Barriers to innovation in construction organizations of different sizes: a case study in Vietnam

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Abstract

Purpose – This study aims to determine barriers to innovation and to develop a quantitative model for the barrier to innovation in Vietnamese construction organizations of different sizes.

Design/methodology/approach – A literature review and discussions with experienced practitioners were implemented to determine barriers to innovation in construction organizations. The rank-based non-parametric test analyzed collected data from a questionnaire survey to examine if there were significant differences between the three groups of organizations, including small, medium and large construction organizations. The fuzzy synthetic evaluation (FSE) technique was employed to develop barrier indexes (BIs) for organizations of different sizes in Vietnam.

Findings – The findings showed 17 barriers to innovation which were categorized into four groups, including organizational, human resources, economic and market barriers. Statistical analysis revealed significant differences regarding barriers to innovation between small, medium and large construction organizations in Vietnam. The post hoc test highlighted barriers to innovation differently separated into two groups: SMEs and large construction organizations. The FSE analysis integrated the identified barriers into the comprehensive BIs for SMEs and large construction organizations. The FSE analysis illustrated that the organizational barrier is the most critical barrier for SMEs. On the other hand, the market barrier received the most significant attention in large construction organizations.

Originality/value – This research is one of the first integrated barriers to innovation into a comprehensive formulation. The indexes provide the decision-makers with a practical and reliable tool to evaluate barriers to innovation in construction organizations of different sizes.

Keywords Barrier, Construction organizations, Innovation, Fuzzy synthetic evaluation (FSE)

Paper type Research paper

1. Introduction

In most nations, the construction sector accounts for about 5–15% of the national product (Meng and Brown, 2018; Yusof et al., 2014). However, it has been considered a traditional industry and publicly criticized because of the dissatisfaction regarding time and cost overrun, low product quality and productivity compared with other industries. A large number of studies noticed a lack of innovation suffered by the industry is one of the main reasons for this situation (Lundberg et al., 2019; Taminiau et al., 2009; Yusof et al., 2014). The role of innovation thus has been recognized by industry peers. Blayse and Manley (2004) highlighted that the higher the levels of innovation, the greater the likelihood that the organization will boost its business achievement. Innovation is essential for productivity improvement, organizational growth and effectiveness (Fernando et al., 2020). Giménez et al. (2019) added that innovation positively affects competitive success, thus ensuring the long-term survival of construction organizations.
Within the construction industry, innovation is often featured by the broad acceptance of new practices stemming from advances in business and technological processes (Lundvall, 2007). Construction organizations principally function and innovate through their employees, the quality of their operations and how they prepare and change to adapt to the fast-changing business environment (Aouad et al., 2010). However, there are numerous barriers to innovation that construction firms need to overcome, which lead to various risks from both external (e.g., industry environment) and internal (e.g., human and financial resources) criteria for the implemented organizations. Innovation resulting in poor investment outcomes can adversely influence organization operations and competition (Barrett and Sexton, 2006; Wei and Lam, 2014). Therefore, it is vital to identify and analyze barriers that potentially hinder innovation from increasing the chance of success of business performance (Suprun and Stewart, 2015).

Firm size is a critical factor affecting innovation in construction businesses. Damanpour (1992) raised the question of whether large or small firms are more successful at innovation performance. Barrett and Sexton (2006) stated that innovation models for small to medium enterprises (SMEs) are not automatically applied to large organizations and vice versa. While small organizations are not likely to allocate much money to research and development (R&D), larger organizations can tolerate the risk of innovation adoption and afford different R&D plans (Meng and Brown, 2018). Consequently, firm size is crucial in investigating barriers to innovation in construction businesses (Hadjimanolis, 1999; Hardie and Newell, 2011; Mojumder et al., 2022). However, previous studies generally either focused on construction SMEs (Hardie and Newell, 2011; Nassar Larenwaju and Faloye, 2015) or neglected the role of firm size (Lijauco et al., 2020; Suprun and Stewart, 2015; Wei and Lam, 2014) to examine barriers to innovation. To the best of our knowledge, there is a lack of study that comprehensively delivers evidence to compare and analyzes obstacles to change among construction companies of different sizes. This neglect will inherently fail to provide a holistic understanding of the impacts of barriers to innovation in different firm sizes.

Vietnam locates in Southeast Asia. After over a thousand years of colonization, war and conflict, Vietnam declared independence in 1975. Vietnam was one of the world’s poorest nations at this time. Since then, Vietnam has shifted from an agricultural society to a transitioning lower-middle-income nation (World-Bank, 2022). Manufacturing has become the backbone of Vietnam’s export-oriented economy in the past decade. This expansion of the manufacturing sector has necessitated the construction of additional production facilities, leading to a rise in the construction industry (Statista, 2021). Innovation is crucial for Vietnamese organizations’ sustainable development (Nguyen, 2022). However, most Vietnamese firms remain imitators and struggle to become innovators (Son et al., 2019). According to the Global Innovation Index (GII, 2021), Vietnam ranked 44 over 132 countries regarding national innovation ecosystems. Nguyen et al. (2019) found that approximately 6% of Vietnamese companies were involved in innovation-related collaboration and less than 1% collaborated with educational and research centers. Vietnamese firms face many obstacles to innovation, especially in a conservative industry like construction (Nguyen, 2022). Thus, studying barriers to innovation in Vietnamese construction firms is essential.

This study’s research question is about which levels of barriers to innovation are in Vietnamese construction organizations of different sizes. To answer this question, the following research objectives are proposed:

RO1. What are the barriers to innovation in Vietnamese construction organizations?

RO2. What are the quantitative models for the barrier to innovation for Vietnamese construction organizations of different sizes?
2. Literature review

2.1 Innovation

Introducing changes through something new is typically called innovation (Nguyen, 2022). Innovation has recently been considered at the heart of the knowledge-based economy (OECD/Eurostat, 2005). Innovation appears when firms perform new or existing activities in different methods or ways (Tookey et al., 2011). In other words, innovation involves adopting new combinations and changing the routine (Yusof et al., 2014). Aouad et al. (2010) argued that innovation is non-linear, complex and dynamic, so there is not a complete and single definition of innovation. Meanwhile, Damanpour (1992) defined innovation as “the adoption of an idea or behavior, whether a system, policy, program, device, process, product or service, that is new to the adopting organization.” The Department of Trade and Industry (DTI) in the UK stated that innovation is “the successful exploitation of new ideas” (Ozorhon, 2013; Ozorhon et al., 2016) and that “it is the key business process to compete effectively in the increasingly competitive global environment” (Ozorhon et al., 2014).

Innovation can be presented in many forms. Blayse and Manley (2004) divided innovation regarding whether it is radical (a breakthrough in technology or science), incremental (improvements based on existing knowledge and experience), system (multiple, integrated innovations), modular (a concept’s change within a component), or architectural (a change in links to other systems or components). Lundvall (2007) classified innovation as being either organizational or technical. While the former comprises introducing advanced management techniques, changes to organizational structure and new business strategic orientations, the latter encompasses either process or product innovation (Bygballe and Ingemansson, 2014).

2.2 Innovation in construction organizations

The trend toward customer-oriented integrated solutions in construction markets requires construction organizations to pinpoint the aspect of differentiation (Kim et al., 2020; Tookey et al., 2011). Although the sector is often criticized for its lack of innovation, the importance of innovation is strategically increasing within this process of change (Suprun and Stewart, 2015). Gradually, construction organizations acknowledge the need to innovate more consciously (Nguyen, 2022).

Generally, innovation can be classified into three levels: project, organization and industry. Meng and Brown (2018) found that firm-level innovation connects project-level and industry-level innovation. However, different parties perform divergent activities in each stage of a construction project. Furthermore, a lack of appropriate performance measurement creates numerous difficulties in monitoring and evaluating project-level innovation (Yetmen, 2007). Thus, Ozorhon et al. (2016) argued that innovation is often observed at the project level because each project is unique, with bespoke designs and different issues in the construction stage. Construction is featured by performing within a project-based environment (Kim et al., 2020). Taking knowledge acquired in a single project, delivering it back to the firm, and adopting it in new projects has been challenging (Bygballe and Ingemansson, 2014). Consequently, an increasing number of studies are focusing on firm-level innovation (Meng and Brown, 2018; Ozorhon et al., 2016), which is the focus of this study. Following the definition reviewed by Saridakis et al. (2019), innovation in this study means implementing a new or significantly improved service and a new organizational method in the business practice of construction firms.

Construction organizations are relatively diverse, with the majority of them being small and medium-sized (Ljauco et al., 2020). This clarifies why the literature on construction innovation focused on SMEs (Dulaimi et al., 2006; Hardie and Newell, 2011; Ljauco et al., 2020). Smaller organizations differ from larger ones regarding divergent aspects, such as resources, capabilities, goals and constraints (Engström and Stehn, 2016). Regarding innovation, construction organizations of different sizes respond differently to other contexts.
While small and medium organizations generally focus on the local market because of limited organizational resources and capabilities, large construction organizations enjoy global competition to continuously foster competitive advantages through innovation (Saridakis et al., 2019).

2.3 Barriers to innovation among construction organizations

Previous studies emphasized the context-sensitive nature of innovation (Aouad et al., 2010; Ozorhon and Oral, 2017). In this way, construction innovation differs from innovation in manufacturing or services. Construction is a project-based industry, which is partly services (surveying, design, consulting, engineering and management) and partly manufacturing (components, materials and equipment) (Ozorhon, 2013). While this feature makes the construction industry unique, it also leads to many obstacles to change for the sector. The literature has revealed many barriers that may hinder organizations from innovating (Awodele et al., 2021; Mojumder et al., 2022; Suprun and Stewart, 2015). Most previous studies categorized innovation obstacles into internal (endogenous) and external (exogenous) barriers (Brattström et al., 2018; Liané et al., 2021; Madrid-Guijarro et al., 2009; Mojumder et al., 2022).

Internal barriers are those that arise within a business. Beyer (2022) classified internal barriers into organizational, human resources and economic sub-groups. First, organizational barriers include organization policies and performance measures (Beyer, 2022). Measuring performance is essential to assess and track an organization’s progress, gain insights into its current accomplishments and evaluate the impact of its innovation practices (Kim et al., 2020). It provides valuable feedback to the decision-making and management in construction firms (Niu et al., 2019). Without performance measurement, managers cannot make informed decisions about what changes are needed and where they should be implemented (Yitmen, 2007). It is widely acknowledged that R&D expenditure is a slow proportion of organizations’ investment (Giménez et al., 2019; López and Yepes, 2020). Only a few construction organizations have taken advantage of government-funded R&D programs (Dulaimi et al., 2002; Kraus et al., 2020; Ozorhon, 2013). Moreover, Engström and Stehn (2016) noted ineffective communication and collaboration were critical barriers to innovation in Sweden’s construction projects.

Second, the human resources barrier includes human-related obstacles within an organization. Construction is featured as a labor-intensive sector and labor costs may account for about 30–50% of the total cost of a project (Meng and Brown, 2018). Nonetheless, the sector faces a shortage of skilled labor (Ozorhon and Oral, 2017). Moreover, the project-based characteristics require the workers to frequently change workplaces that may be far away from their living areas. Furthermore, the limitation of financial resources may not allow SMEs to satisfy employees’ needs for monthly salaries, bonuses and job security (Ocen et al., 2017). In such cases, construction organizations must deal with the problem of keeping their qualified employees (Madrid-Guijarro et al., 2009).

The construction sector is typically perceived to have conservative culture, and construction workers have conservative attitudes to change (Costa et al., 2019; Ozorhon, 2013; Singh and Singh, 2017; Suprun and Stewart, 2015). Construction workers are not required to show a high educational level, thus increasing a close mindset that is not open to questioning (Costa et al., 2019). Employees, on the other hand, are typically not resistant to innovation, but they may attempt to prevent it from being implemented due to concerns about the potential increase in labor burden and threats to their jobs (Liané et al., 2021). In addition (Adafin et al., 2021), argued that a lack of internal employee training is a reason for the low innovation interest in construction companies. As a result, it leads to many obstacles in the innovation process in construction organizations (Ozorhon, 2013).
Third, the economic barrier comprises financial-related obstacles within construction firms. Ultimately, people are in business to make money (Dulaimi et al., 2006). Due to funding deficits and a large amount of initial investment (Laforet, 2011), short-term return and immediate capital expenditure are also crucial concerning construction organizations. Nonetheless, Eriksson et al. (2007) stated that results from continuous improvements and innovation are hard to gain in the short-term. Additionally, innovation implementations are characterized by high uncertainty and risk (Shanker et al., 2017). Additionally, funding deficits, low salaries, and lack of job security are significant barriers that hinder innovation in construction. The culture of risk avoidance and the fear of failure discourage innovation in construction companies. This is because seeking innovative alternatives and experimenting with new ideas may increase risk and uncertainty, leading to a reluctance to invest in innovative solutions (Crespell and Hansen, 2008; Foxon and Pearson, 2008; Laforet, 2011; Suprun and Stewart, 2015). Despite the potential for long-term development through innovation, construction firms may choose short-term profit, especially SMEs (Lijaucò et al., 2020).

The long lifespan of construction projects also limits innovation performance (Ghaben and Jaaron, 2017). Developing countries sensitively face economic uncertainties (Kim and Nguyen, 2021). With a high inflation rate, firms face the high cost of bank loans and insufficient tax privileges (Suprun and Stewart, 2015). To earn employees’ trust and loyalty, construction firms should provide high salaries and job security (Ocen et al., 2017). However, employees may deal with low wages and job security, especially those working for SMEs, because of insufficient salary budgets and difficulties accessing low-interest and concessional loans (Tang et al., 2020).

Meanwhile, external barriers are caused by the external environment. Organizations, especially SMEs, can be weakly responsive to economic turbulence, which may usually happen in developing countries (Gambatese and Hallowell, 2011) and become a critical barrier to innovation (Madrid-Guijarro et al., 2009). Clients also heavily influence construction innovation (Engström and Stehn, 2016; Ozorhon and Oral, 2017). The clients can encourage project team dynamics and team action, formulate strategies and identify new needs to foster innovation (Xue et al., 2014). Nonetheless, Oyedele and Tham (2007) highlighted innovative ideas need special knowledge, but the clients might not know what they want, thus becoming a barrier to promoting innovation performance (Tookey et al., 2011). Barrett and Sexton (2006) stated that unless the project has a strong relevance on national significance, innovation is hardly motivated by government projects. Because innovation contains a high degree of uncertainty and risk (Lundberg et al., 2019; Nguyen, 2022), governments tend to have a conservative approach toward innovation, prioritizing the issuance of construction codes and technical standards as a safe option (Xue et al., 2018). Consequently, Suprun and Stewart (2015) highlighted the construction sector experiences a lack of positive innovation diffusion cycle dynamics due to the absence of government support for innovation.

2.4 Research gap
The review of previous studies highlights that it is essential to investigate barriers to the innovation of construction organizations. Thus, researchers have studied the barriers to the innovation of construction firms in different research contexts. However, the review illustrates some significant concerns. First, most studies were conducted in developed countries like Australia, Sweden and the UK. There is a small number of papers with the target of developing countries. Previous studies highlighted the differences between research contexts would inevitably lead to divergent findings in management studies (Loosemore and Lim, 2017). Thus, further research that emphasizes developing countries (i.e., Vietnam) is
necessary to enrich the current body of knowledge regarding innovation in construction firms.

Second, there needs to be more research investigating barriers to the innovation of construction companies. Current research has merely discussed barriers to innovation as a subsection of their primary studies, such as the driver of innovation (Ozorhon and Oral, 2017); impacts of culture on innovation (Lijauc et al., 2020); innovation creation and diffusion (Ninan et al., 2022; Suprun and Stewart, 2015); and innovation impacts (Barrett and Sexton, 2006; Crespell and Hansen, 2008; Li et al., 2022). The literature review showed a few studies concentrated on searching barriers to the innovation of construction firms in the UK (Wei and Lam, 2014) and the Russian Federation (Suprun and Stewart, 2015). However, Suprun and Stewart (2015) conducted qualitative research without showing the level of barrier to innovation. Wei and Lam (2014) investigated innovation barriers at the project level and neglected the organizational level. Furthermore, these studies did not investigate the effects of firm size on the barrier to innovation, which is an essential element affecting innovation in construction businesses.

Vietnamese construction firms have some unique features compared to other nations. One of the biggest challenges is the small domestic market size. In 2021, the Vietnam construction market was worth $76.1bn, with a growth projection of over 7% between 2023 and 2026 (Globaldata, 2022). This is much smaller than the construction markets of larger economies such as the Russian Federation ($181bn), Indonesia ($234bn), the UK ($448bn), the United States ($1.96tn) and China ($4.4tn). The relatively small size of Vietnam's construction market may limit the resources available to Vietnamese firms to invest in research and development. Additionally, few foreign firms are visiting Vietnam to explore business opportunities (HBC, 2021). This is a limitation for Vietnamese construction firms as they need the opportunity to learn and compete on a global level.

Moreover, Vietnam has a shortage of research centers and innovation hubs specifically focused on the construction industry (HBC, 2021). This may hinder the development of innovative solutions in the industry, potentially slowing down the pace of technological advancement in the country’s construction sector (Tung et al., 2021). Vietnam is currently in a golden demographic period, with a population of approximately 100mn people, 70 million of whom are of working age (HBC, 2021). This period is known as the "golden population" and is a valuable opportunity for countries to boost their development. HBC (2021) expected that the nation will no longer be in this golden period after 2034, which means that Vietnamese construction firms must put enormous effort into catching up with foreign markets.

Moreover, Nguyen (2022) highlighted that the Vietnamese construction industry is influenced by the country’s cultural values, which impact innovation performance. Vietnam’s collectivist culture, shaped by a history of exposure to Confucianism during China’s colonization period, emphasizes strong regard for collectivism, networks and power distance (Tran, 2021). This can result in challenges in forming and implementing creative ideas as decisions are often made collectively and prioritized based on group consensus rather than individual creativity.

These unique factors make it necessary to conduct a localized study to identify the specific barriers to innovation in Vietnamese construction organizations. Findings from other studies may not be applicable to the Vietnamese context, given the distinct cultural, social and economic factors at play. Therefore, a study tailored to Vietnam’s construction firms can provide critical insights into this sector’s unique challenges and opportunities for innovation. By understanding these barriers to innovation, Vietnamese construction firms can develop strategies to overcome them and foster innovation to drive growth and competitiveness.

In summary, a few studies focus on innovation in the construction sector, especially barriers to innovation in developing countries. However, innovation is a crucial aspect of the sustainable development of construction organizations. Therefore, this study aims to bridge this knowledge
gap by identifying barriers to innovation and developing a quantitative model for the barrier to innovation in construction organizations of different sizes focusing on Vietnam.

3. Research methods

3.1 Research design
This study was conducted in three stages, presented in Figure 1. A mixed method was employed in this research. In the first stage, barriers to innovation were identified through the literature review and discussion with experienced practitioners. In stage 2, a pilot and questionnaire survey were employed to collect the data for further analysis. Subsequently, stage 3 presents the establishment of the barrier to innovation indexes in construction organizations of different sizes.

In this study, the use of mixed-method, a combination of quantitative and qualitative studies, was considered appropriate. On the one hand, the use of quantitative approaches to identify barriers to innovation was well-suited in the first research stage. Specifically, the literature review showed few previous studies focusing on construction industry innovation. Moreover, barriers to innovation are significantly affected by the research context. Thus, quantitative approaches enabled the researchers to gather existing knowledge from the literature review and collect valuable comments and opinions from discussions with experienced practitioners. On the other hand, qualitative methods allow researchers to determine the degree of barrier to innovation of construction firms by establishing barrier to innovation indexes. Indeed, the outputs of the first research stage become the inputs to form the questionnaire survey in the second stage. Then, data collected from the survey would be used to formulate the barrier to innovation indexes. The above discussion showed that mixed methods added value by facilitating new knowledge creation and enhancing the findings’ validity (Mckim, 2015), thus becoming the fitting method to achieve the research objectives of this study.
3.2 Data collection

This study employs a combination of a review of literature, discussion with experienced practitioners and a questionnaire survey. In the beginning, a review of relevant literature assists in obtaining general information on construction innovation and identifying barriers to innovation in construction organizations. Afterwards, experienced practitioners knowledgeable in innovation were invited to analyze and re-examine the initial obstacles to innovation. According to Konstantina et al. (2018), selecting an appropriate sample size in qualitative research is a matter of philosophical debate and practical ambiguity. Sim et al. (2018) noted that samples are frequently small (from 2 to 10 participants) and purposeful. Sim et al. (2018) emphasized that “the number of cases is irrelevant; what you do with them is what matters.” Consequently, Hulls et al. (2022) argued that saturation is the most prevalent method for evaluating sample size adequacy.

To be involved in this research stage, the practitioners were required to be experienced and knowledgeable in innovation performance in construction firms. The practitioners should have experience in innovation-related tasks, such as improving organizational performance and developing corporate strategies. To fit the research context, the practitioners should also have contractors’ backgrounds. The interviews aimed to ensure that no essential barriers to innovation related to Vietnamese construction firms were omitted. Additionally, variables significant in other research contexts but may not apply to their Vietnam counterparts should be eliminated or merged with the others. The interview was terminated when saturation was reached, meaning all practitioners reached a consensus, and no new information was gathered.

To begin with, the first practitioner with close working relationships with the researchers was invited to the interview. The interviewee had 35 years of working in the construction industry and held a director position in a construction company. The interviewee was asked to rate the applicability of the initial list of barriers identified from the literature review based on his experience. Subsequently, the snowball sampling technique was employed to identify the other practitioners. Indeed, the first practitioner was asked to introduce potential practitioners who meet the research requirements mentioned above. Recurring the same approach, the other practitioners were identified and interviewed.

The interviewees were also asked to evaluate the applicability of the initial list of barriers to innovation. At the same time, they were provided with the changes proposed by previous practitioners. While the second and third practitioners suggested some changes to prior participants, the fourth and fifth interviewees agreed with the findings, and no new information was gathered. In other words, all practitioners reached a consensus, and saturation was reached. Table 1 shows the demographic of the interviewees in this research stage.

Discussions in Subsection 2.4 show a need for studies focused on analyzing barriers to innovation in construction organizations. Previous studies proposed a list of barriers that fit their research context without categorizing them. However, the categorization of barriers to innovation is essential because it will generate mechanisms to reduce barriers’ existence by minimizing, eliminating, or transforming innovation barriers into innovation facilitators.

<table>
<thead>
<tr>
<th>Interviewer</th>
<th>Work experience (Years)</th>
<th>Position</th>
<th>Size of company</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>35</td>
<td>Director</td>
<td>Medium</td>
</tr>
<tr>
<td>B</td>
<td>20</td>
<td>Vice director</td>
<td>Medium</td>
</tr>
<tr>
<td>C</td>
<td>25</td>
<td>Director</td>
<td>Small</td>
</tr>
<tr>
<td>D</td>
<td>16</td>
<td>Head of Human resources department</td>
<td>Small</td>
</tr>
<tr>
<td>E</td>
<td>20</td>
<td>Head of Bidding and Investment department</td>
<td>Large</td>
</tr>
</tbody>
</table>

Table 1. Demographic of the interviewers in the interview process

Source(s): Nguyen (2023), reproduced with permission
Therefore, as proposed by the literature review in Subsection 2.3, the logic behind the categorization would be steamed from internal and external barriers (Brattström et al., 2018; Liané et al., 2021; Madrid-Guijarro et al., 2009). Following Beyer (2022), internal barriers were categorized into organizational, human resources and economic sub-groups. External barriers were collected and combined into one group called market barriers. The reason for this grouping was that the focus of Beyer (2022) was the sustainable development of organizations in times of crisis. Furthermore, Beyer (2022) did not focus on construction firms, which was the focus of this study. Moreover, Beyer (2022)’s naming was duplicated between the two groups (financial barriers). Therefore, discussions were also conducted with the interviewees regarding categorizing barriers to innovation in the research context. Finally, a list of 17 barriers to innovation which was organized into four clusters, including human resources barrier, economic barrier, organizational barrier and market barrier, were collectively agreed upon by all interviewees. Table 2 illustrates the list of barriers to innovation.

A questionnaire survey followed qualitative interview. The primary purpose is to investigate what potential criteria can hinder innovation in construction organizations of different sizes. Existing research on construction organizations categorized organization size by employing different thresholds. European organizations are grouped into micro/small (1–49 workers); medium (50–249 workers); and large organizations (250 or more workers). The Australian Bureau of Statistics categorizes small, medium and large size organizations.

<table>
<thead>
<tr>
<th>Group</th>
<th>Barriers to innovation</th>
<th>Supporting literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizational barrier</td>
<td>Lack of performance measurement</td>
<td>Yitmen (2007)</td>
</tr>
<tr>
<td></td>
<td>Lack of R&amp;D</td>
<td>Bygballe and Ingemansson (2014), Giménez et al. (2019),</td>
</tr>
<tr>
<td></td>
<td></td>
<td>and López and Yepes (2020)</td>
</tr>
<tr>
<td></td>
<td>Ineffective communication and collaboration</td>
<td>Wei and Lam (2014), Uyarra et al. (2014), and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Engström and Stehn (2016)</td>
</tr>
<tr>
<td>Human resources barrier</td>
<td>Problems keeping qualified employees</td>
<td>Giménez et al. (2019) and Park et al. (2021)</td>
</tr>
<tr>
<td></td>
<td>Conservative perception</td>
<td>Ozorhon (2013)</td>
</tr>
<tr>
<td></td>
<td>Lack of internal employee training</td>
<td>Adafin et al. (2021)</td>
</tr>
<tr>
<td></td>
<td>Shortage of skilled labor</td>
<td>Mohamed et al. (2017)</td>
</tr>
<tr>
<td></td>
<td>Fear of failure</td>
<td>Suprun and Stewart (2015) and Ghaben and Jaaron (2017)</td>
</tr>
<tr>
<td></td>
<td>Low salary and job security</td>
<td>Ghaben and Jaaron (2017), and Tang et al. (2020)</td>
</tr>
<tr>
<td></td>
<td>Bank policies on credit</td>
<td>Suprun and Stewart (2015)</td>
</tr>
<tr>
<td></td>
<td>Funding deficit</td>
<td>Suprun and Stewart (2015) and Ghaben and Jaaron (2017)</td>
</tr>
<tr>
<td>Market barrier</td>
<td>Economic turbulence</td>
<td>Madrid-Guijarro et al. (2009) and Gambatese and Hallowell (2011)</td>
</tr>
<tr>
<td></td>
<td>Lack of demand and willingness of clients</td>
<td>Suprun and Stewart (2015) and Ghaben and Jaaron (2017)</td>
</tr>
<tr>
<td></td>
<td>Traditional tendering and procurement methods</td>
<td>Suprun and Stewart (2015)</td>
</tr>
<tr>
<td></td>
<td>Low level of government support</td>
<td>Suprun and Stewart (2015)</td>
</tr>
<tr>
<td></td>
<td>Restrictions of regulations</td>
<td>Suprun and Stewart (2015) and Ghaben and Jaaron (2017)</td>
</tr>
</tbody>
</table>

Source(s): Nguyen (2023), reproduced with permission
regarding the number of employees of \(<20, 20–199 \) and \(>200\), respectively (Loosemore and Lim, 2018). On the other hand, the Vietnamese government classifies construction organizations into three major groups: micro/small (1–49 employees); medium (50–99 employees); and large organizations (100 or more employees). To fit with the research context, this study adopted the classification of the Vietnamese government.

The questionnaire includes four sections: (1) the survey’s introduction; (2) barriers to innovation; (3) additional comments on innovation; and (4) general information about respondents (work experience and position in construction firms) and their organizations (i.e., number of employees). In the first section of the questionnaire, the definition of innovation proposed by Saridakis et al. (2019) was adopted to ensure that all respondents had a shared understanding of the innovation terminology. In the second section, 17 potential barriers are delivered. Each question asks the respondents to rate the level of a barrier that hinders innovation in a respondent’s company on a seven-point Likert scale: (1) strongly disagree; (2) disagree; (3) somewhat disagree; (4) neutral; (5) somewhat agree; (6) agree; (7) and strongly agree. Additionally, each respondent is proposed to name any other barriers to innovation not included in the questionnaire and rate their levels in the third part.

To increase the applicability of the questionnaire, a pilot study was conducted with the support of a small group of 11 practitioners and researchers. Industrial practitioners who had working and researching relationships with the authors were selected to review the appropriateness of the questionnaire survey. The interviewees have many years of working in construction firms or research experiences regarding construction management. Through the pilot study, possible errors and ambiguous terminologies would be identified. Consequently, the final questionnaire would be easy-to-read with clear meaning, thus lessening content bias. Subsequently, this study collected data by using a non-probability sampling method. This data collection method was selected because the questionnaire requires specific knowledge of the business performance of the respondents’ organizations, such as research and development activities (R&D), financial resources and human resources management. Thus, the participants should have sufficient knowledge and understanding of organizational performance to achieve the research’s objectives. Specifically, participants were questioned whether they had adequate knowledge of research and development activities (R&D), financial resources and human resources management before involving the survey. Only those who answered a "yes" response were invited to continue the study.

The questionnaire was directly delivered to 326 Vietnamese construction practitioners. They were selected from subcontractors and main contractors that represented construction organizations of different sizes across Vietnam. The survey resulted in the return of 195 valid questionnaires. Among the questionnaire responses, 63 (32.3\%) were from small firms, 56 (29.7\%) were from medium firms, and 76 (39.0\%) were from large firms. In terms of experience, the majority of data (48.7\%) was collected from respondents with 6–10 years of working experience, followed by respondents with less than five years of work (27.7\%), and more than ten years (23.6\%). In terms of working position, 121 respondents (62.1\%) held the staff title, 48 respondents (24.6\%) were senior managers, and 26 respondents (13.3\%) were functional managers and deputy directors. Table 3 shows the demographic of the interviewees in this research stage.

### 3.3 Analysis of questionnaire responses

Before analysis, the collected data were checked for normality using skewness, kurtosis and Kolmogorov–Smirnov tests (Kern et al., 2015; Loosemore and Lim, 2018). The results show that the collected data did not satisfy the assumption of the normal distribution, with the skewness and kurtosis values ranging from \(-1.187\) to \(0.946\) and \(-0.217\) to \(0.918\), respectively.
Moreover, the Kolmogorov–Smirnov test reveals that the collected data were statistically significant at $p = 0.000$. Thus, non-parametric tests should be employed in this research.

Subsequently, the rank-based non-parametric test, Kruskal–Wallis H (KH), was employed to examine if there were significant differences between the three groups of organizations regulated by the Vietnam construction industry. The KH is a non-parametric alternative to the one-way analysis of variance (ANOVA), which can be applied to compare the means between two or more groups (Ghaben and Jaaron, 2017). If the evaluated KH test value is less than the critical value at a significance level, the consensus among the three groups is achieved (Ameyaw et al., 2016). Since more than two groups were examined, a post hoc test (i.e., multiple pairwise comparison tests) was conducted to determine which specific groups differed (Loosemore and Lim, 2018).

3.4 Establishment of the barrier to innovation indexes

The KH and its post hoc tests would show different perceptions of barriers to the innovation of construction organizations of various sizes. Therefore, fuzzy synthetic evaluation (FSE) was employed to quantitatively compare the obstacle level between these types of organizations. FSE is a branch of the fuzzy set theory developed by Zadeh (1965) that aims to create a synthetic assessment of research objectives with multiple criteria in a fuzzy decision environment. Gebremeskel et al. (2020) stated that FSE is a unique method for multi-criteria evaluation of research issues involving uncertain and ambiguous information. Innovation is ambiguous and complex (Saridakis et al., 2019; Uyarra et al., 2014). Therefore, FSE becomes a suitable method to analyze the obstacle level of identified barriers and integrate these barriers into a comprehensive index. The procedure of FSE for specific organization types involves the following six steps (Akter et al., 2019; Osei-Kyei et al., 2017):

1. An evaluation system is structured by defining the four given categories as the first-level system as $\omega = \{\omega_O, \omega_H, \omega_E, \omega_M\}$. The corresponding barriers to innovation are also defined as the second-level system:

   $\omega_O = \{\omega_{O1}, \omega_{O2}, \omega_{O3}\}$

   $\omega_H = \{\omega_{H1}, \omega_{H2}, \omega_{H3}, \omega_{H4}\}$
\( \omega_E = \{ \omega_{E1}, \omega_{E2}, \omega_{E3}, \omega_{E4}, \omega_{E5} \} \)

\( \omega_M = \{ \omega_{M1}, \omega_{M2}, \omega_{M3}, \omega_{M4}, \omega_{M5} \} \)

(2) Label the grade alternatives \( G = \{ G_1, G_2, G_3, G_4, G_5, G_6, G_7 \} \). The seven-point scale was applied to ask participants to weigh the importance of the innovation barrier (where \( G_1 \) = extremely important, \( G_2 \) = very low important, \( G_3 \) = low important, \( G_4 \) = fairly important, \( G_5 \) = important, \( G_6 \) = very important, \( G_7 \) = extremely important).

(3) Each group’s weight is determined by the following equation:

\[
W_i = \frac{M_i}{\sum M_i}, \quad 0 \leq W_i \leq 1, \quad \sum W_i = 1
\]  

Where: \( W_i \) = weighting of each category; \( M_i \) = mean score value of each variable/category; \( \sum M_i \) = total of the mean rating of variables/categories.

(4) The FSE method forms membership functions (MFs) for each variable and group. The MFs are reached through the following equation:

\[
MF_{O_i} = \frac{Y_{1O_i}}{G_1} + \frac{Y_{2O_i}}{G_2} + \frac{Y_{3O_i}}{G_3} + \frac{Y_{4O_i}}{G_4} + \frac{Y_{5O_i}}{G_5} + \frac{Y_{6O_i}}{G_6} + \frac{Y_{7O_i}}{G_7}, \quad i = 1, 2, 3. \tag{2}
\]

\[
MF_{H_i} = \frac{Y_{1Hi}}{G_1} + \frac{Y_{2Hi}}{G_2} + \frac{Y_{3Hi}}{G_3} + \frac{Y_{4Hi}}{G_4} + \frac{Y_{5Hi}}{G_5} + \frac{Y_{6Hi}}{G_6} + \frac{Y_{7Hi}}{G_7}, \quad i = 1, 2, 3, 4. \tag{3}
\]

\[
MF_{E_i} = \frac{Y_{1E_i}}{G_1} + \frac{Y_{2E_i}}{G_2} + \frac{Y_{3E_i}}{G_3} + \frac{Y_{4E_i}}{G_4} + \frac{Y_{5E_i}}{G_5} + \frac{Y_{6E_i}}{G_6} + \frac{Y_{7E_i}}{G_7}, \quad i = 1, 2, 3, 4, 5. \tag{4}
\]

\[
MF_{M_i} = \frac{Y_{1Mi}}{G_1} + \frac{Y_{2Mi}}{G_2} + \frac{Y_{3Mi}}{G_3} + \frac{Y_{4Mi}}{G_4} + \frac{Y_{5Mi}}{G_5} + \frac{Y_{6Mi}}{G_6} + \frac{Y_{7Mi}}{G_7}, \quad i = 1, 2, 3, 4, 5. \tag{5}
\]

Where: \( O_i \) refers to the ith organizational barrier, \( H_i \) refers to the ith human resources barrier, \( E_i \) refers to the ith economic barrier, \( M_i \) refers to the ith market barrier. \( Y_{\mu} (j = 1, 2, 3, \ldots, 7; \mu = S_i, T_i, P_i, E_i) \) is the ratio of the participants who rated \( j \) for the importance of a barrier, which shows the degree of the membership function. The terms \( Y_{\mu}/G_i \) illustrate the relation between \( Y_{\mu} \) and its grade alternative instead of fractions.

The MFs are illustrated as follows:

\[
MF_{O_i} = \{ Y_{1O_i}, Y_{2O_i}, Y_{3O_i}, Y_{4O_i}, Y_{5O_i}, Y_{6O_i}, Y_{7O_i} \} \tag{6}
\]

\[
MF_{H_i} = \{ Y_{1Hi}, Y_{2Hi}, Y_{3Hi}, Y_{4Hi}, Y_{5Hi}, Y_{6Hi}, Y_{7Hi} \} \tag{7}
\]

\[
MF_{E_i} = \{ Y_{1E_i}, Y_{2E_i}, Y_{3E_i}, Y_{4E_i}, Y_{5E_i}, Y_{6E_i}, Y_{7E_i} \} \tag{8}
\]

\[
MF_{M_i} = \{ Y_{1Mi}, Y_{2Mi}, Y_{3Mi}, Y_{4Mi}, Y_{5Mi}, Y_{6Mi}, Y_{7Mi} \} \tag{9}
\]

(5) The MFs and weight of all categories are used to compute its final FSE evaluation matrix.
\[ MF_O = \begin{bmatrix} W_{O1} & W_{O2} & W_{O3} \end{bmatrix} x \begin{bmatrix} MF_{O1} \\ MF_{O2} \\ MF_{O3} \end{bmatrix} \] (10)

\[ MF_H = \begin{bmatrix} W_{H1} & W_{H2} & W_{H3} & W_{H4} \end{bmatrix} x \begin{bmatrix} MF_{H1} \\ MF_{H2} \\ MF_{H3} \end{bmatrix} \] (11)

\[ MF_E = \begin{bmatrix} W_{E1} & W_{E2} & \ldots & W_{E5} \end{bmatrix} x \begin{bmatrix} MF_{E1} \\ MF_{E2} \\ \vdots \\ MF_{E5} \end{bmatrix} \] (12)

\[ MF_M = \begin{bmatrix} W_{M1} & W_{M2} & \ldots & W_{M5} \end{bmatrix} x \begin{bmatrix} MF_{M1} \\ MF_{M2} \\ \vdots \\ MF_{M5} \end{bmatrix} \] (13)

(6) The final FSE evaluation matrix for each category is calculated employing the following formulas:

\[ BI_O = \begin{bmatrix} G_1 & G_2 & G_3 & G_4 & G_5 & G_6 & G_7 \end{bmatrix} x MF_O \] (14)

\[ BI_H = \begin{bmatrix} G_1 & G_2 & G_3 & G_4 & G_5 & G_6 & G_7 \end{bmatrix} x MF_H \] (15)

\[ BI_E = \begin{bmatrix} G_1 & G_2 & G_3 & G_4 & G_5 & G_6 & G_7 \end{bmatrix} x MF_E \] (16)

\[ BI_M = \begin{bmatrix} G_1 & G_2 & G_3 & G_4 & G_5 & G_6 & G_7 \end{bmatrix} x MF_M \] (17)

4. Data analysis

4.1 The multiple pairwise comparison test

The result of the KH test is illustrated in Table 4. All KH values are significant with \( p < 0.001 \). Therefore, it can be concluded that there are substantial divergences regarding barriers to innovation between small, medium and large construction organizations in the sample. The post-doc test also highlighted significant differences between small-large and medium-large groups. Meanwhile, there is no statistical evidence of the difference between small and medium groups.
4.2 Fuzzy synthetic evaluation

According to the post hoc test findings, this research merges small and medium organizations into one group called small and medium enterprises (SMEs). The combination is suitable for this study because the post-hoc test illustrates no statistical evidence of the difference between small and medium groups. The combination is also supported by previous studies, which typically investigate SMEs rather than dividing the small and medium-sized groups (Hardie and Newell, 2011; Liu et al., 2017; Saridakis et al., 2019). As a result, the following research objective is to develop a quantitative model for the barrier to innovation in two groups, including SMEs and large construction organizations.

The FSE method was then employed to construct the barrier to innovation indexes for two groups, including SMEs and large construction organizations. Detailed calculations of the barrier to innovation index for large construction organizations are presented as follows.

Following the six steps illustrated in the methodology section, the weightings of each category were computed by employing equation (1). Taking organizational barrier as an example, the weightings of each variable within this category are computed as follows:

\[
W_{Oi} = \frac{4.837}{4.837 + 5.135 + 4.996 + 4.813} = 0.245
\]

Similarly, \(W_{Ei} = 0.260\), \(W_{fi} = 0.253\), \(W_{E} = 0.243\).

The weighting of the first level is computed employing the same formula:

\[
W_{O} = \frac{16.857}{16.857 + 19.588 + 24.454 + 23.000} = 0.201
\]

Using the same technique, the weightings of all variables and each category can be identified. The results are illustrated in Table 5.

The MF is the degree of an alternative’s membership in a fuzzy set. It is determined from Level 2 (17 barriers) to Level 1 (four identified categories). Therefore, before evaluating the MF of the four groups, the MF of each variable was first assessed. Using formulas (10) to (13),
<table>
<thead>
<tr>
<th>Code</th>
<th>Mean score</th>
<th>Weighting</th>
<th>Membership function for variable</th>
<th>Membership function for category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizational barrier</td>
<td>0.201</td>
<td>0.016</td>
<td>0.045</td>
<td>0.022</td>
</tr>
<tr>
<td>C11</td>
<td>5.756</td>
<td>0.082</td>
<td>0.025</td>
<td>0.008</td>
</tr>
<tr>
<td>C12</td>
<td>5.076</td>
<td>0.034</td>
<td>0.017</td>
<td>0.025</td>
</tr>
<tr>
<td>C13</td>
<td>6.025</td>
<td>0.063</td>
<td>0.038</td>
<td>0.025</td>
</tr>
<tr>
<td>Human resources barrier</td>
<td>0.233</td>
<td>0.047</td>
<td>0.061</td>
<td>0.070</td>
</tr>
<tr>
<td>C21</td>
<td>4.874</td>
<td>0.045</td>
<td>0.050</td>
<td>0.101</td>
</tr>
<tr>
<td>C22</td>
<td>4.109</td>
<td>0.134</td>
<td>0.076</td>
<td>0.252</td>
</tr>
<tr>
<td>C23</td>
<td>5.076</td>
<td>0.017</td>
<td>0.076</td>
<td>0.193</td>
</tr>
<tr>
<td>C24</td>
<td>5.529</td>
<td>0.034</td>
<td>0.034</td>
<td>0.076</td>
</tr>
<tr>
<td>Economic barrier</td>
<td>0.291</td>
<td>0.058</td>
<td>0.052</td>
<td>0.060</td>
</tr>
<tr>
<td>C31</td>
<td>4.849</td>
<td>0.067</td>
<td>0.076</td>
<td>0.118</td>
</tr>
<tr>
<td>C32</td>
<td>4.202</td>
<td>0.101</td>
<td>0.118</td>
<td>0.244</td>
</tr>
<tr>
<td>C33</td>
<td>5.328</td>
<td>0.025</td>
<td>0.126</td>
<td>0.261</td>
</tr>
<tr>
<td>C34</td>
<td>4.950</td>
<td>0.034</td>
<td>0.218</td>
<td>0.202</td>
</tr>
<tr>
<td>C35</td>
<td>5.126</td>
<td>0.017</td>
<td>0.193</td>
<td>0.252</td>
</tr>
<tr>
<td>Market barrier</td>
<td>0.274</td>
<td>0.046</td>
<td>0.059</td>
<td>0.086</td>
</tr>
<tr>
<td>C41</td>
<td>4.899</td>
<td>0.068</td>
<td>0.286</td>
<td>0.202</td>
</tr>
<tr>
<td>C42</td>
<td>5.109</td>
<td>0.042</td>
<td>0.252</td>
<td>0.244</td>
</tr>
<tr>
<td>C43</td>
<td>4.706</td>
<td>0.109</td>
<td>0.202</td>
<td>0.202</td>
</tr>
<tr>
<td>C44</td>
<td>4.092</td>
<td>0.118</td>
<td>0.252</td>
<td>0.202</td>
</tr>
<tr>
<td>C45</td>
<td>4.193</td>
<td>0.084</td>
<td>0.277</td>
<td>0.193</td>
</tr>
</tbody>
</table>

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the MF of each variable is computed. Taking O1 (lack of performance measurement) as an example, the results of the importance of this variable in evaluating barriers to innovation are 0.8% of respondents rated E1 as extremely low important, 25% as very low important, 0.08% as low important, 9.2% as fairly important, 21.0% as important, 33.6% as very important, 31.9% as extremely important. Consequently, the MF of O1 is illustrated as follows (equation 3): $MFO_1 = \frac{0.008}{\text{extremely low important}} + \frac{0.210}{\text{very low important}} + \frac{0.008}{\text{low important}} + \frac{0.092}{\text{fairly important}} + \frac{0.36}{\text{important}} + \frac{0.319}{\text{very important}} + \frac{0.16}{\text{extremely important}}$.

Employing equation (7), the $MFO_1$ is shown as follows: $MFO = [0.008, 0.025, 0.008, 0.092, 0.210, 0.336, 0.319]$.

The same approach then defines the MFs of all variables. After that, the MFs of Level 1 are computed by employing the weightings and MFs of all variables within the same category. Table 3 presents the computation results. As an example, the MF of the organizational barrier was calculated as follows:

$MFO = [0.341, 0.301, 0.357] x \begin{vmatrix} 0.008 & 0.025 & 0.008 & 0.092 & 0.210 & 0.336 & 0.319 \\ 0.042 & 0.101 & 0.034 & 0.076 & 0.252 & 0.303 & 0.193 \\ 0.000 & 0.017 & 0.025 & 0.025 & 0.193 & 0.328 & 0.412 \end{vmatrix}$

$= [0.016, 0.045, 0.022, 0.063, 0.217, 0.323, 0.314]$.

The next step is to compute the important value for each category by using equations (14) to (17).

$BI_O = [1, 2, 3, 4, 5, 6, 7] \cdot [0.016, 0.045, 0.022, 0.063, 0.217, 0.323, 0.314] = 4.187$

$BI_H = [1, 2, 3, 4, 5, 6, 7] \cdot [0.047, 0.061, 0.070, 0.185, 0.177, 0.272, 0.188] = 5.417$

$BI_E = [1, 2, 3, 4, 5, 6, 7] \cdot [0.058, 0.052, 0.060, 0.162, 0.237, 0.270, 0.160] = 3.583$

$BI_M = [1, 2, 3, 4, 5, 6, 7] \cdot [0.046, 0.059, 0.086, 0.254, 0.230, 0.224, 0.100] = 4.784$

The barrier to innovation index is formulated regarding the assumption of a linear relationship among innovation barriers. Adopting a linear regression model makes it easy to translate the final results, which have been employed in much previous research (Gebremeskel et al., 2020; Gurmu, 2021; Osei-Kyei et al., 2017). Specifically, the important value of each category is normalized, and the final barrier index is derived as a combination of the four normalized indexes as follows:

$BI_{Large} = (0.236 \times \text{organizational barrier}) + (0.249 \times \text{human resources barrier})$

$+ (0.245 \times \text{economic barrier}) + (0.270 \times \text{market barrier})$

Similarly, the barrier to innovation index for SMEs is computed and illustrated as follows:

$BI_{SMEs} = (0.280 \times \text{organizational barrier}) + (0.246 \times \text{human resources barrier})$

$+ (0.244 \times \text{economic barrier}) + (0.230 \times \text{market barrier})$

The summary of the data analysis is presented in Table 6.
5. Discussions

The quantitative models for the barrier to innovation in Vietnamese construction organizations of different sizes are presented in Section 4. Specifically, the barrier to innovation indexes for large construction firms and SMEs are $B_{ILarge}$ and $B_{ISMEs}$. It can be seen that the barrier to innovation indexes in both types of construction firms consist of four factors, which are organizational, human resources, economic and market barriers. In the $B_{ILarge}$, the market barrier is the most crucial (index = 0.270), followed by human resources (index = 0.249), economic (index = 0.245) and organizational (index = 0.236) barriers. Meanwhile, in the $B_{ISMEs}$, the orders of importance of the barriers are organizational (index = 0.280), market (index = 0.246), human resources (index = 0.244) and economic (index = 0.230) barriers. Detailed discussions are presented in the following subsections.

5.1 Organizational barrier

The organizational barrier includes a lack of performance measurement, a lack of R&D and ineffective communication and collaboration. Nguyen et al. (2019) witnessed that most Vietnamese organizations need to evaluate the innovative abilities of their employees. Also, Kim et al. (2020) highlighted that Vietnamese construction firms need to formulate performance measurements for sustainable activities, such as waste management. While research and development (R&D) expenditures are essential to innovation (Giménez et al., 2019), Bygballe and Ingemansson (2014) highlighted that R&D was poorly invested in construction organizations.

Effective communication and collaboration can assist shared decision-making and allow reliable knowledge transfer (Hu et al., 2009), thus fostering innovation (Rivera-Vazquez et al., 2009). However, many studies (Kim et al., 2016; Nguyen et al., 2017; Nguyen and Chileshe, 2015) highlighted a low level of communication and collaboration between Vietnamese construction organizations. Consequently, ineffective communication and collaboration become a barrier to innovation in Vietnamese construction firms.

The barrier to innovation indexes highlights significant differences between SMEs and large construction organizations regarding organizational obstacles. While SMEs prioritized the organizational category as the most critical barrier to innovation, it was perceived as the lowest important in large construction organizations. The findings shed light on the study of Yitmen (2007), who witnessed that a lack of appropriate performance measurement was a principal challenge of change for innovation in North Cyprus. Indeed, Yitmen’s (2007) finding was validated only in the case of Vietnamese SMEs. Large firms have many employees working for different departments, which are responsible for divergent tasks of numerous projects. Therefore, they usually build performance measures to monitor overall organizational operations and evaluate employee performance in particular (Kim et al., 2020). Thus, a lack of performance measurement was not a significant barrier to innovation in large construction firms.

<table>
<thead>
<tr>
<th>Barrier category</th>
<th>SMEs Important level</th>
<th>SMEs Index</th>
<th>SMEs Ranking</th>
<th>Large organizations Important level</th>
<th>Large organizations Index</th>
<th>Large organizations Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizational barrier</td>
<td>5.647</td>
<td>0.280</td>
<td>1</td>
<td>4.187</td>
<td>0.236</td>
<td>4</td>
</tr>
<tr>
<td>Human resources barrier</td>
<td>4.951</td>
<td>0.246</td>
<td>2</td>
<td>4.417</td>
<td>0.249</td>
<td>2</td>
</tr>
<tr>
<td>Economic barrier</td>
<td>4.920</td>
<td>0.244</td>
<td>3</td>
<td>4.336</td>
<td>0.245</td>
<td>3</td>
</tr>
<tr>
<td>Market barrier</td>
<td>4.634</td>
<td>0.230</td>
<td>4</td>
<td>4.784</td>
<td>0.270</td>
<td>1</td>
</tr>
</tbody>
</table>

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The appearance of the performance measurement system is also critical in assessing the implementation of R&D practices. In contrast, SMEs may fail to make a consistent benchmark for their work. Tung et al. (2021) reviewed that only 9% of small businesses in Vietnam have confirmed R&D expenditures, compared to 26% of medium and large enterprises. Furthermore, Yun (2021) reviewed that only 13.5% of Vietnamese SMEs engage in innovation activities, such as original R&D and technology adoption, and only 0.6% of organizations develop new products. Consequently, it may be impossible to quantitatively assess the benefits of innovation implementation. Moreover, the limited budget becomes a critical barrier that hinders R&D practices in SMEs in comparison with large firms.

5.2 Market barrier
Market barrier contains economic turbulence, lack of demand and willingness of clients, traditional tendering and procurement methods, low level of government support and restrictions on regulations. Economic turbulence has become the first noticeable external barrier because of unstable economic conditions in recent years (Liané et al., 2021), especially in developing countries like Vietnam (Kim and Nguyen, 2021). Moreover, the construction sector is project-based in that the short-term relationships and power structure regarding the temporary nature of the project teams make the transfer of innovations from project to project and project to the organization extremely difficult (Nguyen, 2022). Thus, a lack of demand and willingness to the innovation of clients is a barrier to innovation in the construction context (Ghaben and Jaaron, 2017).

Furthermore, although previous studies highlighted the critical role of government support in the success of innovation performance (Cheah and Ho, 2020), Ghaben and Jaaron (2017) witnessed a low level of government support for innovation performance in the construction sector. Suprun and Stewart (2015) investigated that national and international regulations and standards (e.g., building codes) affect the propensity to innovate and shape the direction of technological change. Besides, Tookey et al. (2011) showed that the construction sector is highly conservative, which works based on traditional tendering and procurement methods and becomes a barrier to innovation. The construction sector is frustrated by an adversarial contractual nature where each stakeholder seeks to reduce risks and costs by passing them to others (Aouad et al., 2010). In most public-funded projects, Vietnamese construction firms are not even allowed to submit the tender document with different technical methods stated in the bidding document.

The barrier to innovation indexes also reveals a significant difference between SMEs and large organizations regarding the market barrier. Despite the market category being the most critical barrier to innovation in terms of large organizations, it had the smallest index value among SMEs. The results shed light on the findings of Suprun and Stewart (2015), which concluded that low levels of government support and regulations restrictions are crucial barriers to innovation in Russian construction firms. Indeed, these barriers are only critical in the case of larger construction companies in Vietnam. Regarding Vietnamese SMEs, low levels of government support and regulations’ restrictions are not considered crucial barriers to innovation.

Involvement in a wide range of projects, especially large-scale projects, increases large organizations’ vulnerability to the fluctuation of domestic and international economics (Kim and Nguyen, 2021). Emerging countries like Vietnam commonly suffer a high inflation rate, which may suddenly result in a significant increase in material prices (Terzis, 2022). In such a case, large firms that are currently performing a traditional lump sum contract for a big project may face detrimental problems. In contrast, SMEs may involve in small projects that are not heavily affected by such fluctuations. They seem to be more flexible to innovate under
restrictions of regulations and a low level of government support in comparison with large organizations.

5.3 Human resources barrier

Human resources barrier includes problems keeping qualified employees, conservative perception, lack of internal employee training and shortage of skilled labor. Ozorhon (2013) and Suprun and Stewart (2015) emphasized that conservative behavior was an innovation process obstacle. Liané et al. (2021) argued that employees typically do not resist innovation. However, they attempt to prevent innovation performance, potentially raise the labor burden and threaten their jobs. Although construction projects heavily rely on a skilled workforce, Mohamed et al. (2017) observed the shortage of skilled labor hindered the application of technological advances in the construction sector. Besides, experienced workers are crucial components of innovation performance in construction firms (Giménez et al., 2019). However, Park et al. (2021) witnessed keeping qualified employees is a severe human resources problem in the construction sector. In addition, Adafin et al. (2021) also argued that a lack of internal employee training is a reason for the low innovation interest in construction companies.

Vietnam has more than 78,000 construction firms, which hire about 4 million employees. However, Khanh et al. (2022) highlighted the relatively low productivity of the Vietnamese construction sector. While the number of skilled laborers is a critical factor affecting productivity, there is still a shortage of skilled labor who can propose innovative improvements in construction works (Khanh et al., 2022). Furthermore, Vietnamese construction firms have to face the problem of keeping qualified employees (Nguyen et al., 2018). As to the nation’s development, various companies are established, and employees are offered new job opportunities with many benefits. Thus, labor retention becomes difficult for Vietnamese construction firms, especially SMEs with limited resources.

The barrier to innovation indexes illustrates that SMEs and large organizations equally prioritize the human resources barrier as the second most critical barrier to innovation. The findings delivered a contradicting meaning to Suprun and Stewart (2015) regarding the human resources barrier. There were no human resources variables among the 16 obstacles to innovation proposed by Suprun and Stewart (2015). In other words, Suprun and Stewart (2015) argued that human resources variables were insignificant barriers to innovation in Russian construction firms. However, the findings were supported by the study of Awodele et al. (2021), who witnessed that lack of technical expertise ranked the second most significant barrier to innovation in the Nigerian construction industry.

5.4 Economic barrier

The economic barrier consists of short-term profit expectations, fear of failure, low salary and job security, bank policies on credit and funding deficit. In a trade-off between short-term economic efficiency and long-term development, construction firms may choose short-term profit, especially SMEs (Lijauco et al., 2020). However, innovation may be costly in the short term, becoming a barrier to construction firms’ innovation (Foxon and Pearson, 2008). Ghaben and Jaaron (2017) also noted that the long life spans of construction projects limit innovation performance within construction. Moreover, Ghaben and Jaaron (2017) debated funding deficit, low salaries and lack of job security are critical barriers that hinder innovation in construction projects. Furthermore, seeking innovative alternatives and experimenting with new ideas are often seen as endeavors that may increase risk and uncertainty for business success (Crespell and Hansen, 2008; Laforet, 2011). However, a risk-avoidance culture result in employees not being bothered to think of implementing innovatively (Ghaben and Jaaron, 2017). In that sense, Suprun and Stewart (2015) highlighted that a fear of failure deterred innovation performance in construction companies.
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The barrier to innovation indexes also show that SMEs and large organizations equally rank economic barrier in the third position. This study yielded a contrasting finding with the study of Awodele et al. (2021), who witnessed that shortage of funds ranked as the most critical barrier to innovation in the Nigerian construction industry. Most Vietnamese construction firms are SMEs with limited organizational resources and external financial support. However, the fund shortage and expectation of short-term profit were not considered significant barriers to innovation in Vietnamese construction firms. Regarding annual sales, Tung et al. (2021) witnessed Vietnamese businesses invest the least in R&D compared to other Southeast Asian nations, which showed fear of failure in Vietnamese organizations. While Cambodia, Malaysia, Philippines and Laos spent 1.9%, 2.6%, 3.6% and 14.5% of their annual revenue on R&D, Vietnamese firms allocate only 1.6% of their yearly income to this activity.

6. Conclusions
6.1 General conclusions
This research investigated barriers to innovation regarding construction organizations of different sizes in the Vietnamese context. The findings showed 17 barriers to innovation which were categorized into four groups, including organizational barrier, human resources barrier, economic barrier and market barrier. Statistical analysis revealed significant differences regarding barriers to innovation between small, medium and large construction organizations. The post hoc test highlighted that barriers to innovation are separated into two groups: SMEs and large construction organizations. The FSE analysis integrated the identified barriers into the comprehensive BIs for SMEs and large construction organizations. The BIs might fill the knowledge gap by illustrating the linear relationship of barriers to innovation, providing a comprehensive tool for decision-makers to improve innovation performance. The FSE analysis showed that the organizational barrier is the most critical barrier for SMEs. On the other hand, the market barrier received the greatest attention in large construction organizations.

6.2 Implications
The research findings will enlarge the current body of knowledge in innovation management. The findings of this study indicate that Vietnamese construction firms face various barriers to innovation, such as the lack of performance measurement, ineffective communication and collaboration, fear of failure, funding deficit and low level of government support. Given the unique features of the Vietnamese construction industry, such as the small domestic market size and limited global competitiveness, the barriers to innovation identified in the study could be even more challenging to overcome. Therefore, it is crucial for Vietnamese construction firms to understand these barriers and find ways to overcome them to stay competitive and innovative in the industry. The study’s quantitative model for the barriers to innovation could be useful for Vietnamese construction firms to evaluate their innovation performance and identify areas that need improvement. With the golden demographic period coming to an end in 2034, it is critical for Vietnamese construction firms to accelerate their innovation efforts to keep pace with global markets and take advantage of the remaining period of this demographic opportunity.

The development of barrier to innovation indexes for SMEs and large construction organizations in Vietnam provides important insights into the challenges faced by these companies in fostering innovation. The study’s findings indicate that organizational barriers are the most critical for SMEs, while market barriers receive the greatest attention in large construction organizations. For SMEs, the organizational barrier includes factors such as
lack of performance measurement, inadequate communication and collaboration and lack of R&D resources. This indicates that companies may need help managing their internal operations and developing new ideas for products or services. These findings suggest the need for investments in employee training and development, enhancing internal communication and collaboration and allocating resources to R&D to promote innovation within the organization.

On the other hand, large construction organizations face market barriers such as economic turbulence, low demand and willingness of clients, traditional tendering and procurement methods and restrictions of regulations indicate that external factors may hinder innovation in construction companies. Addressing these challenges may require companies to adopt new business models, develop partnerships and collaborations and work with policymakers to reduce regulatory barriers to innovation.

6.3 Limitations and future research direction

While the study provides valuable insights into the barriers to innovation in Vietnamese construction firms, its limitations should be considered when interpreting the results. Firstly, the findings were based solely on the opinions of Vietnamese construction professionals. The list of barriers to innovation was formed through a literature review and discussions with experienced Vietnamese practitioners. However, other nations with higher levels of R&D investment, more mature construction markets and different cultural values may face different barriers to innovation. Therefore, further research is needed to better understand the specific challenges faced by construction firms in developing and implementing innovative solutions. Secondly, the study was conducted only at the organizational level, which may not necessarily apply to the project or industry-level innovation. Future research should explore the barriers to innovation at all levels to provide a more comprehensive understanding of the innovation landscape in the construction industry.

Moreover, while the fuzzy set theory employed in the research reduces subjectivity compared to crisp values, the reliance on respondent judgments may still result in potential bias. Therefore, the presented results should be cautiously approached and considered with other studies to obtain a more comprehensive understanding of the barriers to innovation in the construction industry. Furthermore, the study’s small sample size may also limit the generalizability of the results. Therefore, larger sample sizes and more diverse samples could be employed in future research to increase the generalizability of the findings. Future studies can utilize the research plan presented in Figure 1 to investigate the barriers to innovation in other contexts and compare the results to those shown in this study.

References


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