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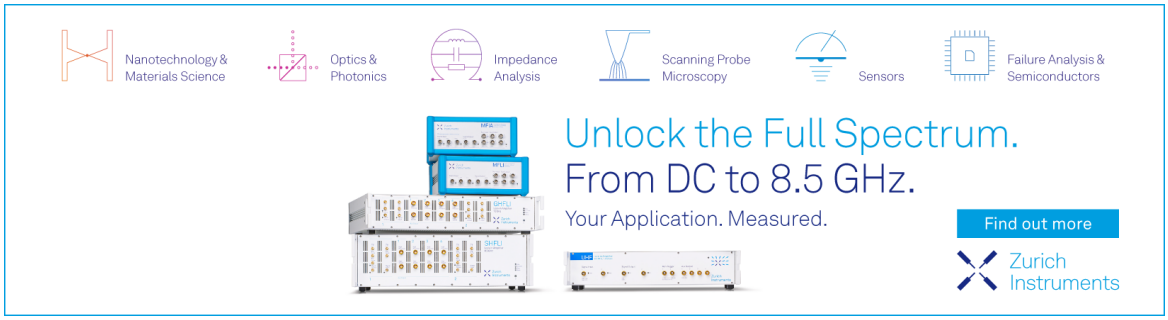

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Construction Safety Performance Measure for Perception of Excavation Hazard by Comprehensive Survey Route

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ABSTRACT: Excavation hazard is one of the most significant risks to worker in the construction site and various measures are adapted to limits the hazards. The present research exposes the detailed survey for excavation hazard features via comprehensive survey approach. This proposed system integrates with stakeholder engagement strategies, robust data collection methodologies, and transparent decision-making processes to enhance hazard management practices in the construction industry. A comparative analysis was conducted to evaluate the proposed method's performance against traditional hazard management methods, including the Delphi Method, Hazard Identification and Risk Assessment (HIRA), and Job Safety Analysis (JSA) respectively. This set of methods are identified the main key factors affecting the safety and compare the safety method significance like reliability, validity, applicability, specificity, and cost effectiveness. The proposed system is exploited maximum reliability, validity, applicability, specificity, and cost effectiveness compared to traditional methods. Based this survey, overall performance score is 9.

Keywords: Construction; Delphi; HIRA; JSA; Performance; Safety.

INTRODUCTION

Excavation hazards overcome perception skill plays the vital role for successful drive of project integrity and save the workers from threats. The consistence between the workers to project influences the major effect on construction site [1-3]. With this different safety protocols and measures are taken from construction site and conducted the awareness program by theoretically [4-6]. Advancement of technological development, the various technologies, safety regulation, and standards are framed to limiting the accidents [7-8]. Excavation features related analysis including feedback, enquiry from, predictive analysis report, and follows the potential mitigation strategies. It helps to reduce the majors' hazards in the construction site [9-11]. Besides, the deep learning technique leads to identify the major issue and support to take the preventive action against the hazard [12-14]. Excavation hazard influences affect the human health [15-16] and preventing static/dynamic analysis are carried [17-19].

With the support of Hazard Identification and Risk Assessment (HIRA) approach, the different kinds of risks to worker in construction site is identify, locate the issue place, researching, and frame the standard policies for reduce

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the hazard [20]. It leads to limits the accidents [21-23]. Job Safety Analysis (JSA) separates tasks into phases, detects hazards, and determines controls to reduce them. Workers are routinely told the dangers of their occupations and how to accomplish them safely [24]. Besides, the composite based materials are used for weight reduction management and various safety measured taken to install [25-27]. Safety Climate Assessment evaluates leadership commitment, communication, and safety regulations to determine workplace safety. It assesses a company's safety culture and suggests improvements. Root Cause Analysis (RCA) and incident investigation investigate workplace accidents to determine their causes [28]. The advantages of advanced material are potential for better performance [29-31]. Companies may prevent future issues by identifying the causes. Safety walkthroughs and inspections regularly inspect the workplace for hazards, compliance with safety laws, and effective control mechanisms. They allow us to constantly identify dangers and improve safety procedures. Safety training and instruction provide workers with the knowledge, skills, and tools they need to perform safely [32]. High strength and light weight materials are used [33]. Effective safety training teaches workers to identify dangers, work properly, and manage crises. This reduces accidents and injuries. BBS Observations examine and evaluate workers' behaviour to discover unsafe circumstances and provide them feedback to be safer [34-36]. Besides advanced material handling technique with light weight material found better alternative for conventional [37-39]. BBS programs concentrate on how people behave and think about safety to create a safety attitude. A company's safety culture evaluation examines safety principles, beliefs, attitudes, and behaviours. Companies may measure their safety culture to see what works and doesn't. They may then improve it and boost safety [40-41]. The recommended method for "a Delphi survey on contractors' perceptions of excavation hazard features" is to repeatedly interview construction industry personnel about excavation hazards [42-43]. Players get well-crafted questions regarding mining dangers, safety, and risk mitigation in each round [44-45]. They then provide their ideas, opinions, and recommendations based on their expertise. They gather the answers, evaluate them, and then return them to the panel. This improves the panel's thoughts and helps them decide. This cyclical procedure continues until all players agree or until no significant responses change. The Delphi poll on contractors' excavation hazards will include a diverse group of construction industry personnel with expertise in excavation, safety management, and risk assessment. Builders, safety managers, engineers, project managers, and other key stakeholders in digging-related construction projects will all be in attendance [46].

The excavation hazard safety related past reports literatures are addressed above and found the research gap on collecting expert opinions, past survey related to major accident reason, and variation in reliability. This research relies on the Delphi poll technique with advanced comprehensive approach, which is known for collecting expert opinions and agreeing on tough problems. We discreetly send multiple rounds of planned questions or surveys to specialists using the Delphi technique associated with comprehensive analysis. The results will be examined for key discoveries, trends, and recommendations for increasing mining industry safety. Delphi survey results will increase mining risk knowledge. They will also assist in establishing best practices and standards for construction workers and others, making construction sites safer.

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PROPOSED COMPREHENSIVE APPROACH

Module 1-selection of panel participants

Figure 1 illustrates the schematic diagram for process selection panel participants for Delphi survey with comprehensive approach, which involves identifying the upcoming criteria’s, volunteers, observing the issues against the system, judging, and select the final group for further assistance.

During the process selection, the criteria related to industry, projects, location, and experiences are defined, which is helpful for identifying the potential participants and from the professional networks. After identifying the participants, measure the specific qualities to fulfill the selection criteria. Based on the workers qualities, they are ranked and invited to conform the work nature and assign the work. Based on work, the participants are instructed to safety regulation and maintain the safety and consider experience, diversity, and inclusiveness when selecting panelists. Final step involves to next stage survey related to current work. Communicate effectively with participants, providing them with necessary information and support throughout the survey process. Conclude the participant selection process, ensuring readiness to proceed with the Delphi survey.

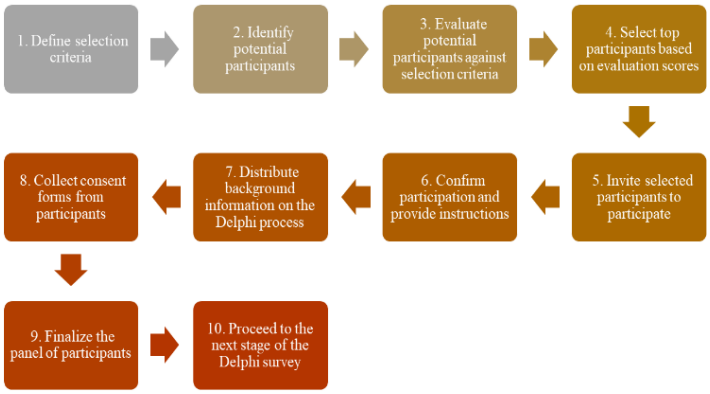

Figure 1 schematic diagram for process selection panel participants for Delphi survey with comprehensive approach

Module 2 – Conducting the initial round of Delphi comprehensive approach

With the implementations of Delphi survey associated with comprehensive approach formulate the structure to minimize the hazards. Figure 2 indicates the steps for conducting the initial round Delphi survey associated with comprehensive approach.

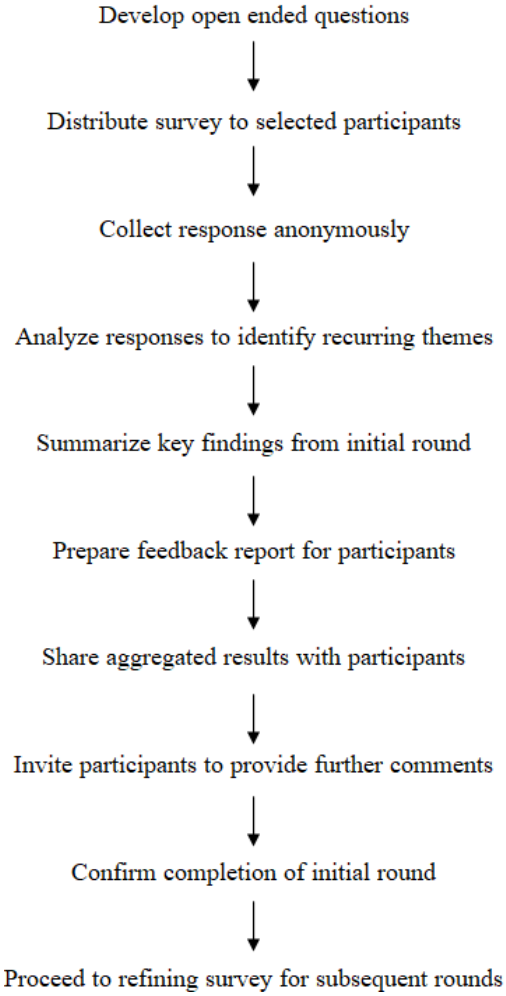

Figure 2 Steps for conducting the initial round of the Delphi survey associated with comprehensive approach

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According to this to make survey questions, send them out to people to answer, collect answers, analyze them, and then summarize the most important results so that they can be used in future surveys. The survey is given confidentially to a select number of panelists, who are urged to respond honestly. To ensure fair analysis, responses are collected anonymously. Next, the replies are examined for common themes, patterns, or areas of agreement or disagreement. This initial Delphi survey sets the tone for succeeding rounds. It provides qualitative data that improves survey questions and agreement-building over time. In the module 2 describe the Expert opinions may be combined and distilled to solve tough issues using the Delphi survey. First, open-ended questions are asked to gather relevant data for the research. These questions seek alternative perspectives on mining dangers and safety. The selected respondents get the survey and answer it confidentially. After that, these replies are examined for common themes, patterns, or areas of agreement or disagreement.

The primary findings from the first round are put into a feedback report and delivered to all participants after the study. Readers are requested to submit comments and opinions to the report. This boosts survey participation. Based on feedback and learning, the poll questions have been improved for the following round. This method ensures that the poll evolves to incorporate new subjects and insights. This clarifies excavation dangers and safety. Algorithm 2 helps collect qualitative data methodically and repeatedly, preparing for Delphi polls and expert opinions.

Module 3 – Interactive round of Delphi comprehensive approach

According to the interactive round of Delphi comprehensive approach, the procedures are structured and Each round, poll questions are improved by looking at previous results and concentrating on areas of disagreement or the need for additional information. Panelists comment on their former replies depending on the final findings once the poll is improved. Anonymous replies are analyzed for trends, agreement, and disagreement. This procedure continues until everyone agrees or the answers don't change significantly. The Delphi poll gathers people's opinions over time. Figure 3 indicates the schematic process diagram for conducting the interactive round of Delphi comprehensive approach.

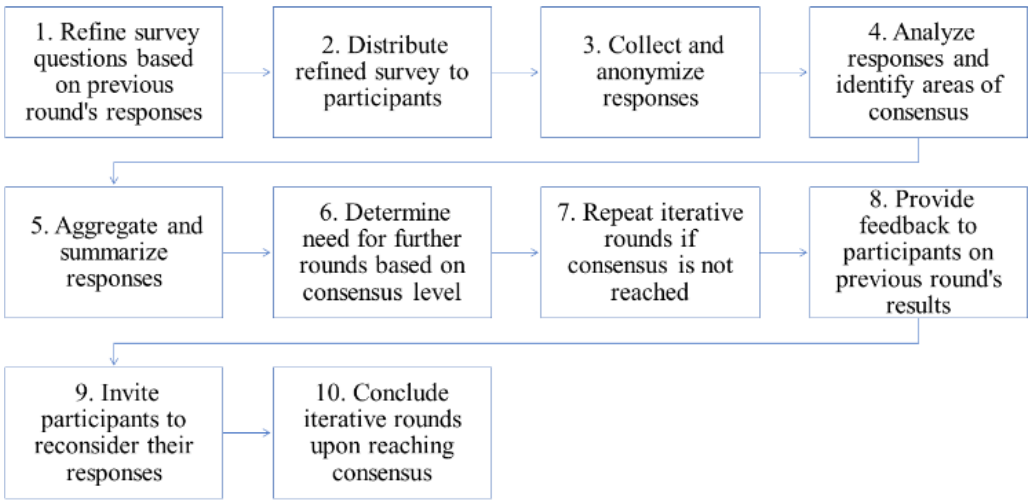

Figure 3 schematic process diagram for conducting the interactive round of Delphi comprehensive approach

First, the poll questions are revised using the previous round's feedback and fresh facts. Look at the participants' replies to discover what they agree and disagree on. This helps alter poll questions to meet new topics and clarify misconceptions. We improve the poll and send it to people via email for private completion. We analyze these anonymous responses to identify common themes and gauge public opinion. If there is no consensus, the process starts again and changes the poll questions depending on research and comments. We inform participants about their performance in the previous round, which encourages them to reflect on and respond more thoughtfully. Keeping the process transparent and open helps people trust it. We continue iterative rounds until we reach consensus, or the responses don't significantly change. This keeps the Delphi survey improving by gathering and synthesizing expert viewpoints to help people understand and make better mining risk and safety choices.

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RESULTS AND DISCUSSION

Reliability analysis

Based on the comprehensive survey of proposed system is related with traditional method on reliability behaviour during the safety of excavation hazards is presents in the Figure 4.

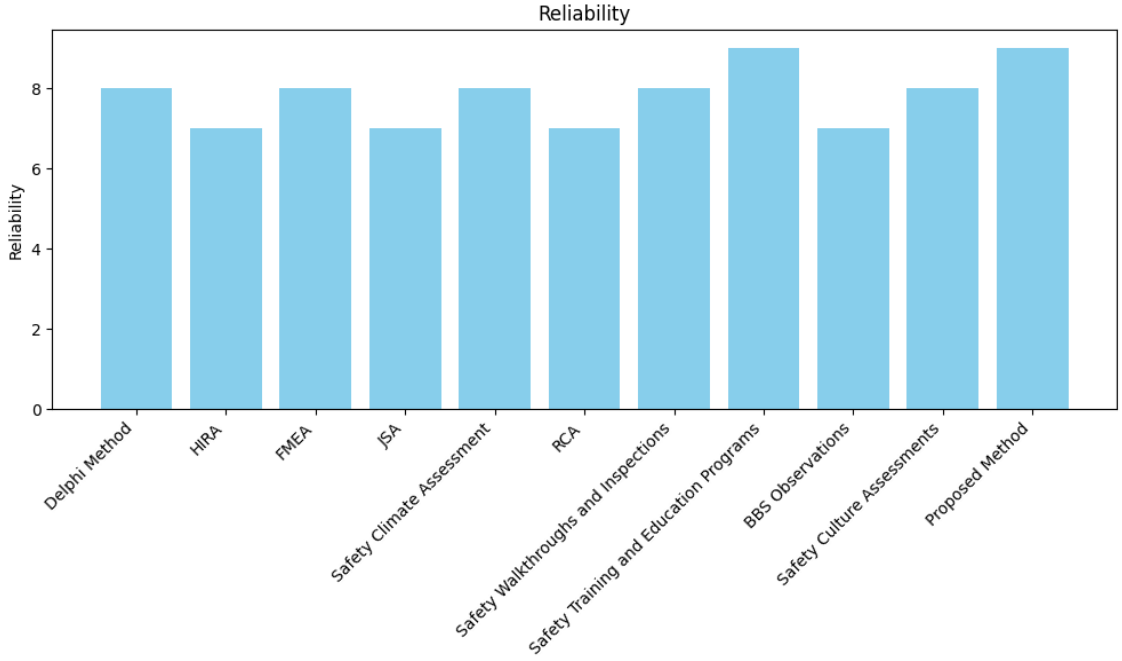

Figure 4 Comparative reliability analysis of proposed method with traditional methods

Based on the risk management related to excavation hazard data is gathered analysis with stakeholder engagement. It clearly spots the location at high risk [4]. Besides, the most common technique of Delphi is attained the score of 8 with high reliability.However, other approaches work well in certain areas, but the suggested method is more effective and covers more ground. Building safety measures' suitability and efficacy depends on assessment criteria. It recorded by more than the score of 7 with good reliability. With the proposed system for expert opinion and with three different initial modules conforms the highest reliability with score of 9.The proposed system approach is revealed more than 8 score influences the more reliability for safety to worker and acts as effective bridge between the worker to project [14]. With improved work safety leads to minimize the hazard issue and limits the problem with human health [15].

VALIDITY ANALYSIS

A comprehensive study of building safety approaches is focused on their effectiveness in key risk management areas. After extensive examination, the offered technique is the best. According to the proposed approaches of validity analysis survey is related to traditional analysis is detailed in the Figure 5. These findings illustrate that the technique considers all digging hazards, including data gathering, analysis, and make the final reports to maintain the safety standards.

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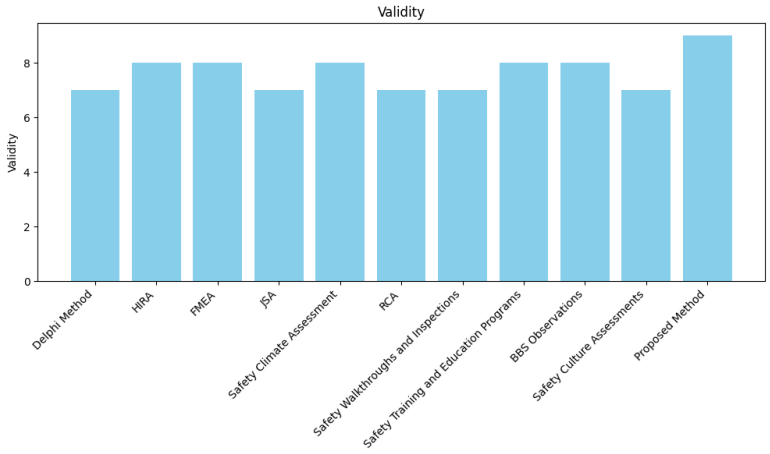

Figure 5 Comparative validity analysis of proposed method with traditional methods

The traditional analysis including Delphi, JSA, RCA, safety walkthrough and inspections, and safety culture assessments is exposed with score of 7 with good validity. Likewise, the validity analysis executed with HIRA, failure mode effective analysis (FMEA), safety climate assessments, and safety training survey recorded with the score of 8. Based on the proposed system implemented with three different module including expert opinion and detailed data analysis is found 9 score of validity. Moreover, the comprehensive approach is proved better validity and meets the safety standards. The expert analysis is validated with different data analysis influences the high safety [16].

APPLICABILITY ANALYSIS

The validity ratings of each approach illustrate how effectively their poll questions capture public opinion on mining risk for availability is exposed in the Figure 6.

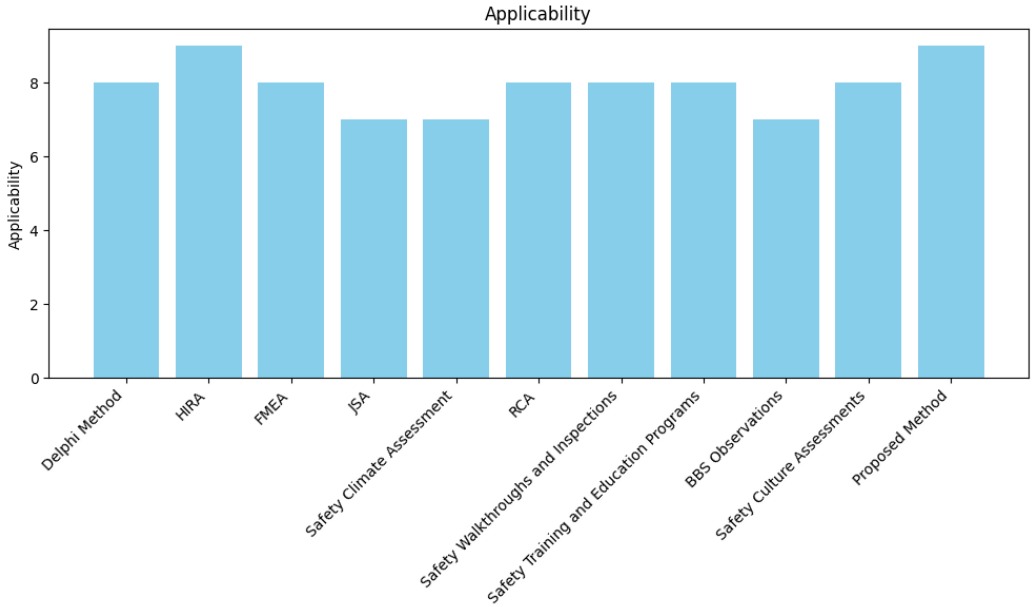

Figure 6 Comparative applicability analysis of proposed method with traditional methods

Based on the validity analysis, the applicability analysis was surveyed and the proposed system is found better applicability and limits the risk. The conventional method meets the 7-8 score of availability and reduced the excavation hazards and improved working standards. The effective static and dynamic approaches lead to spots the specific risk location and take the predictive action against the risk [10]. The proposed technique is exposed better

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applicability with score of 9, and similar to HIRA analysis. Based on score related to other techniques, the proposed system is suitable for construction site and limits the risk during the project execution. It related to number of usefulness with respect to all methods and deals with drilling risk in the building specificity is exploited in the Figure 7.

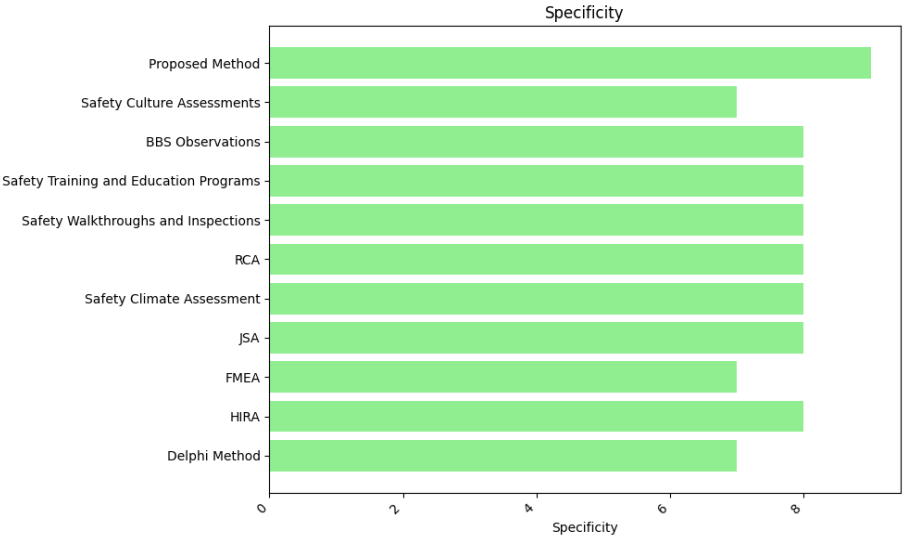

Figure 7 Comparison of Specificity of Proposed Method with Traditional Methods

Moreover, the proposed technique performance is compared with other techniques is listed in the Table 1. The accuracy and cost-effectiveness ratings of several approaches to illustrate how effectively they locate safety measures and manage construction hazards related to proposed system.

Table 1 Comparison of Performance Evaluation Parameters with Construction Safety Methods

Method	Re lia bil V ali dit Fe asi bil pp lic ab - ns iti vit ec ifi cit eff ec tiv an sp ar
Delphi Method	8 7 9 8 7 7 6 8
Hazard Identification and Risk Assessment (HIRA)	7 8 7 9 8 8 7 8
Failure Mode and Effects Analysis (FMEA)	8 8 7 8 7 7 6 8
Job Safety Analysis (JSA)	7 7 8 7 8 8 7 8
Safety Climate Assessment	8 8 8 7 8 8 7 8
Incident Investigation and Root Cause Analysis (RCA)	7 7 8 8 8 8 7 8
Safety Walkthroughs and Inspections	8 7 8 8 7 8 7 8
Safety Training and Education Programs	9 8 9 8 8 8 7 8
Behavior-Based Safety (BBS) Observations	7 8 8 7 7 8 7 8
Safety Culture Assessments	8 7 8 8 8 7 7 8
Proposed Method	9 9 9 9 9 9 9 9

CONCLUSION

The present investigation of Delphi survey associated with comprehensive approach for construction safety (excavation hazards) is analyzed in detail. With the effectiveness of export opinion with improved data analysis with three modules are detailed. Impacts of comprehension analysis associated with Delphi survey on reliability, validity, applicability, specificity, and cost effectiveness of construction safety is measured and its score is compared with traditional methods like Delphi Method, Hazard Identification and Risk Assessment (HIRA), Job Safety Analysis (JSA) etc. This service offers a complete method of risk management that focuses on accuracy, speed, and making sure all parties are happy. To do this, it collects data, gets people involved, and makes decisions that are clear and easy to understand. Additionally, the research on ablation identified the primary factors influencing the effectiveness of the proposed process, along with strategies to enhance its performance. Based on the results of the ablation study, there may be ways to make polls, agreement formulas, and openness measures better to keep up with the constantly

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changing needs of building safety management with high score of 9, which is applicable for reliability, validity, specificity, and cost effectiveness. Future study projects should test the suggested method on real building sites.

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