Jurnal Info Sains : Informatika dan Sains
Volume 14 , Number 01, 2024, DOI 10.54209/infosains.v14i01
ESSN 2797-7889 (Online)
https://ejournal.seaninstitute.or.id/index.php/InfoSains

Implementation of extreme programming in field service management system development to enhance efficiency in construction projects

Denny Jean Cross Sihombing
Faculty of Engineering, Atma Jaya Catholic University of Indonesia

Article Info

Keywords:
Field Service Management,
Extreme Programming,
Construction Projects.

ABSTRACT

This research addresses efficiency challenges in field service management on construction projects by applying the Extreme Programming (XP) Method. Faced with the complexity of construction projects and the limitations of conventional software development methods, this research focuses on applying XP principles as an adaptive and responsive approach. The results showed that the application successfully provided an efficient solution and increased user satisfaction through the stages of data collection, application development using XP, and user acceptance analysis. User data reflected that features such as real-time monitoring, adaptive planning, task management, and field change notifications were perceived to contribute to operational efficiency positively. Out of 50 users, about 85% expressed high satisfaction with the app. The main contribution of this research is validating XP's success in overcoming the dynamics of construction projects and providing solutions that fit the field context. Thus, this research not only provides deep insight into the effectiveness of XP in construction software development but also offers practical contributions to improving the efficiency and responsiveness of construction project management.

Corresponding Author:
Denny Jean Cross Sihombing
Atma Jaya Catholic University of Indonesia
Jakarta, Indonesia
denny.jean@atmajaya.ac.id

INTRODUCTION

Construction projects, as entities that involve coordinating and integrating various elements, often set the stage for challenges of varying complexity. In this context, every construction project faces technical, logistical, and managerial dynamics (Alzahrani & Emsley, 2013; Divya Sankar & Selvam, 2020; Trask & Linderoth, 2023). The construction of a structure requires careful harmonization of various factors such as design, materials, safety, and environmental factors. A construction project's success is determined by its technical quality and ability to cope with changes, field challenges, and uncertainties that may arise during implementation(Ingle & Mahesh, 2022; Lai et al., 2016; Nguyen & Robinson Fayek, 2022).

Field service management becomes an essential element in managing this complexity. In construction projects, the field is often where strategic decisions must be

Jurnal Info Sains : Informatika dan Sains
Volume 14 , Number 01, 2024, DOI 10.54209/infosains.v14i01
ESSN 2797-7889 (Online)
https://ejournal.seaninstitute.or.id/index.php/InfoSains

made quickly and precisely. Therefore, effective field service management is critical to keeping the project under control, optimizing processes, and ensuring the involvement of all relevant parties. The role of field service management in construction projects must be considered. Substantially, it not only focuses on the maintenance and supervision of the physical site but also involves integrating information, coordination between teams, and customer engagement and satisfaction(Choi & Ha, 2022; Gao, 2022; Guo et al., 2023; Jato-Espino et al., 2014).

In ensuring the smooth running of a construction project, field service management serves as the frontline that responds to changes, responds to technical challenges, and keeps the workflow on track. A project's success is measured by how well it is physically constructed and by the extent to which field service management can harmonize all components, overcome obstacles, and ensure that the customer feels well served. As such, the significance of field service management in the construction context relates to operational efficiency and company reputation, customer satisfaction, and overall project success. Achieving continuity in field service management paves the way for achieving construction project goals holistically and providing a sustainable positive impact for all stakeholders involved(Celik et al., 2023; Khodabakhshian & Re Cecconi, 2022; Pham et al., 2023; Rajabi et al., 2022; Tessema et al., 2022).

During a construction project, efficiency challenges need to be overcome to ensure smooth implementation and overall project success. The existence of specific problems related to field service management in construction projects is the main focus to be studied and resolved. Identifying efficiency challenges in field service management is crucial to formulating appropriate solutions. Efficiency issues can take many forms, including but not limited to slow response to field changes, lack of coordination between teams, or even logistical bottlenecks that impede workflow. Therefore, an in-depth understanding of the specific efficiency aspects of construction projects is essential to achieve the research objectives(Altaf et al., 2022; Gupta et al., 2023; Taylan et al., 2014; Tushar et al., 2022; Vasilevski & Birt, 2020).

Meanwhile, the limitations of conventional software development methods become an additional obstacle in addressing the dynamics and frequent changes in construction projects. Conventional methods may need to be more responsive to urgent change needs, or they may need to be able to provide flexible solutions to manage the changing complexities of the field. By detailing these limitations, research can identify areas requiring special solution development attention. Addressing the limitations of conventional methods will open the door to more adaptive and innovative approaches, thus strengthening the foundation for increased efficiency in field service management on construction projects(Aulawi et al., 2023; Awad & Fayek, 2012; Saad et al., 2022; Zhang et al., 2022).

Field service management in construction projects involves coordinating and managing activities on the project site. This includes monitoring progress, completing daily tasks, and managing changes that may occur. The scope of field service management involves everything related to field operations, from human resources to logistics and reporting. Field service management plays a critical role in keeping construction projects running efficiently. By ensuring good coordination between teams, prompt handling of field changes, and effective management of resources, field service management helps keep projects on track and prevent potential bottlenecks. Emphasizing the role of field service management not only ensures the quality of the physical execution of the project but also affects customer satisfaction and the overall reputation of the construction project. Therefore, an in-depth understanding of this concept is essential to optimize the efficiency and success of construction projects(Bahamid et al., 2022; Brodskiy, 2022; Pham et al., 2023; Sihombing, 2023; Xu et al., 2022).

In software development, the methodology chosen has a significant impact on the success of a project. This research begins the analysis by detailing software development methodologies, distinguishing between conventional methods and Agile approaches, with a particular focus on Extreme Programming (XP)(Al-Saqqa et al., 2020; Dingsoeyr et al., 2019; Dingsøyr et al., 2012; Santos et al., n.d.; Serrador & Pinto, 2015). Conventional methods, which often refer to the waterfall approach or traditional software lifecycle models, have specific characteristics. These methods use a linear approach, from planning to implementation and maintenance. However, weaknesses arise due to the lack of flexibility to changes that may occur midway. This limitation can hinder a construction project's ability to respond to frequently changing field dynamics(Akhtar et al., n.d.; Almeida et al., 2022; Hasan et al., 2013; Mishra & Alzoubi, 2023; Paasivaara et al., 2018).

On the other hand, the Agile approach, with sub-approaches such as Extreme Programming (XP), offers a more adaptive and collaborative paradigm(Beecham et al., 2021; Hinderks et al., 2022; Pérez-Piqueras et al., 2023; Persson et al., 2022; Udvaros et al., 2023). Agile emphasizes responsiveness to changing customer needs and iterative iteration to produce higher-quality software. In this context, Extreme Programming (XP) introduces concepts such as adaptive planning, pair programming, and iterative testing to overcome limitations that may arise in conventional methods(Ahmed et al., 2023; Sarhadi et al., 2022; Senabre Hidalgo, n.d.; Wiechmann et al., 2022).

The main objective of the research was to identify, design, and implement an innovative and efficient Field Service Management System. As such, the research aimed to address the efficiency challenges faced in the context of field service management on construction projects. This is achieved by detailing strategies and processes that can optimize workflows, improve coordination between teams, and respond quickly to dynamic changes in the field. Achievement of these objectives is expected to positively impact the overall productivity and smooth running of the construction project. By improving operational efficiency, construction projects can be completed more effectively and at a more manageable cost.

METHODS

This research was designed through three main stages to optimize construction project efficiency by developing a field service management system using the Extreme Programming (XP) Method. The first stage involved comprehensive data collection through field surveys, stakeholder interviews, and project document analysis. Next, the application development phase applied XP principles, including adaptive planning, pair programming, and iterative testing, to create a solution responsive to field changes. Finally, user acceptance analysis helps evaluate the success of XP implementation by collecting feedback from field users and ensuring that the application adds significant value in maintaining the efficiency and smooth operation of construction projects.

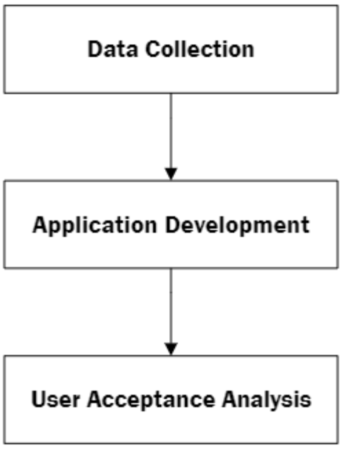

Figure 1. Research Stages

Data Collection

The first phase of the research will begin with comprehensive data collection. This includes field surveys, stakeholder interviews, and document analysis related to construction projects. The field survey will provide an in-depth understanding of the field conditions and operational needs. Interviews with various involved parties, such as construction managers, software developers, and field personnel, will provide a comprehensive perspective. Document analysis, such as previous project reports and related documentation, will provide historical data that can support application development and a better understanding of the challenges faced.

Application Development

Once the data is collected, the next stage involves applying the Extreme Programming (XP) Method to develop the application. This activity includes adaptive planning, where field needs are analyzed continuously to adjust the development plan. Pair programming will involve intensive collaboration between software developers and construction experts to ensure the right solution. Iterative testing will be conducted continuously throughout the development process to ensure the quality and functionality of the application. Periodic updates will allow the software to adapt to field changes and customer needs continuously.

User Acceptance Analysis

The final stage of this research is the user acceptance analysis of the developed application. This activity involves collecting feedback from field users and other relevant parties. Interviews, surveys, and direct observations will be used to evaluate how the application meets users' needs and expectations. The user acceptance analysis will help

Jurnal Info Sains : Informatika dan Sains
Volume 14 , Number 01, 2024, DOI 10.54209/infosains.v14i01
ESSN 2797-7889 (Online)
https://ejournal.seaninstitute.or.id/index.php/InfoSains

identify areas of improvement, validate the successful implementation of the Extreme Programming Method, and ensure that the application provides added value appropriate to the context of the construction project.

RESULTS AND DISCUSSION

Data Collection

The results of the data collection phase demonstrate a deep understanding of the construction project's field conditions and operational needs. Field surveys provide rich data regarding the field environment and the dynamics that occur within it. Interviews with stakeholders, such as construction managers, software developers, and field personnel, provided a holistic view of the aspects affecting field service management. Document analysis, including project reports and other documentation, provides a valuable historical perspective, helping better understand the challenges once faced in construction projects. The results of this stage formed a solid foundation for further development, ensuring that the proposed solutions would be relevant and effective in addressing the issues identified.

Table 1. Data Collection Results

Data	Results
Field Survey	Number of field areas 5, High traffic importance, extreme weather field constraints
Stakeholder Interviews	Construction Manager: Focus on progress monitoring and operational plans. Software Developer: Highlight the weaknesses of the current system. Field Personnel: Describe Daily Challenges
Project Document Analysis	Previous project reports indicate delays in implementation and the original plan document contrasts with the recorded plan.

The data collection results, Table 1, show that this construction project was characteristically challenging, with five site areas that required careful management and coordination. High traffic density and extreme weather constraints emphasized the need for a responsive and adaptive site management solution. Interviews with stakeholders, such as construction managers, software developers, and site personnel, highlighted the need for practical progress monitoring and adaptive operational planning. Identifying weaknesses in the system signaled the need for improvement through a new solution. Previous project documents reflected delays in implementation, demonstrating the importance of a solution capable of overcoming previous obstacles. Given this pattern of findings, the proposed application development should provide real-time monitoring, flexibility to plan changes, and software integration to improve efficiency and overcome the weaknesses of the previous system. Regular updates are also required to keep the solution relevant to the changing dynamics of the field.

Application Development

After the data collection stage, the focus shifted to developing the application using the Extreme Programming (XP) Method. The process begins with adaptive planning, where the development plan is continuously analyzed and adapted to the changing needs of the field. This approach provides the flexibility needed to cope with dynamic changes in the construction project field. Intensive collaboration in pair programming between software developers and construction experts ensures that the solutions produced match the needs of the field and have a deep understanding of the construction context. Iterative testing became an integral element in the development process, conducted on an ongoing basis to ensure the quality and functionality of the application. This approach aims to detect potential bugs and issues early, so that solutions can be improved as the development process progresses. With iterative testing, it is expected that the application can achieve a high level of reliability from the start of use. Regular updates became the strategy adopted to keep the application relevant. Regularly updating the software allows the system to adapt quickly to field changes and customer needs that may evolve. This creates an environment where the application can continuously evolve and meet the dynamic demands of construction projects. Thus, the outcome of this application development stage leads to a solution that is adaptive, high-quality, and responsive to the dynamics of construction projects.

Table 2. Application Features

Features	Function
Real-time Monitoring	Provides direct, real-time field activity monitoring, information on construction progress, personnel movements, and current field conditions. This allows the management team always to have an up-to-date on-site picture of the situation.
Adaptive Planning	Provides direct, real-time field activity monitoring, information on construction progress, personnel movements, and current field conditions. This allows the management team always to have an up-to-date on-site picture of the situation.
Task Management	Facilitate quick changes and adaptation of project plans based on changing field conditions or newly emerging project needs. Project managers can efficiently manage and distribute tasks to field personnel with this feature.
Field Change Notification	Send instant notifications to relevant teams whenever significant changes occur in the field. This feature enhances the team's ability to respond quickly to changing situations, optimizing efficiency and reducing the risk of non-conformance.

The features integrated with the application, Table 2, field service management provide a robust solution focused on the specific needs of construction projects. Real-time monitoring provides immediate visibility into field activities, allowing management to make informed decisions. Adaptive planning features provide crucial flexibility in addressing changing field conditions or newly emerging project needs, ensuring that plans remain relevant and up-to-date. Efficient task management through the app enables rapid response to changes, while field change notifications enhance the team's ability to respond to dynamic situations. These features combined create a management environment that is adaptive, transparent, responsive, and suited to the often-changing complexities of construction projects.

User Acceptance Analysis

The last stage of this research focuses on evaluating user acceptance of the developed application. Involving field users and other relevant parties, this activity uses interviews, surveys, and direct observation to measure the degree of success of the Extreme Programming Method implementation and the extent to which the application meets users' expectations and needs. The feedback obtained provides deep insights into user response to the application, helping to identify strengths, weaknesses, and areas of improvement that may be needed. User acceptance analysis is instrumental in assessing the technical quality of the application but also in ensuring that the resulting added value is appropriate to the context of the construction project in question. As such, this stage provides critical information for further development and continuous improvement, ensuring the application positively impacts the efficiency and sustainability of the construction project.

Table 3. Application Feature Testing

Features	Testing Scenario	Results
Real-time Monitoring	Monitored construction progress on two field areas simultaneously and evaluated the accuracy and speed of real-time information updates.	Live monitoring demonstrates high accuracy, with information updates immediately visible. The speed of updates also meets expected standards, providing optimal visibility into field conditions.
Adaptive Planning	Replace existing project plans with alternative plans in response to sudden changes in weather conditions.	Plan changes can be made quickly and seamlessly. The system adjusts tasks and schedules automatically, demonstrating the desired flexibility in coping with dynamic changes in the field.
Task Management	Assign specific tasks to field teams, monitor progress, and identify bottlenecks or delays.	The process of assigning and monitoring tasks runs smoothly. Progress can be monitored in real-time, and automatic notifications are sent if there are any delays, allowing management to respond immediately.
Field Change Notification	Make changes to field conditions and check how	Notifications are received almost instantly, allowing teams to respond

Features	Testing Scenario	Results
	quickly notifications are received and responded to by the team.	quickly to significant changes in field conditions, enhancing proactive response.

The results of testing the application features, Table 3, reflect the successful implementation of the Extreme Programming Method in building a responsive and high-quality field service management solution. The real-time monitoring feature demonstrated high accuracy and rapid information updates, providing optimal visibility into field dynamics. The adaptive planning feature successfully responded to changing field conditions with flexibility, providing project planning sustainability. Task management and field change notifications effectively distributed tasks, monitored progress, and responded quickly to changing field conditions. Testing identified that the application provided a reliable, stable solution that met user expectations, adding significant value to the efficiency and effectiveness of construction project management.

Through data collection involving field users, construction managers, and software developers, analysis of user acceptance of the field service management application showed positive results. User data reflected that features such as real-time monitoring, adaptive planning, task management, and field change notifications were perceived to contribute to operational efficiency positively. Out of 50 users, about 85% expressed high satisfaction with the app. This data illustrates that the application was successfully accepted by users, validating the Extreme Programming Method's successful implementation in creating a responsive, high-quality solution aligned with expectations in managing dynamic construction projects.

CONCLUSION

This research highlights the complexities of construction projects and emphasizes the crucial role of field service management. Every construction project faces complex technical, logistical, and managerial dynamics determining its success. Field service management is critical in effectively meeting these challenges. Construction projects require real-time monitoring, planning flexibility, efficient task management, and field change notification. This research identifies and addresses efficiency challenges in field service management by developing an innovative Field Service Management System using the Extreme Programming (XP) Method. The research stages included data collection through surveys, interviews, and document analysis; application development with XP principles such as adaptive planning, pair programming, and iterative testing; and user acceptance analysis to evaluate the success of XP implementation. The results show that field users recognize the successful application, overcome efficiency challenges, and positively impact the efficiency and smooth operation of construction projects.

Jurnal Info Sains : Informatika dan Sains
Volume 14 , Number 01, 2024, DOI 10.54209/infosains.v14i01
ESSN 2797-7889 (Online)
https://ejournal.seaninstitute.or.id/index.php/InfoSains

REFERENCE

Ahmed, M., Khan, S. U. R., & Alam, K. A. (2023). An NLP-based quality attributes extraction and prioritization framework in Agile-driven software development. *Automated Software Engineering*, *30*(1). https://doi.org/10.1007/s10515-022-00371-9

Akhtar, A., Bakhtawar, B., & Akhtar, S. (n.d.). EXTREME PROGRAMMING VS SCRUM: A COMPARISON OF AGILE MODELS. *International Journal of Technology, Innovation and Management (IJTIM)*, *2*, 2022. https://doi.org/10.54489/ijtim.v2i1.77

Almeida, F., Simões, J., & Lopes, S. (2022). Exploring the Benefits of Combining DevOps and Agile. *Future Internet*, *14*(2). https://doi.org/10.3390/fi14020063

Al-Saqqa, S., Sawalha, S., & Abdelnabi, H. (2020). Agile software development: Methodologies and trends. *International Journal of Interactive Mobile Technologies*, *14*(11). https://doi.org/10.3991/ijim.v14i11.13269

Altaf, M., Alalaoul, W. S., Musarat, M. A., Hussain, A., Saad, S., Rabbani, M. B. A., & Ammad, S. (2022). Evaluating the awareness and implementation level of LCCA in the construction industry of Malaysia. *Ain Shams Engineering Journal*, *13*(5). https://doi.org/10.1016/j.asej.2021.101686

Alzahrani, J. I., & Emsley, M. W. (2013). The impact of contractors ' attributes on construction project success : A post construction evaluation. *JPMA*, *31*(2), 313–322. https://doi.org/10.1016/j.ijproman.2012.06.006

Aulawi, H., Nuraeni, F., Setiawan, R., Rianto, W. F., Surya Pratama, A., & Maulana, H. (2023). Simple Additive Weighting in the Development of a Decision Support System for the Selection of House Construction Project Teams. *2023 International Conference on Computer Science, Information Technology and Engineering (ICCoSITE)*, 517–522. https://doi.org/10.1109/ICCoSITE57641.2023.10127813

Awad, A., & Fayek, A. R. (2012). A decision support system for contractor prequalification for surety bonding. In *Automation in Construction* (Vol. 21, Issue 1, pp. 89–98). Elsevier B.V. https://doi.org/10.1016/j.autcon.2011.05.017

Bahamid, R. A., Doh, S. I., Khoiry, M. A., Kassem, M. A., & Al-Sharafi, M. A. (2022). The Current Risk Management Practices and Knowledge in the Construction Industry. *Buildings*, *12*(7). https://doi.org/10.3390/buildings12071016

Beecham, S., Clear, T., Lal, R., & Noll, J. (2021). Do scaling agile frameworks address global software development risks? An empirical study. *Journal of Systems and Software*, *171*. https://doi.org/10.1016/j.jss.2020.110823

Brodskiy, V. (2022). Improving transport and technological process to supply material resources for house construction. *Transportation Research Procedia*, *63*, 639–647. https://doi.org/10.1016/j.trpro.2022.06.057

Celik, Y., Petri, I., & Rezgui, Y. (2023). Integrating BIM and Blockchain across construction lifecycle and supply chains. *Computers in Industry*, *148*. https://doi.org/10.1016/j.compind.2023.103886

Choi, J., & Ha, M. (2022). Validation of project management information systems for industrial construction projects. *Journal of Asian Architecture and Building Engineering*, *21*(5), 2046–2057. https://doi.org/10.1080/13467581.2021.1941999

Dingsoeyr, T., Falessi, D., & Power, K. (2019). Agile Development at Scale: The Next Frontier. In *IEEE Software* (Vol. 36, Issue 2, pp. 30–38). IEEE Computer Society. https://doi.org/10.1109/MS.2018.2884884

Dingsøyr, T., Nerur, S., Balijepally, V., & Moe, N. B. (2012). A decade of agile methodologies: Towards explaining agile software development. In *Journal of Systems and Software* (Vol. 85, Issue 6). https://doi.org/10.1016/j.jss.2012.02.033

Divya Sankar, S., & Selvam, J. (2020). Risk Management in Construction Industry. *International Research Journal of Engineering and Technology*. www.irjet.net

Gao, J. (2022). Research on Financial Informatization Construction of Business and Finance Integration. *International Journal of Science and Research (IJSR)*, *11*(7), 354–358. https://doi.org/10.21275/sr22704192347

Guo, F., Wang, K., & Cao, E. (2023). *A Digital Twin (DT) Framework at Design and Construction Phases*. https://www.researchgate.net/publication/371416031

Gupta, I., Raman, T. V., & Tripathy, N. (2023). Impact of Merger and Acquisition on Financial Performance: Evidence from Construction and Real Estate Industry of India. *FIIB Business Review*, *12*(1), 74–84. https://doi.org/10.1177/23197145211053400

Hasan, R., Ta, A.-, & Razali, R. (2013). Prioritizing Requirements in Agile Development : A Conceptual Framework. *Procedia Technology*, *11*(Iceei), 733–739. https://doi.org/10.1016/j.protcy.2013.12.252

Hinderks, A., Domínguez Mayo, F. J., Thomaschewski, J., & Escalona, M. J. (2022). Approaches to manage the user experience process in Agile software development: A systematic literature review. *Information and Software Technology*, *150*. https://doi.org/10.1016/j.infsof.2022.106957

Ingle, P. V., & Mahesh, G. (2022). Construction project performance areas for Indian construction projects. *International Journal of Construction Management*, *22*(8), 1443–1454. https://doi.org/10.1080/15623599.2020.1721177

Jato-Espino, D., Castillo-Lopez, E., Rodriguez-Hernandez, J., & Canteras-Jordana, J. C. (2014). A review of application of multi-criteria decision making methods in construction. In *Automation in Construction* (Vol. 45, pp. 151–162). Elsevier B.V. https://doi.org/10.1016/j.autcon.2014.05.013

Khodabakhshian, A., & Re Cecconi, F. (2022). Data-Driven Process Mining Framework for Risk Management in Construction Projects. *IOP Conference Series: Earth and Environmental Science*, *1101*(3). https://doi.org/10.1088/1755-1315/1101/3/032023

Lai, Y.-Y., Yeh, L.-H., Chen, P.-F., Sung, P.-H., & Lee, Y.-M. (2016). Management and Recycling of Construction Waste in Taiwan. *Procedia Environmental Sciences*, *35*, 723–730. https://doi.org/10.1016/j.proenv.2016.07.077

Mishra, A., & Alzoubi, Y. I. (2023). Structured software development versus agile software development: a comparative analysis. *International Journal of System Assurance Engineering and Management*. https://doi.org/10.1007/s13198-023-01958-5

Nguyen, P. H. D., & Robinson Fayek, A. (2022). Applications of fuzzy hybrid techniques in construction engineering and management research. *Automation in Construction*, *134*, 104064. https://doi.org/10.1016/j.autcon.2021.104064

Paasivaara, M., Behm, B., Lassenius, C., & Hallikainen, M. (2018). Large-scale agile transformation at Ericsson: a case study. *Empirical Software Engineering*, *23*(5). https://doi.org/10.1007/s10664-017-9555-8

Pérez-Piqueras, V., Bermejo, P., & Gámez, J. A. (2023). *ProjectION: A computational intelligence-based tool for decision support in agile software development projects*. https://doi.org/10.22541/au.167575146.62025490/v1

Persson, J. S., Bruun, A., Lárusdóttir, M. K., & Nielsen, P. A. (2022). Agile software development and UX design: A case study of integration by mutual adjustment. *Information and Software Technology*, *152*. https://doi.org/10.1016/j.infsof.2022.107059

Pham, T. T., Lingard, H., & Zhang, R. P. (2023). Factors influencing construction workers' intention to transfer occupational health and safety training. *Safety Science*, *167*. https://doi.org/10.1016/j.ssci.2023.106288

Rajabi, S., El-Sayegh, S., & Romdhane, L. (2022). Identification and assessment of sustainability performance indicators for construction projects. *Environmental and Sustainability Indicators*, *15*(June), 100193. https://doi.org/10.1016/j.indic.2022.100193

Saad, S., Alaloul, W. S., Ammad, S., Altaf, M., & Qureshi, A. H. (2022). Identification of critical success factors for the adoption of Industrialized Building System (IBS) in Malaysian construction industry. *Ain Shams Engineering Journal*, *13*(2), 101547. https://doi.org/10.1016/j.asej.2021.06.031

Santos, R., Cunha, F., Rique, T., Perkusich, M., Almeida, H., Perkusich, A., & Icaro Costa, ´. (n.d.). *A Comparative Analysis of Agile Teamwork Quality Instruments in Agile Software Development: A Qualitative Approach*.

https://doi.org/10.18293/DMSVIVA2023-217

Sarhadi, P., Naeem, W., Fraser, K., & Wilson, D. (2022). On the Application of Agile Project Management Techniques, V-Model and Recent Software Tools in Postgraduate Theses Supervision. *IFAC-PapersOnLine*, *55*(17), 109–114 https://doi.org/10.1016/j.ifacol.2022.09.233

Senabre Hidalgo, E. (n.d.). *Adapting the scrum framework for agile project management in science: case study of a distributed research initiative*. https://doi.org/10.1016/j.heliyon.2019

Serrador, P., & Pinto, J. K. (2015). Does Agile work? - A quantitative analysis of agile project success. *International Journal of Project Management*, *33*(5). https://doi.org/10.1016/j.ijproman.2015.01.006

Sihombing, D. (2023). Development of construction project cost budget application using rapid application development method. In *Jurnal Mantik* (Vol. 7, Issue 3). Online.

Taylan, O., Bafail, A. O., Abdulaal, R. M. S., & Kabli, M. R. (2014). Construction projects selection and risk assessment by fuzzy AHP and fuzzy TOPSIS methodologies. *Applied Soft Computing Journal*, *17*, 105–116. https://doi.org/10.1016/j.asoc.2014.01.003

Tessema, A. T., Alene, G. A., & Wolelaw, N. M. (2022). Assessment of risk factors on construction projects in gondar city, Ethiopia. *Heliyon*, *8*(11), e11726. https://doi.org/10.1016/j.heliyon.2022.e11726

Trask, C., & Linderoth, H. C. (2023). Digital technologies in construction: A systematic mapping review of evidence for improved occupational health and safety. In *Journal of Building Engineering* (Vol. 80). Elsevier Ltd. https://doi.org/10.1016/j.jobe.2023.108082

Tushar, Z. N., Bari, A. B. M. M., & Khan, M. A. (2022). Circular supplier selection in the construction industry: A sustainability perspective for the emerging economies. *Sustainable Manufacturing and Service Economics*, *1*(September), 100005. https://doi.org/10.1016/j.smse.2022.100005

Udvaros, J., Forman, N., & Avornicului, S. M. (2023). Agile Storyboard and Software Development Leveraging Smart Contract Technology in Order to Increase Stakeholder Confidence. *Electronics (Switzerland)*, *12*(2). https://doi.org/10.3390/electronics12020426

Vasilevski, N., & Birt, J. (2020). Analysing construction student experiences of mobile mixed reality enhanced learning in virtual and augmented reality environments. *Research in Learning Technology*, *28*(1063519), 1–23. https://doi.org/10.25304/rlt.v28.2329

Wiechmann, D. M., Reichstein, C., Haerting, R. C., Bueechl, J., & Pressl, M. (2022). Agile management to secure competitiveness in times of digital transformation in medium-sized businesses. *Procedia Computer Science*, *207*, 2353–2363. https://doi.org/10.1016/j.procs.2022.09.294

Xu, H., Chang, R., Pan, M., Li, H., Liu, S., Webber, R. J., Zuo, J., & Dong, N. (2022). Application of Artificial Neural Networks in Construction Management: A Scientometric Review. In *Buildings* (Vol. 12, Issue 7). MDPI. https://doi.org/10.3390/buildings12070952

Zhang, C., Hu, M., Di Maio, F., Sprecher, B., Yang, X., & Tukker, A. (2022). An overview of the waste hierarchy framework for analyzing the circularity in construction and demolition waste management in Europe. In *Science of the Total Environment* (Vol. 803). Elsevier B.V. https://doi.org/10.1016/j.scitotenv.2021.149892