utilizing BIM for interface coordination, enforcing strict technical credential audits for personnel, and streamline Variation Order (VO) governance protocols.

Limitations and Future Research: While this study provides a comprehensive 360-degree multi-stakeholder perspective ($N = 73$), the findings are contextually bounded to a multi-contract Mega-Airport Terminal Project in Thailand. Future research could expand this framework to international aviation projects or incorporate longitudinal tracking of contract claims and digital tool adoption to further validate interface risk mitigation strategies.

Remark

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