

# Predicting the Time Impact and Identifying the Practical Responses to Claim Causes in Building Projects

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## ABSTRACT

Construction claims are inevitable and usually result in negative impacts on the project performance, and especially the project delays. This study aims to predict the time impacts and identify the practical responses to claim causes in building projects. Firstly, potential claim causes were identified through an extensive literature review and verified by a group of nine claim experts. Face-to-face interviews were conducted with these experts to establish the causal relationships among the identified claim causes. These relationships were then used to structure a Bayesian Network (BN) model for predicting the time impacts of each claim cause. The BN model comprised 13 claim causes of which only one claim cause (i.e. change orders) was independent. Subsequently, the historical data on the claim causes were collected from 112 actual building projects via a structured questionnaire survey. The data were then encoded and used as input to the model. A real case study project was used to demonstrate the predictive capability of the model. The results showed that the BN model is capable of effectively predicting the time impact levels of the claim causes. Next, twelve claim experts were invited to identify response strategies for each claim cause. It was found that the five response strategies commonly adopted for addressing claim causes are the: acceptance, avoidance, mitigation, contingency plan/reserve, and transfer. The present study also identified practical response methods for dealing with such claim causes. This study contributes a practical approach for forecasting the potential time impacts of the claim causes and formulating practical responses, thereby enhancing the claim management practices in building projects.

*Keywords-claim causes; Bayesian Network; time impacts; predict; response strategies; response methods*

## I. INTRODUCTION

The number of construction claims has continuously increased and their negative impacts on the project performance have been irrecoverable [1]. Claims usually arise when the actual works differ from those specified in the contract [2]. These claims result in unwanted effects, including schedule delays [3, 4]. A survey in Western Canada pointed out that most construction claims were associated with delays. The delays, in many cases, exceeded 100% of the original contract

duration [5]. When the construction claims are not resolved amicably, they can escalate into disputes, which often contribute to project delays, financial losses, and the deterioration of relationships among the project participants [6, 7]. Globally, the average cost and time resulting from the construction disputes were 43.4 million USD and 14.8 months, respectively [8]. Unfortunately, the frequency and severity of the construction claims have witnessed sharp rises over the past decades [4]. This trend underscores the need for more effective claim management approaches and further scholarly

investigation to enhance the current claim management practices and contribute to the existing body of knowledge.

A thorough understanding of the underlying causes that give rise to claims is essential for project participants to formulate effective claim management strategies, proactively address the potential project risks, and ultimately improve the overall project outcomes [9]. The causes of common claims in construction projects have been explored [10-18]. Additionally, the impacts of claim causes have been qualitatively evaluated in terms of frequency and severity [10, 19, 20]. The types and causes of the construction claims as well as the evaluation of their impacts have been provided. However, two major issues concerning the construction claims remain unaddressed in the existing body of research. First, a limited number of studies have examined the quantitative predictions of the time impacts of the claim causes during the project execution [21]. Several prior studies proposed various scales for evaluating the impacts of the claim causes in terms of frequency and severity. For example, a five-point Likert scale was employed to evaluate the frequency of claim causes, ranging from 1 (unlikely) to 5 (most likely) [10]. Likewise, a five-point Likert scale (i.e. (1) never, (2) rare, (3) average, (4) frequent, and (5) very frequent) was used to assess the likelihood of claim occurrence in the United Arab Emirates (UAE) [19]. In addition, authors in [20] applied a five-point Likert scale to evaluate the impact of claim causes leading to schedule delays, ranging from 1 (no influence) to 5 (very strong influence). Authors in [22] provided a more comprehensive perspective by integrating both the frequency and severity dimensions and classifying the claim causes according to their characteristics. However, these studies primarily focused on the qualitative evaluation of the impacts of the claim causes and did not offer a quantitative analysis. This results in a lack of quantitative foundation to support informed decision-making and constrains the potential for accurately predicting schedule-related risks associated with the claim causes. Consequently, this hinders the proactive planning and effective schedule-related risk management. Assessing the effects of potential claim causes on the project schedule is crucial for claim management; however, this task is often complex and challenging in practice [23].

Second, the existing literature has lacked comprehensive investigations into the response strategies and methods for preventing the claim causes. In construction management, risk response has been scarcely addressed [24] and the response to claim causes is no exception. In fact, the frequency and severity of claims tend to escalate as construction projects progress toward their final stage if the appropriate strategies are not formulated in the earlier stages [1]. This underscores the importance of proactively addressing claims and their underlying causes during the initial stages of a project. Authors in [12] also emphasized that preventing claims is the priority over resolving them once they occur. Few research works provided recommendations to prevent or reduce the construction claims. For example, authors in [19] conducted a questionnaire survey to collect recommendations on effective claim management practices across different project stages to address the claims in the UAE. These recommendations provide the fundamental approach for reducing the claims encountered in construction projects. However, these studies

primarily focused on how to manage the claims rather than how to manage their causes. There is, thus, a lack of studies investigating the proper response strategies and methods for claim causes. This research gap frequently results in inadequate or delayed responses when such causes arise, thereby negatively impacting the overall project performances. Since different claim causes entail distinct characteristics, project participants need to address and respond to each claim cause in a different and specific manner.

There are evident knowledge gaps in predicting the time impacts of claim causes, as well as in identifying the response strategies and methods to prevent and mitigate these impacts. To fill these knowledge gaps, the present study proposes a new model for predicting the time impacts of the causes of construction claims initiated by contractors against owners in building projects. It also identifies practical response strategies and methods to address them efficiently. This study investigated recently completed building projects in Vietnam, including residential and office buildings, hospitals, and hotels. These projects adopted the design-bid-build delivery method. The results can assist project participants in forecasting the time impacts of the claim causes and choosing the appropriate solutions to deal with them, contributing to efficient claim management practices.

## II. RESEARCH METHODOLOGY

Figure 1 presents the research methodology used in this study. Initially, an extensive review of the relevant literature was conducted to compile the causes of construction claims initiated by contractors against owners. Next, a group of nine experts on construction claims were invited to refine the list of the claim causes previously compiled to suit the research context in Vietnam through a two-round interview. They were also asked to determine the causal relationships among the claim causes, which were then used to develop a BN model for predicting the time impacts of claim causes. The time impacts were quantified by the extent of Time Overruns (TO) in building projects. A BN network, which is also called a Causal Network or a Belief Network, is a robust methodology for representing knowledge and reasoning under conditions of uncertainty [25]. It can visually represent the probabilistic cause-and-effect relationships between nodes (random variables) in the form of Directed Acyclic Graphs (DAGs) [26-28].

BN is a pragmatic tool that can integrate both empirical data and expert judgment, making it particularly well-suited for domains where the data may be limited or uncertain [28]. A BN network is the best-fit methodology for causal modeling in complex contexts, as it effectively treats uncertainty, facilitates the development of expert systems that incorporate domain-specific expert knowledge, and is combined with other methods [28, 29]. Subsequently, the historical data of the claim causes from recently completed building projects in Vietnam were collected. These data were then encoded and used as input for the BN model. A real case study project was employed to demonstrate the predictive capability of the model. Finally, semi-structured interviews, using a designed questionnaire, were conducted with 12 experts (the nine previous experts and three new ones) to determine the response strategies and

methods for dealing with various claim causes. This study adapted five response strategies from the Project Management Institute [30], namely, acceptance, avoidance, mitigation, contingency plan/reserve, and transfer. The experts were requested to choose the most appropriate response strategies for addressing each identified claim cause. In addition, they were asked to explicitly propose response methods for each claim cause based on their project knowledge and experience.

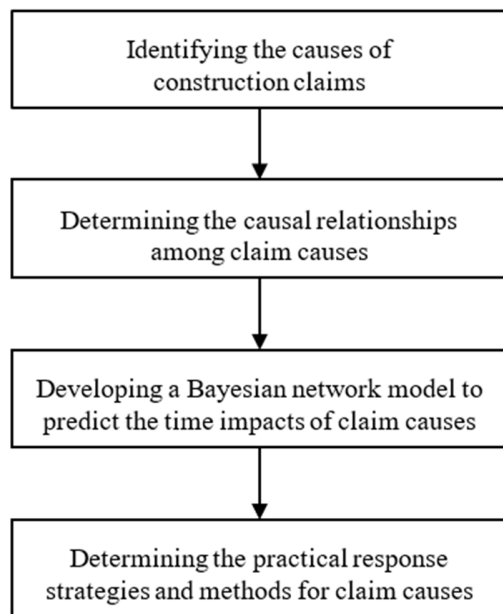


Fig. 1. Research methodology.

### III. BN MODEL FOR PREDICTING TIME IMPACTS OF CLAIM CAUSES

A preliminary list of claim causes raised by construction contractors against project owners was compiled through a comprehensive review of previous studies on the causes of construction claims. This list was then verified by a two-round interview with nine eligible claim experts. The selection of eligible experts was based on a set of predefined criteria encompassing professional experience, positions, academic background, and role as follows: (1) possessing a minimum of six years of practical experience in claim management within the Vietnamese construction industry; (2) holding a middle or senior management position; (3) having attained a bachelor's or higher degree; and (4) being currently employed by either a contractor or owner organization. Among these experts, four were employed by project owners and five by contractors. In terms of professional experience, three experts had experience ranging from 6 to 10 years, another three had 11 to 15 years, and the remaining three had more than 15 years in the construction industry. Regarding the academic background, two experts held bachelor's degrees, while seven held master's degrees. The experts also represented various professional roles: one was a senior or top-level manager; three experts held (vice) project director positions; one was the project or functional manager; one served as a (vice) site manager; two

were senior quantity surveyors, and one held the role of a legal officer.

In the first round (semi-structured interviews), the experts were asked to express their agreement or disagreement about the "likelihood of generation of claims" and "basis of claim" (based on the FIDIC Red Book) for each claim cause listed in a pre-designed questionnaire. This list was established based on an extensive literature review of prior international studies on the causes of construction claims. If more than half of the experts agreed that a certain claim cause does not occur frequently or it does not have merit to claim, it would be removed from the list. The claim causes, which were eliminated, include verbal instructions (without a written document) by project owners, issues related to measurement and valuation of works, cooperative attitude/communication, accidents caused by project owners, project insurance provided by the project owners, issues related to the project owners' management, and difficulties in implementation. Additionally, some claim causes were combined due to their similarity in nature while some of them were renamed to make their meanings clearer. The acceleration requirements by project owners were combined into change orders by project owners. Issues related to project owners' supervisor were merged with project owners' delay. Unforeseen issues were changed to unexpected increase in or escalation of material, labor, and equipment prices. Third-party interferences were renamed to failure/interference of the third party. Notably, no additional claim cause was suggested by the experts. Finally, 13 claim causes were considered in the second round.

In the second round (structured interviews), the experts were asked to evaluate the "level of claim generation" for the claim causes on a five-point Likert scale, where 1 indicates a "very low" level and 5 indicates a "very high" level. The "levels of claim generation" of the 13 causes were calculated using their mean values. The mean score threshold of 3.0 on a five-point Likert scale was employed as a screening criterion to exclude the insignificant claim causes and retain those deemed significant. Since all mean values were greater than 3.0 and the maximum standard deviation (1.424) was not high, all claim causes were considered significant. The 13 claim causes in this study include: site possession (CC01), inadequate documents (CC02), change orders by project owners (CC03), failure/interference of the third party (CC04), project owners' delay (CC05), project owners' procurement of material or equipment (CC06), project owners' failure to obtain licenses/permits (CC07), project owners' payment (CC08), termination/suspension of works (CC09), differing site conditions (CC10), unexpected increase in or escalation of material, labor, and equipment prices (CC11), force majeure (CC12), and delivery/completion of works (CC13). Many of these claim causes were reported in previous research works and were considered significant contributors to time overruns in construction projects, such as change orders by project owners [31], project owners' delay, differing site conditions [32], and unexpected increase in or escalation of material, labor, and equipment prices [31].

Once the significant claim causes were identified, their causal relationships were structured by conducting structured

interviews with the nine previous experts. A questionnaire was designed to assist experts in choosing the most appropriate type of relationship between any two claim causes  $i$  and  $j$ . Based on their knowledge and professional experience, the experts were instructed to indicate their judgment by choosing one of the four symbols provided in the questionnaire. The symbol "O" signifies that there is no relationship between both claim causes  $i$  and  $j$ . The symbol "V" indicates that the claim cause  $i$  might lead to or influence the claim cause  $j$ . The symbol "A" indicates that the claim cause  $j$  might lead to or influence the claim cause  $i$ . The symbol "X" reflects a mutual influence between both claim causes. The final relationship between each pair of claim causes was based on the consensus of the majority of the experts. The symbols used in the questionnaire were derived from the Interpretive Structural Modeling (ISM) methodology.

ISM is a well-established methodological approach used to determine and structure the causal relationships among the variables based on experts' judgment [33, 34]. Due to the similarities between the ISM and BN models (e.g. directed graphical models, three types of nodes in the models, and the use of experts' knowledge and experience), the outputs from ISM can be referenced to determine the relationships among the variables for building the BN models [29]. Thus, this study employs the ISM method to develop a model that captures the causal relationships among the claim causes. Detailed procedural descriptions of the ISM method can be found in [35, 36]. Due to the limited space, this study cannot elaborate on its specific implementation steps. In conclusion, a total of 13 claim causes and 17 corresponding causal relationships are incorporated into a BN model, as portrayed in Figure 2.

In the next step, a series of in-depth interviews was conducted with the nine previous experts to establish a rating scale for evaluating the time impacts of the claim causes. A consensus was achieved among the experts on the suitability of expressing TO as percentages of the project duration for constructing the rating scale. To ensure an agreement on the scale structure, the individual expert opinions were shared and discussed with subsequent experts. Feedback was provided to previous experts until a consensus was reached. As a result, a three-point rating scale was established to evaluate the time impact of the claim causes, which includes the following categories: 1 = "low" ( $TO \leq 1\%$ , meaning that  $TO \leq 1\%$  of the project duration), 2 = "moderate" ( $1\% < TO \leq 1.5\%$ ), and 3 = "high" ( $TO > 1.5\%$ ). This scale was then incorporated into a formal survey questionnaire. This study adopted a purposive sampling strategy where the respondents were selected based on their knowledge and expertise to be studied and their willingness to participate [37, 38]. The questionnaire (in either softcopy or online form) was sent to respondents who have worked in the Vietnamese construction industry through emails and various communication platforms, Facebook and Zalo, a messaging application from Vietnam. The respondents were explained the survey's objective, information security, questionnaire structure, claim causes' time impacts, and how to answer the questionnaire. The survey was carried out over a period of approximately two months. In total, 115 responses

were received. The 3 out of these 115 responses were removed since they had less than 3 years of experience. Ultimately, a total of 112 valid questionnaires remained for the next steps.

The relationships of each node and its parent nodes in the BN model can be quantitatively represented by Conditional Probability Tables (CPTs) [39]. The encoded data representing the time impact levels of the claim causes were used to establish the combinations of states between the child nodes and their respective parent nodes to form CPTs. Specifically, the time impact levels were categorized and encoded using the values of "1" for low, "2" for moderate, and "3" for high. The encoded values were then statistically analyzed and used to construct CPTs, which were subsequently used as input to the BN model.

To construct the BN model, this study utilized the software GeNIe Academic Version 4.0.2304.0 by "BayesFusion, LLC" [40]. Figure 3 displays the BN model for predicting the time impacts of the claim causes in building projects. As exhibited in Figure 3, the BN model includes 13 claim causes (nodes) among which only one claim cause is independent (i.e. change orders, CC03). Each claim cause comprises three time impact states: low, moderate, and high, each of which is associated with the corresponding probability. The proposed BN model can be used to predict the state of any child node if it has at least one associated parent node. To perform the prediction, the observed states of the parent nodes are input into the BN model. The state of the child node with the highest associated probability is then identified as the predicted outcome.

This study employs the node "termination/suspension of works" (CC09) in a case study project excluded from the training dataset to demonstrate the predictive capability of the BN model. This claim cause is a child node influenced by three parent nodes: project owners' procurement of material or equipment (CC06), project owners' failure to obtain licenses/permits (CC07), and project owners' payment (CC08). The states of CC06, CC07, and CC08 are low, high, and low, respectively. Figure 4 presents the predictive result of the time impact level of claim cause CC09, along with the associated probabilities, given the states of claim causes CC06, CC07, and CC08.

As observed, the predicted probability distribution of CC09 is 31% for "low," 15% for "moderate," and 54% for "high." Based on this distribution, claim cause CC9 is predicted to result in a "high" time impact on the project schedule, as the probability of a TO under the "high" state is approximately 54% – the highest among the three states. This prediction aligns with the actual outcome observed in the case study project, which experienced a TO exceeding 1.5% due to the issues regarding the termination or suspension of works. This implies that the BN model demonstrates a strong capability in predicting the time-related impacts of claim causes in building projects.

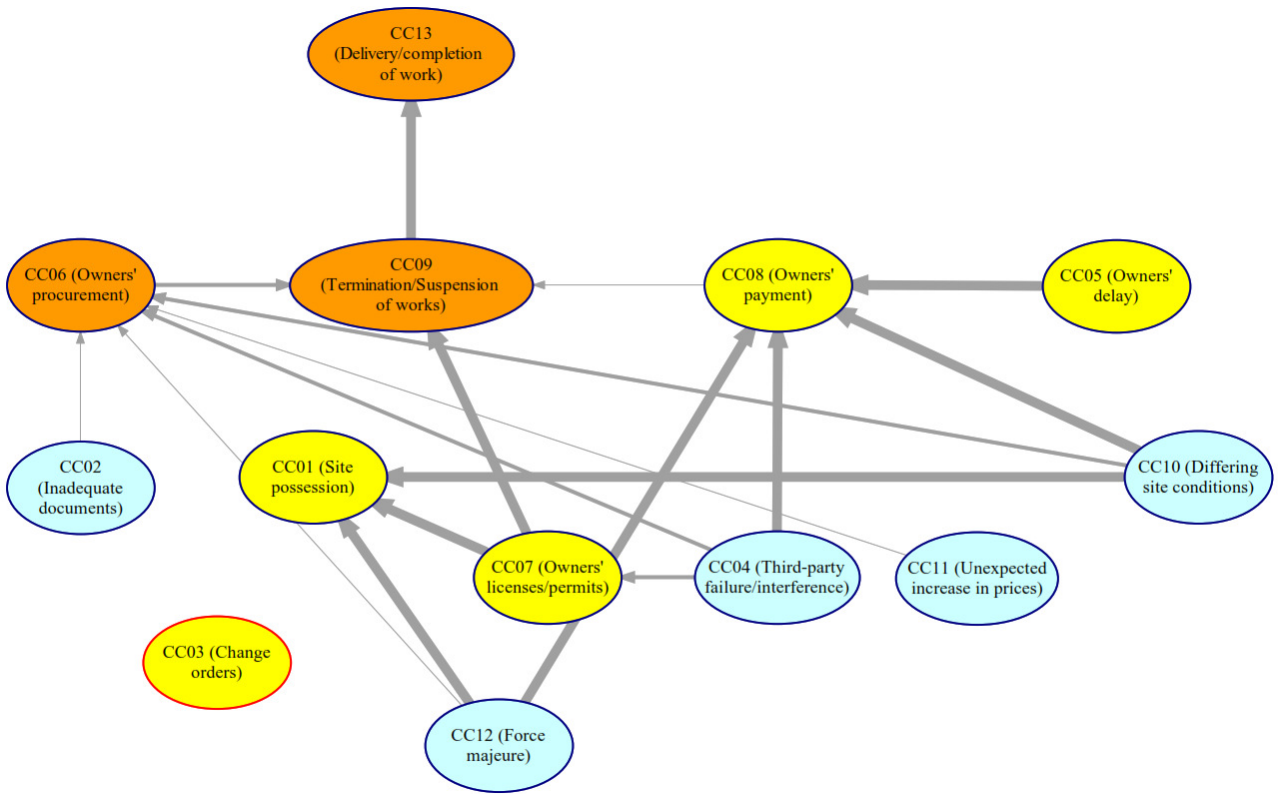


Fig. 2. BN model of the 13 construction claim causes.

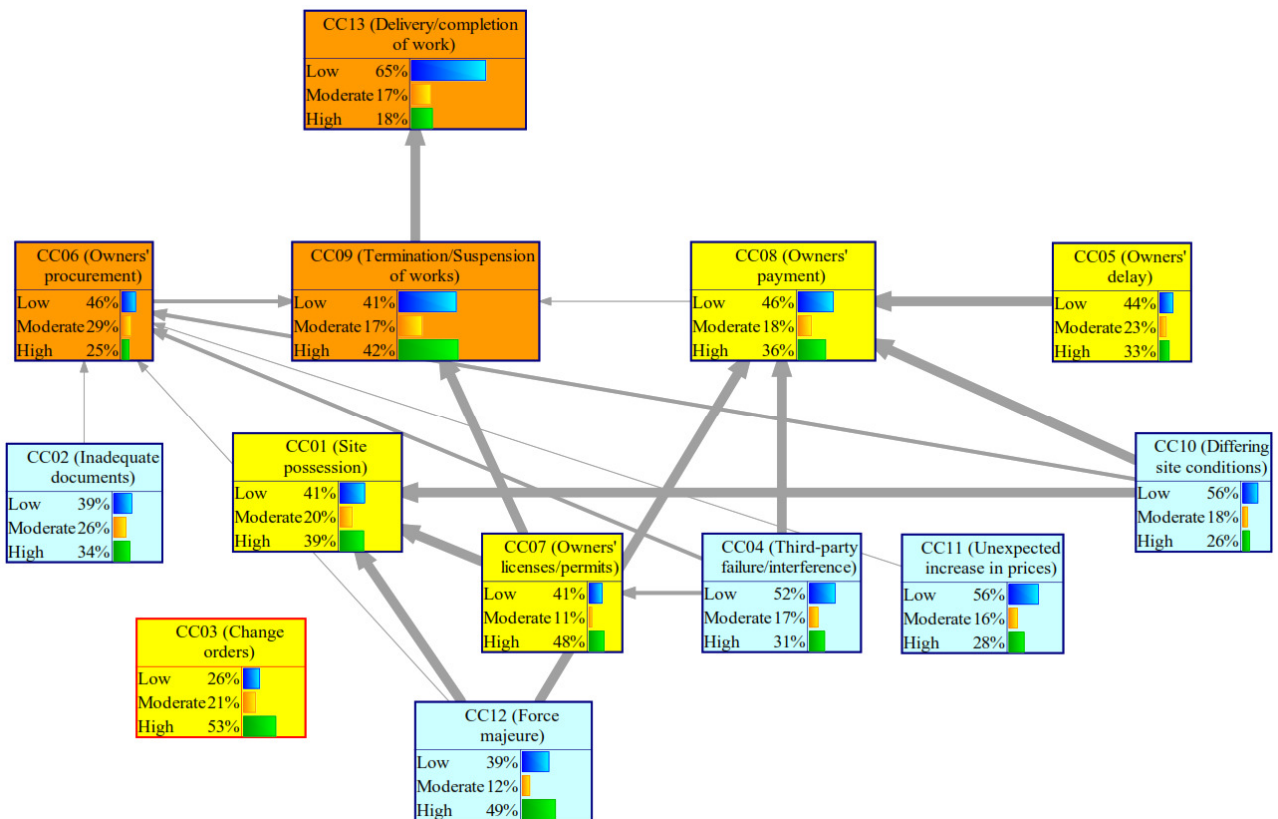


Fig. 3. BN model for predicting the time impacts of the claim causes developed by GeNIe.

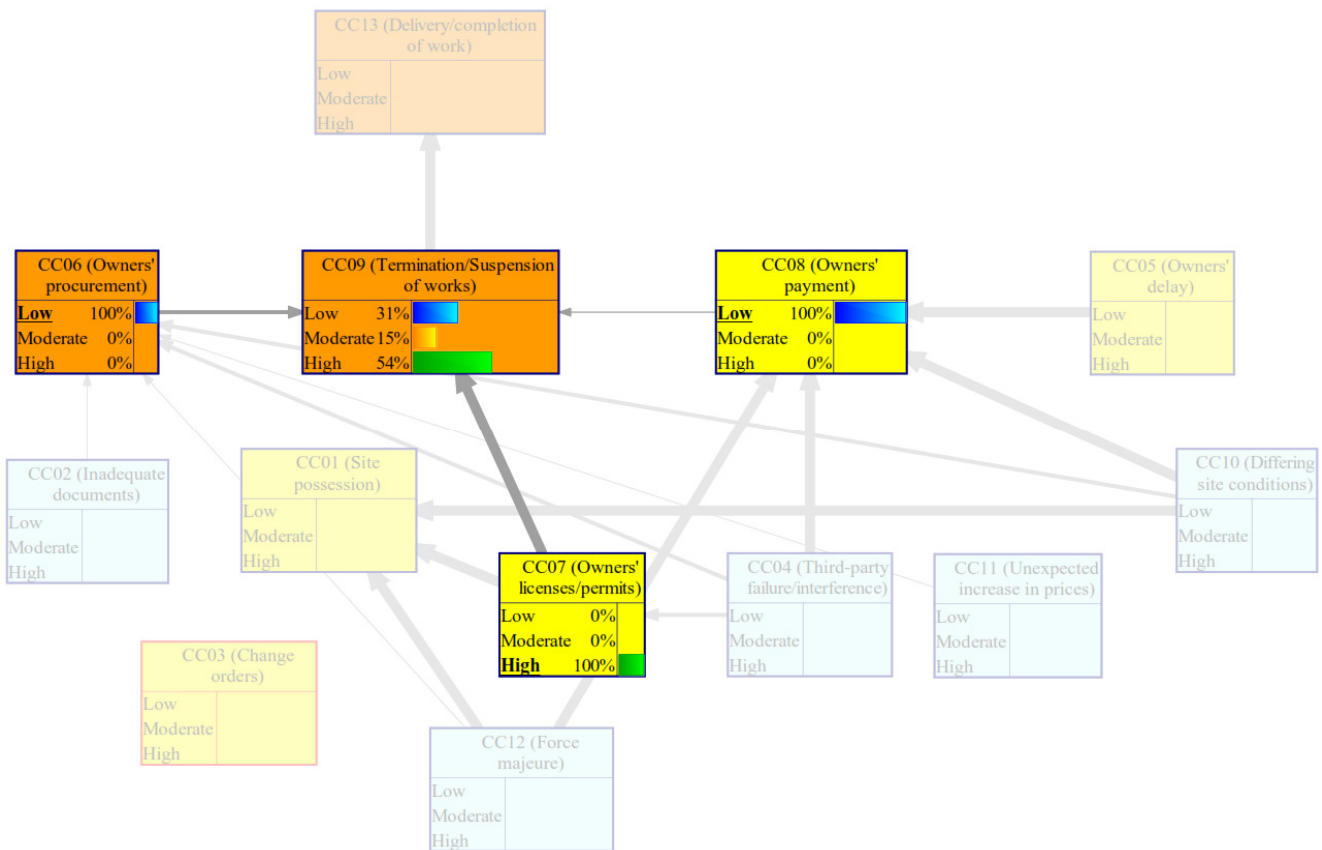


Fig. 4. BN model for predicting the time impact level of claim cause CC09, given the states of claim causes CC06, CC07, and CC08.

#### IV. PRACTICAL STRATEGIES AND METHODS FOR RESPONDING TO CLAIM CAUSES

In this study, five strategies for responding to claim causes were adapted from those of the Project Management Institute [30], namely, acceptance, avoidance, mitigation, contingency plan/reserve, and transfer. The acceptance strategy recognizes the existence of a claim cause without taking any proactive measures. This approach may be appropriate when the claim cause is of minor importance or when addressing it through other means is not feasible or cost-effective. The avoidance strategy entails actions for eliminating the claim cause or protecting the project from its effects. It is generally suitable for high-impact claim causes with a high likelihood of occurrence. The mitigation involves efforts to reduce either the likelihood or the impact of a claim cause to an acceptable level. Proactive mitigation is often more effective than the reactive measures taken after the cause has materialized. A contingency plan/reserve serves as a predefined course of action if the primary strategy is not effective or if an accepted claim cause occurs. This strategy encompasses identifying specific trigger events that initiate the response, such as missed intermediate milestones. The transfer strategy involves shifting the impact and management responsibility of a claim cause to a third party, often involving the payment of a premium. Since these strategies offer only a general approach to addressing the claim causes, they should be complemented by specific response methods that are appropriately aligned with the characteristics

of each claim cause and the contextual conditions under which it arises. To identify the response strategies and methods for each claim cause, three additional experts were invited to join the previously engaged nine experts. The demographic profiles of the three additional experts are: an expert was employed by a project owner, while the other two worked with contractors. In terms of the professional experience, one expert had 6-10 years, another had 11-15 years, and the third had more than 15 years of experience in the construction industry. All of them held bachelor's degrees. Regarding their professional roles, one served as a (vice) project director, while other two were senior quantity surveyors. During the semi-structured interviews, the 12 experts were asked to choose one or more response strategies corresponding to each claim cause. Table I presents the response strategies for the claim cause related to inadequate documents (CC02). The number in each parenthesis denotes the number of experts selecting that strategy for the corresponding claim cause. The following symbols represent the number of expert selections: Δ indicates that the response strategy was selected by 1-4 experts, O denotes that the response strategy was selected by 5-8 experts, and ♦ demonstrates that the response strategy was selected by 9-12 experts. For example, for "2.2 inconsistencies in the drawings and specifications" in Table I, mitigation is the most selected response strategy (selected by nine experts), followed by avoidance (five experts), and contingency plan/reserve strategy (one expert).

TABLE I. RESPONSE STRATEGIES FOR THE CLAIM CAUSE RELATED TO INADEQUATE DOCUMENTS (CC02)

Claim causes	Response strategies				
	Acceptance	Avoidance	Mitigation	Contingency plan/reserve	Transfer
Inadequate documents					
2.1 Errors and omissions in design or specifications (Inadequate work specifications or specifications that result in non-constructability)	Δ(1)	Δ(4)	◆(9)		
2.2 Inconsistencies in the drawings and specifications		O(5)	◆(9)	Δ(1)	
2.3 Inconsistencies in architectural, structural, and Mechanical, Electrical, and Plumbing (MEP) design		O(5)	◆(10)		

TABLE II. RESPONSE METHODS FOR THE CLAIM CAUSE RELATED TO SITE POSSESSION (CC01)

Claim causes	Response strategies and methods				
	Acceptance	Avoidance	Mitigation	Contingency plan/reserve	Transfer
Site possession 1.1 Failure of the project owner in handing over site possession to the contractor on the due date 1.2 Insufficient possession of the site to carry out the work	Do not take any action unless the claim cause occurs		Grasp information in a timely manner via meetings to have appropriate behavior/response for each circumstance		Sign fixed-price contracts together with back-to-back clauses with subcontractors/suppliers as soon as possible
			Grasp information from owners and other sources to have a plan for allocating resources properly		
			Specify the time of handing over the site as a milestone in the schedule attached in contract (1.1)		
			Specify compensation clauses for late handing over the site or clauses for supporting/paying for damages of prolongation (1.1)		
			Stipulate that the commencement day in the schedule will be only valid when receiving sufficient site to avoid disputes of schedule (1.2)		
			Undertake a comprehensive site investigation before contract negotiation/construction phase (1.2)		

The experts were also requested to explicitly propose how to respond to each claim cause based on their knowledge and experience. These response methods were then categorized into five response strategies. Table II illustrates the response methods for the claim cause related to site possession (CC01). As can be seen, the response methods for CC01 encompass one acceptance method, six mitigation methods, and one transfer method. The response methods without numbers in parentheses indicate the methods applicable to general causes, whereas those with the numbers in parentheses represent the methods specific to their corresponding individual causes. For example, the response method "sign fixed-price contracts together with back-to-back clauses with subcontractors/suppliers as soon as

possible," categorized under the transfer strategy, is applicable to all causes related to site possession (CC01); whereas the response method "specify the time of handing over the site as a milestone in the schedule attached in contract (1.1)," categorized under the mitigation strategy, is specifically applicable to the cause "1.1 failure of the project owner in handing over site possession to the contractor on the due date." Given the diversity and complexity of the construction projects, there is no single response method or strategy applicable to a specific claim cause. Accordingly, the identified response methods serve as a valuable reference for construction practitioners to make informed decisions and adopt the most

appropriate methods based on the specific context, project conditions, and available resources of the respective projects.

## V. CONCLUSION

This study proposes a Bayesian Network (BN) approach for predicting the time impacts of claim causes in building projects. The developed BN model encompassed 13 claim causes among which only one claim cause (i.e. change orders) was identified as an independent variable. A real-world project was utilized as a case study to validate the model's predictive capability. The findings demonstrated that the BN model can effectively forecast the time impact levels of the claim causes. The BN predictive model equips the project participants with a rational way to evaluate the potential time impacts of the claim causes. In addition, this study provides a semi-structured interview-based approach to identify the response strategies to deal with each of the claim causes. The findings revealed five commonly adopted response strategies, including acceptance, avoidance, mitigation, contingency plan/reserve, and transfer. This study also identified specific response methods corresponding to each claim cause. The proposed strategies and methods can be adapted to mitigate or eliminate the adverse effects on the construction projects of the claim causes.

This study, however, entails several limitations that should be addressed in future research. The applicability of the proposed BN model was validated using data solely from construction projects in the Vietnamese context. Even though the model can be used to manage claim causes in countries with similar cultural and economic conditions as those of Vietnam, it may not be applicable to other countries. In addition, the scope of this study was limited to building projects, which may constrain the broader implementation of the findings. Future studies are encouraged to explore claim causes across different national contexts and various project types to enhance the generalization and robustness of the proposed approaches. Furthermore, the limited number of experts in this study may constrain the robustness of the identified causes and their associated causal relationships. Therefore, the findings should be applied with caution in future research.

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