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An Innovative Transformation Assessment Model for High-altitude Operations Based on Multi-dimensional Indicator System

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Abstract

This paper presents an innovative transformation assessment model for high-altitude operations in the construction industry. The model addresses critical safety challenges and inefficiencies in traditional high-altitude work by integrating emerging technologies and modern management practices. Using a mixed-methods approach, including case studies, interviews, and quantitative analysis, the research identifies five key dimensions for assessment: policy and regulatory environment, technological innovation, human resources, safety management, and cost-benefit analysis. The model employs a hierarchical structure and utilizes the Analytic Hierarchy Process (AHP) to weigh various evaluation elements within each dimension. A case study demonstrates the model's practical application, revealing its effectiveness in guiding strategic decision-making for innovative transformation. The study concludes that this comprehensive assessment model provides a scientific and actionable framework for companies to evaluate and implement innovative practices in high-altitude operations, potentially leading to significant improvements in safety, efficiency, and overall performance in the construction industry.

Keywords: High-altitude operations, Innovative transformation, Assessment model, Analytic Hierarchy Process.

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1. Introduction

The construction industry has witnessed a significant increase in high-altitude projects in recent years, driven by rapid urbanization and technological advancements. While these projects showcase architectural marvels and engineering prowess, they have inherent risks that cannot be overlooked. High-altitude operations, essential for constructing skyscrapers and maintaining tall structures, pose considerable safety challenges that demand urgent attention and innovative solutions.

The dangers associated with high-altitude work are multifaceted and severe. Falls from heights remain the leading cause of fatalities in the construction industry. Critical issues, including inadequate safety measures, low operator awareness, outdated equipment, and management inefficiencies, plague traditional high-altitude operation models. These factors jeopardize workers' lives and negatively impact project quality, timelines, and overall productivity.

The construction industry must undergo a paradigm shift towards innovative transformation in high-altitude operations to address these challenges. This transformation is not merely an option but a necessity for the sustainable and safe development of the sector. Key areas of innovation include advanced safety technologies, modern management models, enhanced training methods, and regulatory advancements. For instance, integrating cutting-edge safety equipment and implementing innovative safety technologies has shown promising results in improving worker safety (Chen and Liu, 2022). Similarly, implementing behavior-based safety management systems and data-driven risk assessment tools has significantly improved safety performance across various construction sites.

This study aims to develop a comprehensive, innovative transformation model for high-altitude operations in the construction industry. The primary objectives include conducting a systematic analysis of safety risks and management challenges, evaluating emerging technologies and operational models, constructing an innovative transformation model, testing the model through case studies, and formulating evidence-based policy suggestions for industry stakeholders.

The significance of this research extends beyond academic interest. It has profound implications for improving workplace safety, advancing the industry, developing regulations, promoting sustainable development, and empowering workers. By addressing the root causes of accidents, the study aims to reduce fatalities and injuries in high-altitude operations significantly. The research outcomes can directly contribute to enhanced safety training programs, improving workers' safety awareness and self-protection capabilities and thus eliminating accident hazards (Olsen, 2024).

2. Literature Review

The existing literature on high-altitude operations in engineering encompasses various aspects, from fundamental definitions to cutting-edge technologies and innovative transformation models. This review synthesizes key findings and insights from multiple studies, providing a comprehensive overview of the field.

Stencel (2006) thoroughly explores the challenges and opportunities in high-altitude operations. Their research identifies key obstacles practitioners face and highlights potential areas for improvement, offering a balanced perspective on the field's current state and future potential. This balanced approach is crucial for understanding the complexities of high-altitude operations and developing effective strategies for improvement.

A significant body of literature focuses on emerging technologies in high-altitude operations. Nam et al. (2021) offer comprehensive reviews of innovative technologies, examining their current applications and projecting future trends in high-altitude airborne wind energy. Their work is complemented by Chen and Liu (2022), who provide detailed analyses of specific technological advancements and their impact on operational safety and efficiency. These studies collectively demonstrate the potential of new technologies to transform high-altitude operations while acknowledging the challenges associated with their implementation.

Bai and Zhao (2021) explore the theoretical underpinnings of innovative transformation in high-altitude operations through their novel occupational safety risk analysis method. Their study provides crucial insights into the conceptual frameworks that guide innovation in the field. Building on this theoretical foundation, Lu and Cai (2019) present specific challenges and countermeasures for construction safety during high-altitude railway projects. These works collectively provide a robust theoretical and practical basis for understanding and implementing innovative approaches in high-altitude operations.

The collective body of literature reviewed here points to several key conclusions. High-altitude operations in engineering are complex and challenging, necessitating continuous research and innovation (Ding et al., 2021). Traditional methods are increasingly inadequate, highlighting the urgent need for transformation and improvement. Emerging technologies offer significant opportunities to enhance operational efficiency and safety, though their implementation faces various challenges (Jayakumar et al., 2024). Risk assessment and management are crucial components of successful high-altitude operations, requiring systematic approaches to identify, evaluate, and mitigate potential hazards (Das et al., 2024).

Mehta et al. (2022) document the significant increase in high-altitude projects driven by rapid urbanization and technological advancements. Mo et al. (2023) further emphasize the considerable safety challenges that demand urgent attention and innovative solutions. Li et al. (2019) analyze how falls from heights remain the leading cause of fatalities in the construction industry.

Niu et al. (2021) identify critical issues in traditional high-altitude operation models, including inadequate safety measures, low operator awareness, outdated equipment, and management inefficiencies. In a later study, Niu et al. (2024) discuss how implementing behavior-based safety management systems and data-driven risk assessment tools has significantly improved safety performance across various construction sites.

Yadav et al. (2021) systematically analyze safety risks and management challenges, while Mei et al. (2024) offer evidence-based policy suggestions for industry stakeholders. Future research in this field should prioritize applying innovative technologies, refining theoretical models, strengthening risk management strategies, and upgrading traditional methods. The literature emphasizes the importance of collaborative efforts among various stakeholders, including government entities, private enterprises, research institutions, and practitioners. Moreover, there is a growing recognition of the need for interdisciplinary collaboration in addressing the complex challenges of high-altitude operations. Researchers can develop more comprehensive and effective solutions by combining diverse perspectives and expertise from engineering, safety science, materials science, and human factors (Kassem et al., 2024).

3. Research Methods

This study employs a mixed-methods approach to investigate innovative transformations in high-altitude engineering operations. The research design incorporates both qualitative and quantitative methods to ensure a comprehensive understanding of the subject.

3.1 Qualitative Research Methods

The qualitative research methods employed in this study comprise three main components: case studies, in-depth interviews, and focus groups. Each of these methods contributes unique insights to the research on innovative transformations in high-altitude engineering operations.

3.1.1 Case Studies

Two in-depth case studies were conducted to provide real-world examples of innovative solutions in high-altitude operations. The first case study focused on the Taipei 101 Building Exterior Wall Cleaning Robot. This study examined the introduction of exterior wall cleaning robots, analyzing the technical solutions implemented, safety management measures, and personnel training plans. The research team assessed the benefits in cleaning efficiency, risk mitigation strategies, and cost reduction achievements. Data was collected through interviews with building management, cleaning contractors, and robot R&D teams.

The second case study investigated the Taichung Thermal Power Plant Chimney Maintenance Suspension System. This study centered on the implementation of a suspended working platform inside the chimney. The analysis covered technical difficulties encountered and overcome, process optimization strategies, and safety and reliability measures. The assessment focused on improvements in maintenance efficiency and enhancements in personnel safety. Data collection involved interviews with power plant management, maintenance technicians, and equipment suppliers.

These case studies offer deep insights into the challenges, solutions, and outcomes of implementing new technologies and methods in high-altitude operations.

3.1.2 In-depth Interviews

Semi-structured interviews were conducted with a range of stakeholders, including managers, engineers, and technicians involved in high-altitude operations. These interviews explored thoughts and practices in the process of innovative transformation, feedback on implemented innovations, and perspectives on challenges and opportunities in high-altitude operations.

The semi-structured format allowed for consistency across interviews while providing flexibility to explore unique insights from each participant. This method captures rich, detailed data about individual experiences and perspectives on innovation in high-altitude operations, providing a nuanced understanding of the human factors involved in technological and procedural changes.

3.1.3 Focus Groups

Focus group discussions were organized with a diverse set of experts, including BIM (Building Information Modeling) experts, architects, structural engineers, and construction management personnel. These discussions explored BIM's application prospects in high-altitude operations, practical paths for BIM implementation in areas such as hoisting planning, safety assessment, and progress simulation. The groups also analyzed cases of BIM empowerment in high-altitude operations transformation.

These focus groups facilitated interactive discussions where participants could build on each other's ideas, leading to rich, collaborative insights that might not emerge in individual interviews. This method proved particularly valuable for understanding the interdisciplinary nature of innovations in high-altitude operations.

3.1.4 Significance of Qualitative Methods

The combination of these qualitative methods provides a comprehensive, multi-faceted understanding of innovative transformations in high-altitude engineering operations. They offer rich, detailed data about complex processes and experiences, allow for exploration of unexpected themes and insights, and capture the context and nuances of innovative transformations.

Moreover, these methods enable an in-depth understanding of the challenges and opportunities in high-altitude operations and facilitate the development of theories grounded in real-world experiences. By using a mix of case studies, interviews, and focus groups, the research gains both depth and breadth in its exploration of the subject, providing a solid foundation for understanding the complex dynamics of innovation in this field.

3.2 Quantitative Research Methods

The quantitative component of this study employed a multi-faceted approach to gather and analyze numerical data related to innovative transformations in high-altitude operations. This approach consisted of three main elements: a structured questionnaire survey, comprehensive data analysis, and web-based data collection.

3.2.1 Structured Questionnaire Survey

A carefully designed questionnaire was distributed to collect industry-wide data on various aspects of innovative transformation in high-altitude operations. The survey targeted various industry professionals, including project managers, engineers, safety officers, and company executives. Questions were formulated to gather information on topics such as the adoption rates of new technologies, perceived benefits and challenges of innovations, safety improvements, efficiency gains, and cost-effectiveness of new methods.

The questionnaire used a combination of closed-ended questions with Likert scales for quantitative measurements and open-ended questions for additional insights. This design allowed for both statistical analysis and the capture of nuanced perspectives that might not be fully expressed in scaled responses.

3.2.2 Comprehensive Data Analysis

The study collected relevant data on innovative applications of high-altitude operations from various sources. This included safety indicators (such as accident rates and near-miss incidents), efficiency indicators (like project completion times and resource utilization rates), and cost-effectiveness measures (including return on investment for new technologies and long-term cost savings).

Statistical analysis methods were employed to examine trend changes and impact effects. These methods included descriptive statistics to summarize the data, inferential statistics to test hypotheses about the effectiveness of innovations, and regression analyses to identify factors significantly influencing the success of innovative transformations.

The analysis also incorporated longitudinal data where available, allowing for examining changes over time as innovations were implemented and refined. This approach provided insights into both the immediate and long-term impacts of innovative practices in high-altitude operations.

3.2.3 Web-based Data Collection

To supplement the primary data collected through surveys and industry sources, the research team employed web crawling techniques to gather additional relevant information. Over 5,000 reports were collected from mainstream media and industry websites. This data collection method allowed for the incorporation of public perceptions, industry trends, and reported case studies that might not have been captured through the survey or official data sources.

The web-crawled data was processed using natural language processing techniques to extract relevant information and sentiment analysis to gauge industry and public attitudes towards innovations in high-altitude operations.

3.2.4 Integration of Quantitative Methods

These quantitative methods worked in concert to provide a comprehensive numerical foundation for the study. The survey data offered current, first-hand information from industry professionals. The analysis of safety, efficiency, and cost data provided concrete metrics to assess the impact of innovations. The web-crawled data offered a broader context and captured emerging trends and public discourse around high-altitude operations.

By triangulating data from these various sources, the study aimed to build a robust quantitative understanding of the state of innovation in high-altitude operations. This approach allowed for identifying statistically significant trends, quantifying impacts, and developing predictive models for the future of high-altitude work innovations.

The quantitative findings from these methods complemented the qualitative insights, providing a well-rounded, data-driven basis for understanding the complex landscape of innovative transformations in high-altitude engineering operations.

3.3 Research Subjects and Sampling

A total of 30 representative companies were selected based on multiple criteria to ensure a comprehensive and diverse sample. The selection considered geographical distribution, company size, company type, and development stage in terms of technology application. Table 1 presents the distribution of these companies.

Table 1: The distribution of sampling companies

	Category	**Number of Companies**
Geographical Dimension	Northern Region (e.g., Taipei, New Taipei, Taoyuan)	10
	Central Region (e.g., Taichung, Changhua, Nantou)	8
	Southern Region (e.g., Kaohsiung, Tainan, Pingtung)	8
	Eastern Region (e.g., Yilan, Hualien, Taitung)	4
Company Size	Large Enterprises (e.g., 500 or more employees)	8
	Medium-sized Enterprises (e.g., 100-500 employees)	12
	Small Enterprises (e.g., fewer than 100 employees)	10
Company Type	Property Owners (e.g., large construction companies, real estate developers)	6
	General Contractors (e.g., large engineering companies)	8
	Specialty Subcontractors (e.g., aerial work specialty contractors)	10
	Technical Service Providers (e.g., safety assessment, equipment supply, technical consulting)	6
Development Stage and Application Characteristics	Traditional Companies (mainly manual operations for aerial work)	10
	Transitional Companies (actively exploring and applying new technologies and processes)	12
	Innovative Companies (large-scale application of automated, informatized, and intelligent technologies)	8

3.4 Data Collection and Analysis

The study employed a comprehensive data collection and analysis approach, incorporating qualitative and quantitative methods to ensure a thorough investigation of innovative transformations in high-altitude operations. Figure 1 provides an overview of this process.

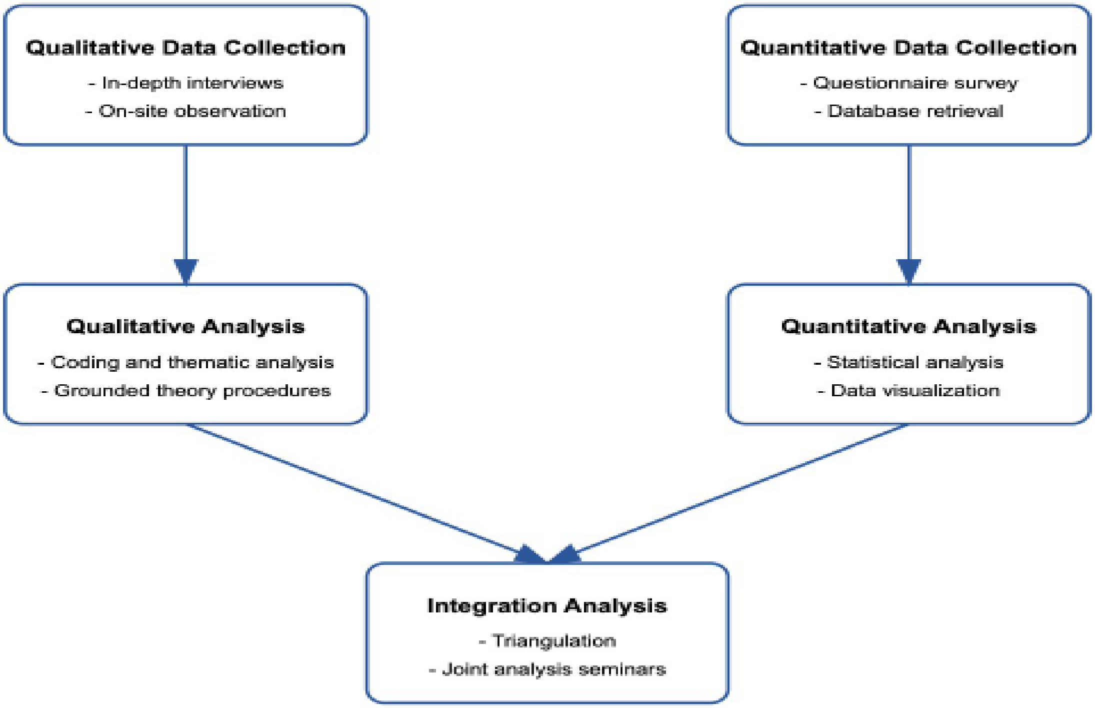

Figure 1: Data Collection and Analysis Flowchart

3.4.1 Qualitative Data Collection and Analysis

The qualitative data collection process was extensive and multi-faceted. It began with 90 in-depth interviews with senior managers, project managers, and safety directors. Each interview lasted between 60 to 90 minutes, resulting in a rich corpus of data totaling 1.2 million words of transcribed material. These interviews provided deep insights into the decision-making processes, challenges, and successes in implementing innovative practices in high-altitude operations.

To complement the interview data, the research team conducted on-site observations of 10 high-altitude operation projects over two months. This fieldwork yielded 450,000 words of observation logs, 1,200 on-site photographs, and 60 hours of audio-visual materials. These observations provided crucial context and allowed the researchers to witness firsthand the implementation of innovative practices in real-world settings.

Additionally, three expert symposiums were organized, each involving 10-15 experts and lasting 2-3 hours. These symposiums generated 60,000 words of minutes, capturing collaborative discussions and expert opinions on the future of high-altitude operations innovation.

The analysis of this qualitative data was rigorous and systematic. The research team utilized Atlas.ti software for coding and thematic summarization. They applied grounded theory coding procedures, including open, axial, and selective coding, to identify key themes and concepts emerging from the data. The team also conducted frequency analysis and cross-analysis of thematic categories to identify patterns and relationships within the data.

3.4.2 Quantitative Data Collection and Analysis

The quantitative data collection was equally comprehensive. A questionnaire survey was distributed to 200 companies, yielding 156 valid responses, representing a 78% validity rate. This survey provided broad insights into industry trends and practices. The team retrieved databases from Taiwan's Ministry of Economic Affairs and Ministry of Labor to supplement the survey data. This data included information on the number of high-altitude operation enterprises, the scale of employees, and safety accident data over the past five years, providing a macro-level view of the industry. Furthermore, the team employed web crawling techniques to gather over 5,000 relevant reports from mainstream media and industry websites, capturing public discourse and reported innovations in the field.

The quantitative data analysis utilized SPSS 26.0 for descriptive statistical analysis, factor analysis, and regression analysis. The team also applied Python's Pandas and Matplotlib libraries for data cleaning, integration, and visualization, allowing for sophisticated statistical analysis and clear graphical representation of trends and patterns.

3.4.3 Integration Analysis

The final stage of analysis involved integrating the qualitative and quantitative findings. The team combined the qualitative thematic framework with quantitative key influencing factors, using triangulation for cross-validation. This process ensured that insights from one method could be corroborated and expanded upon by the other.

To facilitate this integration, the research team conducted three joint analysis seminars involving both qualitative and quantitative researchers. These collaborative sessions allowed for a holistic interpretation of the data, ensuring that the final analysis leveraged the strengths of both methodological approaches.

This comprehensive research methodology, combining in-depth qualitative insights with broad quantitative data, ensured a thorough investigation of innovative transformations in high-altitude operations. As illustrated in Figure 1, the approach provided both depth and breadth to the study's findings, offering a nuanced understanding of the complex dynamics at play in this rapidly evolving field.

4. High-altitude Work Innovation Transformation Model

4.1 Model Dimensions and Element Identification

The model identifies five main dimensions through literature reviews and expert interviews. These dimensions and their specific evaluation elements were analyzed using the Analytic Hierarchy Process (AHP). This method involves comparing elements to determine their relative importance, resulting in weight matrices. Expert input was critical for assigning these weights, which underwent consistency checks. The weight assigned to each evaluation element can be expressed as a matrix $\boldsymbol{W}$, with weights w_{ij}corresponding to the j-th element within the i-th dimension.

4.2 Model Structure Design

The model structure follows a hierarchical design, with evaluation elements nested within broader dimensions. The relationships between these elements and their dimensions are central to the calculation process, enabling systematic assessment across the hierarchy.

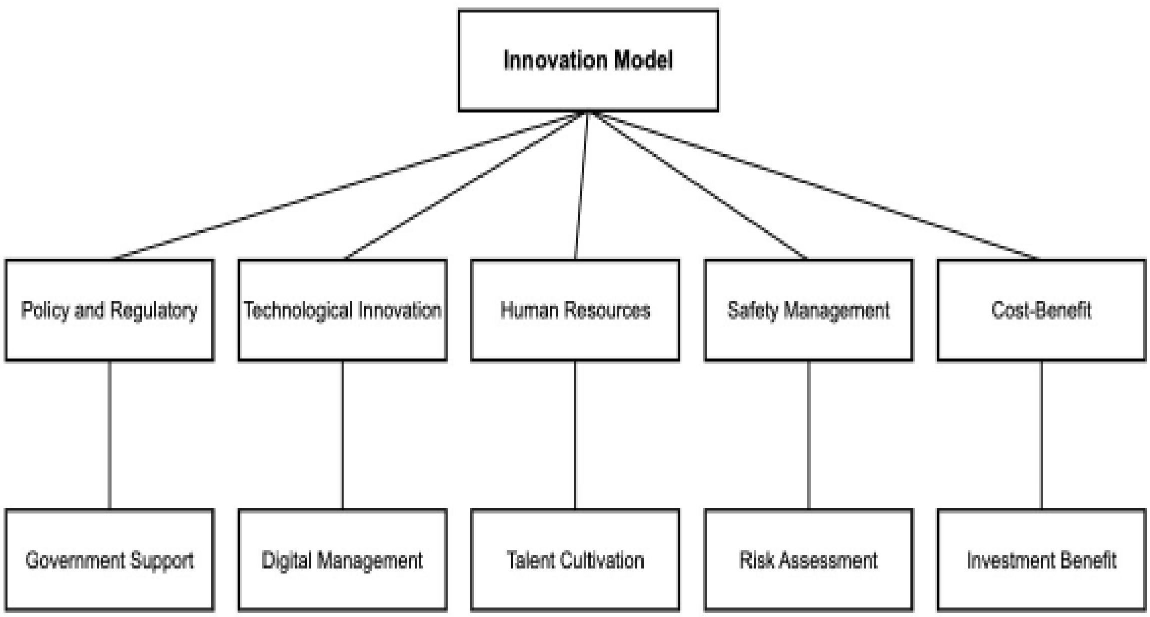

Figure 2: Hierarchical Model Structure

Figure 2 presents a structured approach to understanding and potentially implementing innovation transformation. It suggests that successful innovation requires consideration of external environmental factors, internal organizational elements, and technological capabilities. The framework provides a way to systematically analyze and address various aspects that contribute to innovative capacity and transformation within an organization or system.

4.3 Model Operation Mechanism

1. *Measurement Scales and Calculation Methods*

Each evaluation element is rated on a defined scale. For instance:

- **Government support** is evaluated on a scale of 1 to 5, with 1 being the lowest support and 5 the highest. The score is based on the number of relevant policies, funding levels, and the quality of resources.
- **Regulatory standards** are rated on a 1 to 5 scale, with 1 indicating very inflexible or inapplicable standards and 5 representing highly flexible and applicable standards.

The score for each element E_{ij} is calculated based on these scales.

2. *Interaction Between Dimensions and Elements*

The score for each dimension G_i is calculated as a **weighted sum** of its corresponding evaluation elements:

$$G_i = \sum_j w_{ij} \times E_{ij} \tag{1}$$

Where:
G_i is the score of the *i-th* dimension,
w_{ij} is the weight of the *j-th* element of the iii-th dimension,
E_{ij} is the score of the *j-th* element of the *i-th* dimension.

The **total score** *S* of the model aggregates the scores of all dimensions. Depending on the desired representation of interactions among dimensions, *S* can be computed as a weighted average, a product, or another function, such as:

$$S = f(G_1, G_2, G_3, G_4, G_5) \tag{2}$$

For example, if a weighted average is used, the total score *S* might be expressed as:

$$S = \sum_i E_i \times G_i \tag{3}$$

Where w_i represents the weight of the *i-th* dimension.

3. *Model Operation Process*

1. **Data collection**: Data for each evaluation element is gathered through surveys, reports, or expert assessments.
2. **Data input**: The collected data is input into the model for processing.
3. **Calculate dimension scores**: Using the equation (1) $G_i = \sum_j w_{ij} \times E_{ij}$, scores for each dimension are calculated.
4. **Calculate total score**: The total score *S* is computed using the function

$$S = f(G_1, G_2, G_3, G_4, G_5) \tag{4}$$

5. **Result presentation**: The total score and dimensional scores are presented to stakeholders.
6. **Model optimization**: Feedback is used to adjust weights, scales, or dimensions, refining the model for future use.

4.4 Model Case Verification and Adaptation

In this section, the **Soaring Eagle High-altitude** company serves as an example to demonstrate the model's application. This company specializes in high-rise building exterior cleaning and maintenance and is facing challenges such as intense industry competition and rising costs. The company adopted the proposed evaluation model to assess the feasibility and priority directions of transformation.

Evaluation Process

The transformation evaluation process follows six key steps, as illustrated below

1) Data Collection

The **Soaring Eagle High-altitude** team, consisting of management, technical experts, and financial personnel, gathered comprehensive data from the following sources:

- Annual reports
- Business documents
- Interviews with front-line employees and industry experts
- Competitor visits

The data covered **technology**, **market**, **financial**, **policy**, and other relevant areas for a holistic view of the company’s position.

2) Data Input

The collected data were input into the evaluation model. Scores were assigned to various evaluation indicators based on the company's performance. Below is an example of scoring for the **technology** and **financial** dimensions.

Table 2: Example of Data Input for Key Dimensions

Dimension	Indicator	Score
Technology	Equipment Advancement	4
Technology	Technological Innovation Capability	3
Financial	Profitability	3
Market	Market Development	4
Policy	Government Support	5

3) Calculate Dimension Scores

Analytic Hierarchy Process (AHP) and other methods to understand the relative importance of dimensions and elements:

We used hypothetical data to conduct an Analytic Hierarchy Process (AHP) on the evaluation elements. First, we needed to establish a weight matrix for the evaluation elements. We invited 5 experts to make pairwise comparisons of the evaluation elements, resulting in the following weight matrices (Table 3 to Table 7):

Table 3: Policy and Regulatory Dimension

	Government Support	**Regulatory Standards**	**Approval Process**
Government Support	1	1/2	1/3
Regulatory Standards	1/2	1	1/2
Approval Process	1/3	1/2	1

Table 4: Technological Innovation Dimension

	New Equipment R&D	**Safety Device Improvement**	**Digital Management**	**Emerging Tech Integration**
New Equipment R&D	1	2	1/2	1/3
Safety Device Improvement	1/2	1	1/3	1/4
Digital Management	2	3	1	1/2
Emerging Tech Integration	3	4	2	1

Table 5: Human Resources Dimension

	Talent Cultivation	**Education and Training**	**Team Collaboration**	**Innovative Thinking**
Talent Cultivation	1	1/2	2	3
Education and Training	2	1	3	4
Team Collaboration	1/2	1/3	1	2
Innovative Thinking	1/3	1/4	1/2	1

Table 6: Safety Management Dimension

	Risk Assessment	**Safety Regulations**	**Accident Prevention**	**Safety Performance**
Risk Assessment	1	2	3	1/2
Safety Regulations	1/2	1	2	1/3
Accident Prevention	1/3	1/2	1	1/4
Safety Performance	2	3	4	1

Table 7: Cost-Benefit Dimension

	Investment Benefit	**Maintenance Cost**	**Construction Efficiency**	**Loss Reduction**
Investment Benefit	1	3	2	1/2
Maintenance Cost	1/3	1	1/2	1/4
Construction Efficiency	1/2	2	1	1/3
Loss Reduction	2	4	3	1

Next, we calculated the weight vectors for the evaluation elements under each dimension based on the weight matrices and performed consistency checks. After verification, we obtained the following results:

Table 8: Weights of Evaluation Elements for Each Dimension

Dimension	Evaluation Element	Weight
Policy and Regulatory	Government Support	0.539
	Regulatory Standards	0.297
	Approval Process	0.164
Technological Innovation	New Equipment R&D	0.124
	Safety Device Improvement	0.084
	Digital Management	0.319
	Emerging Tech Integration	0.473
Human Resources	Talent Cultivation	0.262
	Education and Training	0.493
	Team Collaboration	0.160
	Innovative Thinking	0.085
Safety Management	Risk Assessment	0.373
	Safety Regulations	0.199
	Accident Prevention	0.106
	Safety Performance	0.322
Cost-Benefit	Investment Benefit	0.370
	Maintenance Cost	0.105
	Construction Efficiency	0.196
	Loss Reduction	0.329

Table 8 clearly shows the weight results for each evaluation element under its respective dimension. Through this tabular presentation, we can quickly identify which evaluation elements occupy more important positions within their dimensions. This helps decision-makers to quickly identify factors that need to be focused on and prioritized in the process of promoting innovative transformation in engineering high-altitude operations, thereby formulating more targeted and effective strategic plans.

In this way, we obtained the relative weights of the evaluation elements under each dimension. These weights can help us determine which factors should be focused on and prioritized when promoting innovative transformation in high-altitude engineering operations. For example, in the policy and regulatory dimension, government support has the highest weight, so seeking government support should be the primary task in promoting innovative transformation.

The Analytic Hierarchy Process (AHP) is an effective decision-making tool that can help us identify key elements in a complex system of factors, providing a quantitative basis for formulating innovative transformation strategies.

(4) Calculate Total Score

The total innovation transformation score was calculated by integrating the weighted dimension scores into the total evaluation function. The function used was a weighted sum of the dimensions.

$$S = \sum_i E_i \times G_i \quad (5)$$

Where:

S is the total score

w_i is the weight of dimension *i*

G_i is the score of dimension *i*

The final total score for Soaring Eagle High-altitude was 3.9, which indicated that the company was in the "good" category for innovation transformation. This score demonstrated a solid foundation and areas for improvement.

(5) Result Presentation

The evaluation results were presented in a structured report, highlighting the strengths and weaknesses of the company's current situation. A visual representation of the dimension scores helped illustrate the company's performance across different areas.

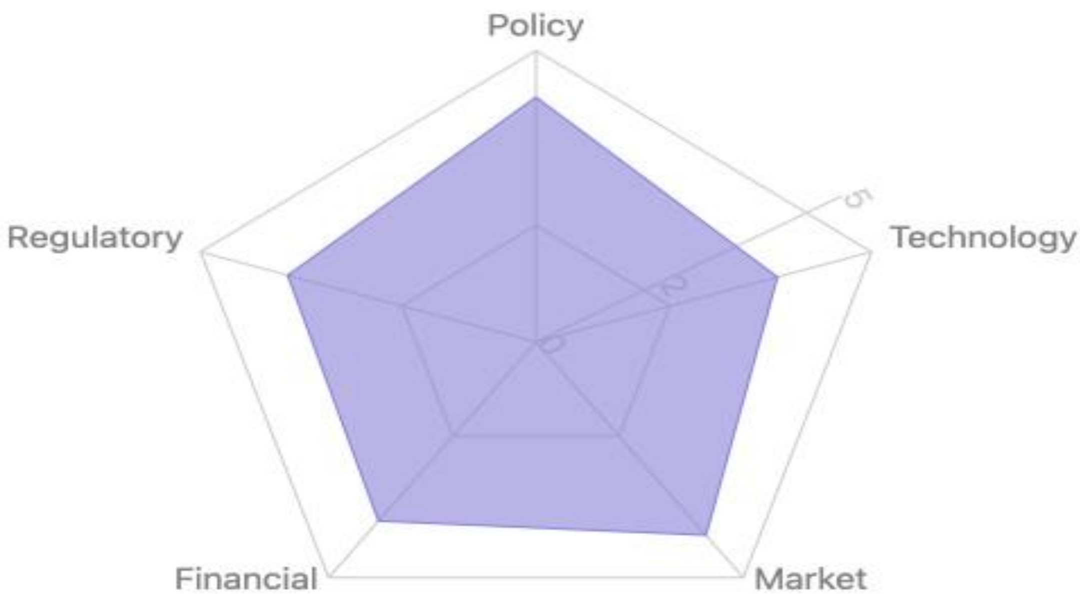

Figure 3: Radar Chart of Dimension Scores

Figure 3 provides a detailed illustration and explanation of the Radar Chart of Dimension Scores. This detailed illustration and explanation of Figure 3 provides a comprehensive understanding of the company's current situation in terms of its innovative transformation in high-altitude operations, serving as a valuable tool for strategic planning and decision-making.

Key Insights from the Results:

1. **Strengths**: Strong performance in **market development** and **policy support**, which provides significant opportunities for innovation.
2. **Weaknesses**: Areas such as **cost control** and **talent reserve** required attention to improve competitiveness.
3. **Opportunities**: Future trends, such as **artificial intelligence** and **new materials**, were identified as key areas for the company to explore, especially in developing unmanned and automated solutions.

(6) Model Optimization

In the process of implementing innovation transformation, **Soaring Eagle High-altitude** regularly reviewed the effectiveness of the transformation and made adjustments to improve accuracy. For example, the company updated the policy dimension's weight in response to changing industry regulations and modified several performance indicators that inadequately reflect transformation progress.

Soaring Eagle High-altitude achieved significant milestones after more than a year of effort. Notably, the company developed an innovative wall-cleaning robot that improved work efficiency and safety, contributing to a substantial profit increase. Government subsidies also played a role in helping the company achieve financial success. The model was praised for providing a clear, actionable framework for guiding the company's transformation.

5. Conclusion

The innovative transformation assessment model for high-altitude operations represents a significant advancement in evaluating and guiding companies through their transformation efforts. By quantifying key indicators across multiple domains and employing sophisticated mathematical methods, this model objectively assesses a company's potential and priorities for innovative transformation, offering a solid foundation for strategic decision-making.

The case study of Soaring Eagle High-altitude Company validates the model's effectiveness, demonstrating its capacity to guide companies towards significant economic and social benefits. Through this assessment, companies can identify their strengths and weaknesses, formulate targeted strategies, and continuously optimize their transformation journey.

However, the application of this model is not without challenges. Its effectiveness relies heavily on the quality and comprehensiveness of data collected. Moreover, the model must be adaptable to specific industry characteristics and company situations. It's crucial to remember that while the model provides valuable insights, it should complement, not replace, managerial experience and judgment. Companies must view the assessment results in the broader context of their vision, resources, and both short-term and long-term objectives.

Looking to the future, the high-altitude operation industry stands at the cusp of unprecedented opportunities and challenges. Breakthroughs in information technology, equipment manufacturing, and new materials offer exciting possibilities. To capitalize on these, companies must cultivate a strategic awareness of innovative transformation, accurately gauge industry trends, increase innovation investment, and strengthen collaborative efforts with research institutions.

This innovative transformation assessment model provides essential theoretical and practical support for the industry's evolution. This model serves as a powerful tool for navigating the complex terrain of high-altitude operations. It fosters innovation and drives sustainable growth in an environment rich with both challenges and opportunities. The journey of innovative transformation is ongoing, requiring collaborative efforts from both theoretical and practical domains to ensure continued progress and success in this critical industry.

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