Jurnal Media Komunikasi Dunia Ilmu Sipil (MoDuluS)
Volume 7, No 1, Juni 2025, pp 63-70
p-ISSN 2714-9021
e-ISSN 2714-9013

The Adaptability and Innovation Capacity of Small and Medium Construction Companies to Information and Computers Technology in the Developing Countries

Rizal Bahaswan[1*)], Amrun Rosyid[2)], Alexander Machicky Mayestino[3)], Dani Eko Guntoro[4)]

[1]Civil Engineering Department, Universitas Narotama
[2]Management Department, Universitas Narotama
[3]Information System Department, Universitas Narotama
[4]Public Works and Water Resources Department of Sidoarjo Regency

Email: rizal.bahaswan@narotama.ac.id

Abstract

The construction industry in developing countries is undergoing a pivotal transformation, driven by the integration of information and communication technology (ICT). This study investigates how ICT adoption influences the adaptability and innovation capabilities of small and medium-sized enterprises (SMEs) within this sector. Employing a mixed-methods approach, the research combines quantitative data from 50 construction SMEs across chosen regions in Indonesia, with qualitative insights from 15 in-depth interviews. Findings reveal that ICT significantly enhances both adaptability and innovation performance. Notably, adaptability serves as a key mediating factor, linking ICT usage to innovative outcomes. Technologies such as mobile-based project coordination tools, cloud platforms, and Building Information Modeling (BIM) were found to improve operational responsiveness and foster novel approaches in project execution and service delivery. However, the study also identifies critical contextual challenges—including limited infrastructure, cost barriers, and cultural resistance—that hinder widespread ICT integration. The research contributes to theory by extending the Technology-Organization-Environment (TOE) framework to include adaptability as a mediating construct. Practically, it offers policy and managerial recommendations for enabling digital transformation in resource-constrained construction environments. Ultimately, the study underscores the strategic potential of ICT to enhance resilience and competitiveness among construction SMEs, provided that adoption is contextually supported and strategically implemented.

Keywords: *adaptability; innovation capacity; small and medium construction companies; information and computer technology; developing countries*

1. INTRODUCTION

Rapid developments in information and communication technology (ICT) are causing a dynamic transition in the construction industries recently. ICT tools have brought both big potential and complicated obstacles, especially for small and medium-sized businesses (SMEs), which make up a crucial portion of the economy in developing countries. SMEs in the construction industry frequently work in conditions that are confined by a lack of funding, dispersed operations, and limited access to cutting-edge technologies. ICT shows up as a potential equalizer in many situations, allowing for greater flexibility and encouraging creativity in project management, design, and implementation.

It is crucial to research how ICT affects SMEs in the construction industry for a number of reasons. First off, SMEs are key contributors to employment and economic growth in developing countries, but because of structural inefficiencies, their productivity frequently lags (Bahaswan, Mudjanarko, et al., 2020). Second, because construction is an information-intensive industry by nature, it greatly benefits from enhanced data flow, communication, and teamwork—areas where ICT may have a considerable influence (Hasan et al., 2019; Lota et al., 2022; Samad & Kazi, 2005). Lastly, the worldwide drive for digital transformation

p-ISSN 2714-9021
e-ISSN 2714-9013

necessitates a better comprehension of how these technologies can be successfully integrated into conventional industries like construction, particularly in settings with developmental limitations. This study tackles a crucial intersection between technological integration and sustainable industry growth by concentrating on the adaptability and innovation capacity of SMEs.

Research on the digital transformation of the construction industry has increased during the last ten years. Building information modelling (BIM), mobile platforms, and cloud-based project management systems are major ICT innovations that are changing construction workflows (Ismail et al., 2019; B. Liu et al., 2021; Y. Liu et al., 2020). Simultaneously, studies like those by Hammad and Akintoye highlight how ICT can improve supply chain coordination and decision-making effectiveness in SMEs in the construction industry (Hammad & Akintoye, 2017).

Emerging research in developing nations has focused on particular difficulties such low digital literacy, high upfront expenses, and limited infrastructure (Agyekum et al., 2021; Kapur et al., 2018). Nevertheless, other writers contend that despite these obstacles, small-scale ICT adoption might result in quantifiable gains in innovative capacity and operational flexibility (Musa et al., 2022). Zhao and Gao have highlighted the connection between ICT use and innovation performance, especially in situations with limited resources. They claim that contextualized ICT methods can fill institutional gaps and encourage innovative problem-solving in SMEs (Zhao & Gao, 2016).

However, current research is still dispersed and frequently concentrates on big businesses or the overall effects of ICT without paying particular attention to the complex dynamics of SMEs in the construction industry. Furthermore, despite the existing theoretical frameworks surrounding ICT adoption—such as the Diffusion of Innovations (DOI) and the Technology-Organization-Environment (TOE) model—their empirical applicability in SME-centric construction environments is still quite limited (Gambatese & Hallowell, 2011; Kale & Arditi, 2010; Wipulanusat et al., 2019).

There are still a number of gaps in the present literature, despite growing scholarly attention. First, there is little empirical data on how ICT promotes innovation and adaptability, particularly for SMEs in developing nations' construction industries. A large portion of the research ignores the potential and contextual challenges particular to less developed regions since it either focuses on rich economies or generalizes across industries.

Second, the two objectives of innovation and adaptation are frequently discussed separately, but in reality, they are related—businesses that can change with the times are more likely to innovate, and vice versa. The goal of this work is to investigate this link in a coherent way.

Third, the informal organizational structures and changing environmental variables that characterize SMEs in developing nations are frequently overlooked by current models of ICT adoption. Context-sensitive research that takes into account the cultural, economic, and policy contexts is desperately needed.

The purpose of this study is to look into how ICT affects small and medium-sized businesses' capacity for innovation and adaptability in construction industry in developing countries. The following are the particular goals of this study:

1. To determine the kinds of ICT tools and systems that SMEs in the construction industry in developing nations typically use.
2. To evaluate how ICT adoption affects an organization's ability to respond to changing environmental conditions.
3. To assess how ICT promotes innovation in the areas of projects, processes, and products.
4. To investigate the mediating elements that affect the relationship between ICT, adaptation, and innovation, such as corporate culture, leadership, and government assistance.
5. To suggest a framework for ICT integration in construction SMEs with developmental restrictions that is based on context.

This study makes several important contributions to the body of existing literature. First of all, by concentrating on SMEs in the building industry in underdeveloped nations—a setting that is still underrepresented in ICT-related research—it closes the empirical gap. Second, the study offers a more comprehensive

p-ISSN 2714-9021
e-ISSN 2714-9013

view of ICT's strategic significance by examining innovation outputs and adaptability at the same time. Thirdly, it enhances the theoretical applicability of current ICT adoption models by incorporating stakeholder viewpoints and context-specific variables.

The report also provides useful advice on how to use ICT to increase resilience and competitiveness for policymakers, business executives, and SME management. A crucial instrument for boosting technological capability and innovation-driven growth among construction SMEs in developing countries will be the creation of a customized ICT integration framework.

2. METHODOLOGY

Research design

In order to obtain a thorough grasp of how ICT affects adaptation and creativity in construction SMEs in developing nations, this study uses a mixed-methods research methodology, combining qualitative and quantitative techniques. Because ICT adoption is complex and involves both quantifiable results (like project efficiency and innovation rate) and contextual nuances (like organizational culture and leadership support), a mixed-methods approach is appropriate for this study.

The research employs a sequential explanatory design, starting with a quantitative survey to identify general trends and moving on to qualitative interviews to gain more in-depth understanding. This enables the theme inquiry in the second phase to be guided by the original numerical data.

Population and Sampling

The population for this study consists of small and medium-sized construction enterprises operating in selected regions of East Jawa province, Indonesia. In order to have the diversity in sampling, we were targeting enterprises based on their home base, which are big city, small city and rural areas. These regions are chosen for their active construction sectors and observable ICT integration efforts.

- Sampling Strategy (Quantitative): A stratified random sampling method will be employed to ensure representation across different SME sizes, regions, and ICT usage levels. The target sample size is 50 SMEs.
- Sampling Strategy (Qualitative): Purposeful sampling will be used to select 15 participants from the survey phase who exhibit either high or low ICT integration levels. These will include project managers, IT leads, and business owners.

Data Collection Methods

- Quantitative Data Collection: Using verified constructs from previous research (Ghobakhloo & others, 2012; Molla & Licker, 2005), a structured questionnaire will be created. ICT use, organizational flexibility, innovation results, and mediating factors (e.g., culture, leadership) will all be evaluated.
- Gathering Qualitative Data: Semi-structured interviews will delve deeply into the tactics, obstacles, and perceived advantages of ICT adoption. To ensure confidentiality, interviews will be videotaped, transcribed, and anonymized.

Measurement Analysis

The questionnaire will include Likert-scale items adapted from:

- ICT usage metrics (e.g., ERP, BIM, mobile tech)
- Adaptability scales (Burns & Stalker, 1961)
- Innovation scales (OECD, 2005)
- Contextual enablers and barriers (e.g., leadership support, government policy)

Reliability and validity will be tested through a pilot study involving 5 respondents, followed by Cronbach's alpha and exploratory factor analysis.

Data Analysis

- Quantitative Data Analysis: To investigate the connections among ICT use, adaptability, and innovation, descriptive statistics, correlation analysis, and multiple regression will be employed. The mediating effects can also be tested using structural equation modeling, or SEM.
- Qualitative Data Analysis: NVivo software will be used for thematic analysis. Based on the content of the interviews as well as theoretical frameworks, themes will be coded both inductively and deductively.

p-ISSN 2714-9021
e-ISSN 2714-9013

This chapter presents a thorough methodological approach intended to investigate the complex effects of ICT on SMEs in the construction industry in emerging nations. Combining survey and interview techniques guarantees both depth and breadth of understanding, which is consistent with the study's main goal of producing conclusions that are contextually aware and empirically supported.

RESEARCH FINDING

Demographic of Respondents

Sixty-eight percent of the SMEs questioned had less than fifty workers, and the majority had been in business for more than five years. Approximately 55% of businesses had incorporated ICT into their operations in some capacity, such as mobile communication platforms or cloud-based project management systems. Business owners (30%), project managers (40%), IT managers (15%), and site engineers (15%) were among the occupations of the respondents.

Quantitative Findings

ICT Adoption

The most commonly used ICT technologies (figure 1), according to the findings, are digital documentation systems (38%), mobile-based project coordination apps (47%), and building information modeling (22%). On the other hands, cost (65%), a lack of technical expertise (52%), and erratic internet connectivity (41%), were among the obstacles mentioned (figure 2).

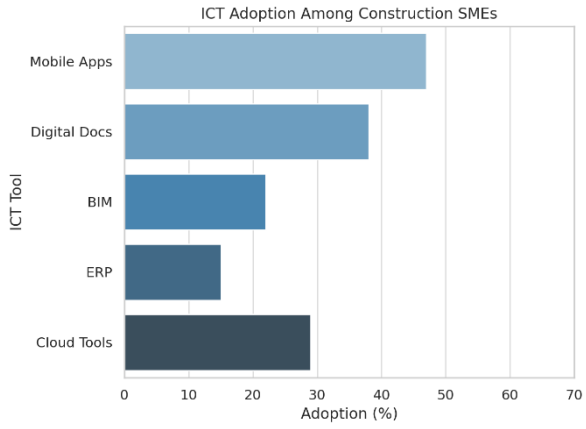

Figure 1. ICT adoption on SME construction

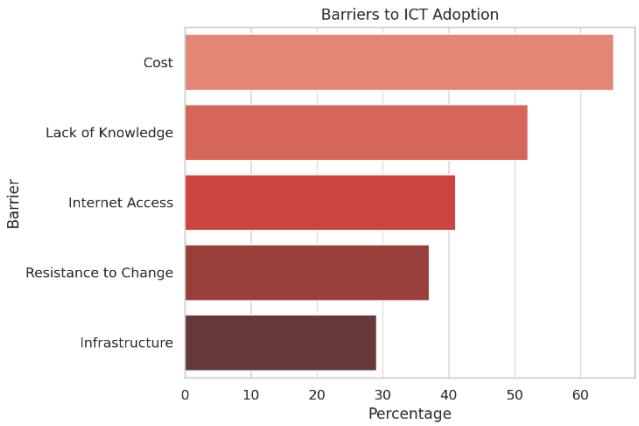

Figure 2. Barriers for SME construction on ICT adoption

ICT and Organizational Adaptability

ICT use and organizational adaptability were significantly positively correlated, according to regression analysis ($\beta = 0.47$, $p < 0.001$). SMEs who used real-time communication technologies showed more adaptability in risk response, project rescheduling, and client requirement adaptation.

ICT and Innovation Outcomes

ICT use was favorably connected with innovation indicators, including the launch of new services, enhanced project workflows, and client engagement strategies ($r = 0.53$, $p < 0.01$). The association between ICT use and innovation is mediated by adaptability, according to structural equation modeling.

Qualitative Findings

Perceived Benefits of ICT

Efficiency gains, better decision-making, and greater client communication were highlighted by interviewees. "With mobile updates from sites, we can tackle problems before they worsen," said one participant.

Challenges and Constraints

A number of issues were frequently brought up, including resistance from senior management, a lack of ICT skills, and inadequate government supports. One participant who operates in less developed region said, "Digital instruments are not trusted by our director. He favors in-person updates."

p-ISSN 2714-9021
e-ISSN 2714-9013

Strategic Adaptation and Innovation

Better project turnaround times, drone use for site monitoring, and incorporation of client comments into design changes were noted by participants from companies with greater ICT adoption. These companies frequently have access to outside training programs and younger leadership.

Cross-Region Observations

- Big city-based region: More diversity in ICT tools but cultural resistance to change is pronounced.
- Small city-based region: High mobile tool usage but infrastructure challenges remain a bottleneck.
- Rural based region: Cost remains the dominant barrier, with most firms relying on basic tools like WhatsApp and Excel.

Summary of Findings

1. ICT adoption significantly enhances both adaptability and innovation in construction SMEs.
2. Adaptability mediates the effect of ICT on innovation.
3. Key enablers include leadership support, digital literacy, and affordable access to infrastructure.
4. Main barriers involve cost, resistance to change, and inadequate policy frameworks.

3. DISCUSSION AND ANALYSIS

This chapter synthesizes the empirical findings with the existing literature discussed earlier. It critically examines how the adoption of information and communication technology (ICT) contributes to adaptability and innovation in construction SMEs in developing countries. The discussion is structured around key themes: ICT as an enabler of adaptability, ICT-driven innovation, mediating factors, and contextual challenges.

ICT as an Enabler of Adaptability

In line with previous research, the quantitative findings showed a statistically significant correlation between organizational adaptability and ICT use ($\beta = 0.47$, $p < 0.001$) (Alshawi & Ingirige, 2003; Ghobakhloo et al., 2011). Construction SMEs who used ICT solutions, such as real-time communication platforms and mobile apps, demonstrated more flexibility in managing risks, allocating resources, and modifying timelines.

This is supported by the qualitative results, which show that participants emphasized how digital tools enabled distant decision-making and improved on-site issue management. This bolsters the claim that ICT serves as a stabilizing and enabling force in dynamic project environments, particularly in areas with logistical and infrastructure challenges.

ICT and Innovation Outcomes

ICT use and innovation activities have a substantial positive link ($r = 0.53$, $p < 0.01$), suggesting that technology tools are essential for promoting process and product innovation. Firms with higher levels of digital maturity were recognized for innovations including automated client feedback loops, drone monitoring, and 3D design updates via BIM.

This bolsters the claim made that ICT not only simplifies processes but also encourages experimentation (Lu & Sexton, 2006). This analysis, however, supports comparable innovation processes within resource-constrained SMEs in developing countries, despite the literature's frequent focus on large enterprises in developed nations.

The Mediating Role of Adaptability

The relationship between ICT and innovation is largely mediated by adaptability, according to the results of the structural equation modeling. By providing empirical evidence that ICT fosters innovation through flexibility rather than as a stand-alone engine, this nuanced conclusion builds on the work of Ghobakhloo (Ghobakhloo & others, 2012).

This has important ramifications since it implies that initiatives to increase creativity should start with enhancing organizational flexibility and responsiveness. This reaffirms the significance of responsive planning systems, process digitization, and leadership development.

Contextual Enablers and Constraints

A number of contextual elements became important variables:

- Leadership Support: More receptive to experimentation and ICT integration were younger, tech-savvy leaders.
- Training and Capacity Building: Businesses that made ICT literacy

investments had more seamless transitions and wider advantages.
- Infrastructure and Cost: Similar to findings (Esselaar et al., 2007; Mutula & Van Brakel, 2006), Internet dependability and software costs continued to be significant obstacles.

Different phases of ICT evolution were highlighted by the cross-region comparison. Despite having high cellphone adoption rates, rural region-based lacked adequate infrastructure. Despite cultural barriers, big city region-based demonstrated a broader diversity of technologies. Cost-driven conservatism was evident in small city region-based SMEs, which restricted ICT use to simple uses. These two resistances was in line with previous research (Bahaswan, Parastuty, et al., 2020).

Revisiting the Research Gap

This study fills a crucial gap in the literature by examining the ICT-adaptability-innovation triad in SME construction contexts across multiple developing countries. Prior research often fragmented these themes or excluded the construction sector. This study's integrated, context-sensitive perspective provides a more comprehensive understanding.

Moreover, the empirical validation of adaptability as a mediator contributes new insights to the theoretical frameworks of ICT adoption, suggesting refinements to models such as TOE and DOI when applied to SMEs in developing settings.

The discussion demonstrates that ICT adoption greatly increases creativity and flexibility in SMEs in the construction industry; yet, these advantages depend on contextual enablers including infrastructure, training, and leadership. Adaptability's mediating function strengthens the need for comprehensive approaches in digital transformation initiatives by providing theoretical depth and useful guidance.

4. CONCLUSION

This study investigated how information and communication technology (ICT) may help small and medium-sized businesses (SMEs) in the construction sector in developing nations become more innovative and adaptable. It was determined, using both quantitative and qualitative data, that ICT adoption is essential for enhancing organizational responsiveness and innovative results. Interestingly, adaptability turned out to be a key mediator that influenced how much ICT can inspire creative behaviors.

According to the study, companies who use cloud-based tools, BIM platforms, and mobile communication reported being more innovative and flexible in their project execution. However, the study also showed that contextual facilitators like institutional support, infrastructure availability, staff training, and leadership commitment limit the benefits of ICT, which are not always automatic.

The study filled a major gap in the literature by looking at SMEs in some region-based and provided a context-sensitive view of the relationship between ICT, adaptation, and innovation. It included both empirical data and useful concepts that may be applied to construction SMEs around the world that are dealing with comparable developmental issues.

Key Contributions

- Empirical Contribution: This study is among the first to empirically test the mediating role of adaptability in the ICT-innovation relationship within construction SMEs in developing countries.
- Theoretical Contribution: It enhances the Technology-Organization-Environment (TOE) and Diffusion of Innovations (DOI) models by incorporating adaptability and contextual variables.
- Practical Contribution: The findings offer clear recommendations for SMEs, policymakers, and development agencies aiming to leverage ICT for sectoral transformation.

5. RECOMMENDATIONS

For SME Owners and Managers

- Invest in ICT tools incrementally, starting with affordable and user-friendly platforms.
- Foster a digital culture through regular training and leadership engagement.
- Prioritize adaptability by embedding flexible practices into daily operations.

For Policymakers and Development Agencies

- Provide targeted subsidies and financial incentives to encourage ICT adoption in construction SMEs.
- Strengthen digital infrastructure and internet accessibility, especially in underserved regions.
- Develop national and regional ICT training programs tailored to the construction sector.

For Industry Associations

- Promote knowledge sharing through conferences, digital innovation labs, and mentorship networks.
- Collaborate with tech providers to offer bundled, cost-effective ICT solutions.

Future Research Directions

- Conduct longitudinal studies to examine how ICT-driven adaptability evolves over time.
- Expand research into other regions to validate and refine the proposed framework.
- Investigate sector-specific ICT tools and their differential impact on micro vs. medium-sized construction firms.

Final Remarks

Construction SMEs in emerging nations are at a turning point in an era of growing digitalization. This study highlights the revolutionary potential of ICT to improve both operational resilience and innovation capability when implemented strategically and backed by enabling ecosystems. The findings of this study offer timely counsel for inclusive, technology-driven growth, as sustainable infrastructure is given priority in global development agendas.

6. DAFTAR PUSTAKA

Agyekum, K., Ayarkwa, J., & Adinyira, E. (2021). Digital transformation challenges in African construction SMEs. Construction Innovation, 21(4), 689–708.

Alshawi, M., & Ingirige, B. (2003). Web-enabled project management: An emerging paradigm in construction. Automation in Construction, 12(5), 549–564.

Bahaswan, R., Mudjanarko, S. W., Wulandari, A., & Parastuty, Z. (2020). Financing model for small-medium scale contractors in indonesian. Proceedings of the International Conference on Industrial Engineering and Operations Management, 59, 2238–2246.

Bahaswan, R., Parastuty, Z., Wulandari, A., & Mudjanarko, S. W. (2020). Innovation within Small-Medium Scale Contractors in Indonesia. The Spirit of Society Journal, 4(1), 57–65. https://doi.org/10.29138/scj.v4i1.1197

Burns, T., & Stalker, G. M. (1961). The Management of Innovation. Tavistock.

Esselaar, S., Stork, C., Ndiwalana, A., & Deen-Swarray, M. (2007). ICT usage and its impact on profitability of SMEs in 13 African countries. Information Technologies and International Development, 4(1), 87–100.

Gambatese, J. A., & Hallowell, M. (2011). Factors that influence the development and diffusion of technical innovations in the construction industry. Construction Management and Economics, 29(5). https://doi.org/10.1080/01446193.2011.570355

Ghobakhloo, M., Arias-Aranda, D., & Benitez-Amado, J. (2011). Adoption of e-commerce applications in SMEs. Industrial Management \& Data Systems, 111(8), 1238–1269.

Ghobakhloo, M., & others. (2012). Information technology adoption in SMEs: An integrative framework. International Journal of Business and Management, 7(5), 1–12.

Hammad, A. A., & Akintoye, A. (2017). ICT and supply chain coordination in construction SMEs. Journal of Construction Engineering and Management, 143(9), 5017008.

Hasan, A., Ahn, S., Rameezdeen, R., & Baroudi, B. (2019). Empirical Study on Implications of Mobile ICT Use for Construction Project Management. Journal of Management in Engineering, 35(6). https://doi.org/10.1061/(asce)me.1943-5479.0000721

Ismail, Z., Zakaria, S., & Ghazali, F. M. (2019). Impact of BIM on construction industry performance. International Journal of Built Environment and Sustainability, 6(1), 1–10.

Kale, S., & Arditi, D. (2010). Innovation Diffusion Modeling in the Construction Industry. Journal of Construction Engineering and Management, 136(3). https://doi.org/10.1061/(asce)co.1943-7862.0000134

Kapur, R., Choudhary, V., & Saxena, S. (2018). Barriers to ICT adoption in developing

p-ISSN 2714-9021
e-ISSN 2714-9013

countries. ICTACT Journal on Management Studies, 4(1), 642–648.

Liu, B., Yang, B., Xiao, J., Zhu, D., Zhang, B., Wang, Z., & Dong, M. (2021). Review of optimization dynamically applied in the construction and the application potential of ICT. Sustainability (Switzerland), 13(10). https://doi.org/10.3390/su13105478

Liu, Y., Tan, Y., & Xue, X. (2020). Cloud-based project management for SMEs in construction. Automation in Construction, 114, 103187.

Lota, P. S., Vijayashree, T. M., & Dave, B. (2022). Streamlining production management in construction projects with ICT. CSI Transactions on ICT, 10(2), 73–84. https://doi.org/10.1007/s40012-022-00359-6

Lu, S., & Sexton, M. (2006). Innovation in small construction knowledge-intensive professional service firms: A case study of an architectural practice. Construction Management and Economics, 24(12), 1269–1282.

Molla, A., & Licker, P. S. (2005). Perceived e-readiness factors in e-commerce adoption: An empirical investigation in a developing country. International Journal of Electronic Commerce, 10(1), 83–110.

Musa, R., Hassan, M. F., & Harun, N. H. (2022). Incremental ICT adoption and innovation in SMEs. Journal of Engineering and Applied Sciences, 17(3), 337–343.

Mutula, S. M., & Van Brakel, P. (2006). E-readiness of SMEs in the ICT sector in Botswana with respect to information access. The Electronic Library, 24(3), 402–417.

OECD. (2005). Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data (3rd ed.). OECD Publishing.

Samad, A., & Kazi, S. (2005). ICT in Construction and Facilities Management: Vols. VI-ICT i.

Wipulanusat, W., Panuwatwanich, K., Stewart, R. A., & Sunkpho, J. (2019). Innovation diffusion process in the Australian construction industry. IOP Conference Series: Materials Science and Engineering, 652(1). https://doi.org/10.1088/1757-899X/652/1/012001

Zhao, X., & Gao, S. (2016). ICT and innovation performance in resource-constrained firms. Technology in Society, 45, 71–80.