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Comparative Analysis of Data Driven Software Tools in Asian Countries: Advancing the Development of Engineering Projects

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Abstract

A number of software tools are developed to improve the quality of the products developed in various fields of life, including engineering. The main purpose of the data-driven software tools the engineers design is to develop products on time with the requirements and specifications given by the customers. The most famous data-driven software tools specialized for engineering projects are AutoCAD, CATIA, Primavera, and ZW3D, which are widely considered good and appropriate tools in Asian countries for working on civil, electrical, and mechanical projects. Each software tool has unique characteristics; some of them are useful for civil engineering projects, while others are good for mechanical and electrical engineering projects. The main objective of conducting this research is to determine the best data-driven engineering tool. In this research, quantitative research methodology through survey techniques is employed for data collection. Data was collected from the already-existing users of the above-mentioned engineering tools. The resultant data is statistically analyzed. The results of the current study show that CATIA is better and preferable in terms of all identified features. However, with respect to robustness, Primavera is found to be slightly higher than CATIA. The results of this study aim to assist engineers, especially in Asian countries, in selecting appropriate tools for their data-driven engineering projects and thus be more effective and efficient in the engineering process.

Keywords: Data driven; Software tools; Engineering projects; Comparative analysis; Asian countries; Engineering development

INTRODUCTION

In the engineering domain, engineers are working on different aspects of projects that require a considerable amount of effort to complete the requirements given by the organizations. These

project requirements are based on 2D and 3D models, drawings, and simulations. Mostly, the engineers prefer to use the latest tools for working on this dimensional arrayed work (Akanbi et al., 2022; Richardson et al., 2008). Various domains like healthcare, agriculture, retail, and whole-sale businesses are already using different tools and changing the way of traditional operations (Araújo et al., 2021; Hearn et al., 2004; McEliece, 2012). There are currently a lot of tools available for this task. However, the availability of a myriad of tools presents a challenge for engineers to understand and choose tools appropriately. This calls for considering several features of the project: team, organization, time and financial constraints, and the tools themselves. Although most of the available tools support necessary functionalities and offer desired features, it is still an important activity to cross-compare these tools and identify the most preferred one with most of the features in one place (Peccati et al., 2011; Vieira et al., 2003). This will help the engineers save their development time, costs, and efforts with tight deadlines and budgetary conditions.

In the field of engineering, there is a vast use of tools and applications that make the engineering work possible to undertake. Also, there has been a lot of research in this direction. A comprehensive study of the available tools and applications for engineering projects is given by Mentor (Lorenzoni et al., 2021; Meyer, 2001). The study has offered a theoretical framework for understanding the nature and fieldwork of engineering projects. Similarly, Thakur (Akinbi et al., 2021; Thakur, 2013) has surveyed CAD models and provided a list of models that can be leveraged for modeling and designing computer-based applications with respect to the pitch of each engineering field. According to this study, the models can be categorized into two categories, including the simulation-based model and the technique-based model. The authors have stated that the models measure different aspects; however, a very minor pitch can be observed in terms of their data visualization. Likewise, Simpson (Devendorf et al., 2009) has suggested adopting a statistical approach for data analysis by analyzing various 2D and 3D techniques. It is suggested that, as most applications are based on statistical rules, engineers should prefer to use CAD tools such as AutoCAD and CATIA, as they offer consistent design and development of engineering applications.

As a result, there are currently many tools available for the development of engineering projects. While these tools offer support for all essential functions, they are slightly different in terms of their support for different engineering domains such as civil, mechanical, electrical, etc. The most widely used tools in this regard are AutoDesk, MATLAB, AUTOCAD, CATIA, ZW3D, MechDesigner, PTC, Brics, and Solid Works. A well-known problem with these listed tools is that they do not support 3D rotation and precision. Therefore, they do not enable the development of engineering projects that require 3D view, plug-in support to fit different environments, and import/export features after finalizing the project.

In this regard, the main objective of the current study is to comparatively analyze the most promising data-driven software tools available for developing engineering projects. The study analyzes four of these tools, including AutoCAD, Primavera, CATIA, and ZW3D. The tools are analyzed in terms of five key attributes: usability, understandability, precision, functionality, and robustness. The results are quantitatively analyzed. The conclusions drawn herein are targeted at helping the software engineers choose the best tool for their project according to various project requirements. Similarly, the study advances scientific literature on the topic and provides a conclusive description of the included tools.

Modern engineering and construction projects heavily rely on data-driven software solutions. The way engineers and architects plan, create, and manage construction projects has been changed by the software tools available, which include AutoCAD, Primavera, and many more. This part of the paper provides a summary of the main characteristics, advantages, and difficulties of data-driven engineering software solutions. This paper mostly focuses on AutoCAD and Primavera, two well-known tools used frequently in the industry. One of the most popular computer-aided design (CAD) software programs in the engineering and architecture fields is

AutoCAD, created by Autodesk. It offers a complete platform for producing 2D and 3D drawings and models for engineers and architects. By providing a wide range of tools and features, such as parametric modeling and dynamic blocks, which allow engineers to easily build complicated designs, AutoCAD considerably increases design efficiency (Smith 2018). AutoCAD makes it easier for project teams to work together by enabling real-time design file sharing and editing, which minimizes misunderstandings and mistakes. Engineers are able to make data-driven decisions during the design and planning phases thanks to the integration of AutoCAD with data analysis and visualization technologies. According to some research, AutoCAD has a steep learning curve and requires continual training in order to reach its full potential (Brown & Johnson 2020). Working with different CAD software versions may also cause software compatibility problems.

Another software tool that also acts as a key component of data-driven project management is Primavera, which is an Oracle tool (Li & Wu 2017). A number of different data-driven engineering software applications and tools are available in addition to AutoCAD and Primavera to address various areas of engineering and building projects. Software for building information modeling (BIM), GIS, and specialized analysis programs are a few examples of these tools. BIM solutions, like Autodesk Revit, enable multidisciplinary collaboration and data-rich 3D modeling, providing a comprehensive approach to design and construction. Spatial analysis, site selection, and infrastructure planning all require GIS software, such as ArcGIS (ESRI 2021). Engineering designs are more accurate and reliable thanks to the enhanced structural and mechanical analysis provided by tools like ANSYS and ETABS (ANSYS 2022). This wide range of available software tools has issues with interoperability, and there is a need for specialized training for their users.

The remainder of the paper is structured as follows: Section 2 presents a methodological approach. Results are presented and discussed in Section 3. The paper concludes with an outlook for future research in Section 4.

DATA DESCRIPTION AND METHODOLOGY

The main objective of conducting this research is to determine the best engineering tool. In this research, a quantitative research methodology is applied. A quantitative survey technique is used for data collection. Data was collected from already-existing users of the engineering tools and then analyzed with the help of statistical analysis. Figure 1 shows the overall procedure of this study.

In terms of this study, four tools have been selected for analysis and cross-comparison. The included tools are AUTOCAD, Primavera, CATIA, and ZW3D. The tools are being analyzed with respect to five different attributes, including usability, understandability, precision, functionality, and robustness. These parameters are chosen because they are most common and form the basis for the selection of various tools. Furthermore, literature also suggests the importance of these parameters and the foremost reference given to them.

The data for the analysis has been collected from participants of different public or private universities and software development houses and centers within the Sindh region of the developing country of Pakistan. In total, 8 institutions have been included, comprising 4 universities and 4 software companies. Moreover, practitioners at different levels have been chosen for data collection according to their knowledge of the domain and experience with the application of engineering tools under study. The different participant groups included project managers (12 participants), software designers (26 participants), software developers (45 participants), and faculty members of higher education institutions (67 participants). In total, 150 participants were included for data collection purposes. The data is analyzed and presented for each tool separately and aggregately for all tools in terms of all five included aspects (See figure 1).

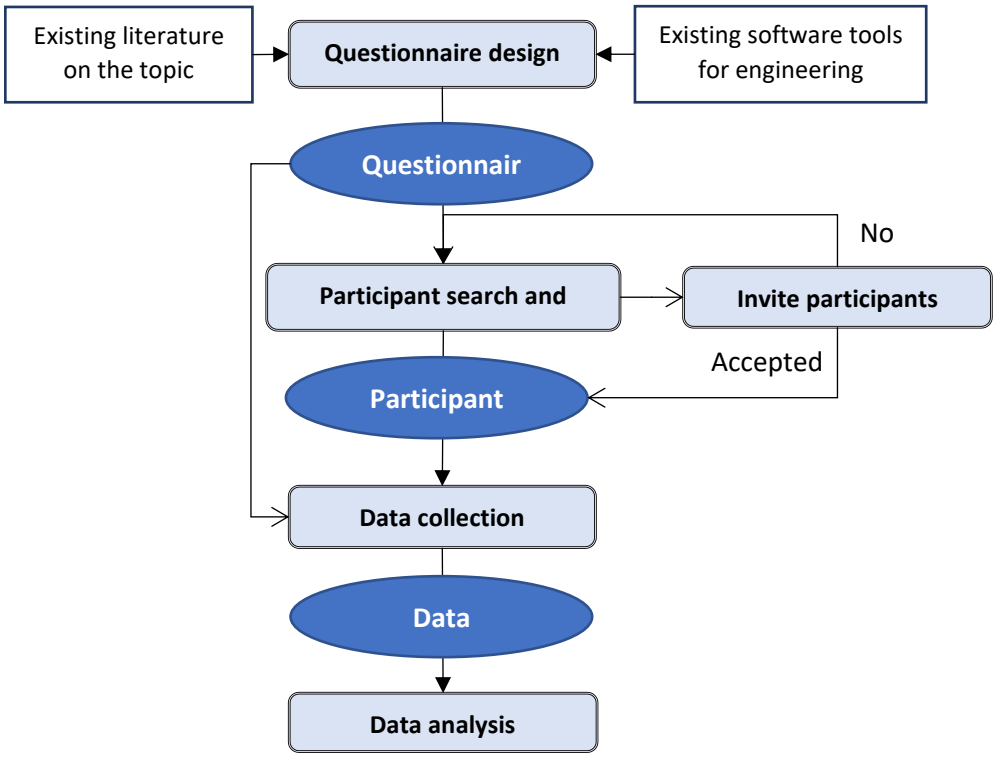

Figure 1.
Overall research procedure of the study

RESULTS AND DISCUSSION

Table 1 shows the results of data analysis in terms of identified attributes of all included tools. The data is presented in percentage with respect to each participant group of the study and on average across the study sample of 150 participants.

AutoCAD

As given in Table 1, from the usability perspective, the rating of AutoCAD tool varies between 62% and 84%. It is important to note here that 62% usability is provided by the faculty members who are a bit less involved with the practical work among our study participant groups. On the contrast, the tool has received 84% by the software developers who are directly involved with the development work with these tools and better understand the external and internal parameters of the tools and are better considered to assess the usability of the tool. Form the understandability perspective, the AutoCAD is marked between 73% and 91%. Again, the software developers have reported this tool more understandable. The reported 91% understandability of this tool by the software developers is noteworthy as they are often presented with many projects on daily basis with varying requirement and compilation and debugging procedures. It is also worth mentioning here that faculty members have also marked the tool understandable with about 80% as their lectures and class room practices are also more concerned with the understanding of the tools and their ease of elaboration. From the precision perspective, the AutoCAD tool is rated between 91% and 100%. It is very important to note here that it is found most precision tool according to faculty members and softer designers, also it is marked 98% precision oriented by the software developers. From the functionality perspective, the AutoCAD varies between 86% and 91%. The functionality of the tool is often considered primary factor as without supporting required functionality, tool is not applicable in a particular context. Having functionality described as more

than 80% by different participants shows that the AutoCAD tool offers state of the art functionality except desired support for few tasks. The last attribute is the robustness which is an important attribute as it allows the tool to switch between different user views, switch the application/project from one working environment to another, and the like. This supports the flexibility and portability with is highly required in current ages especially where the project work is divided among different teams located at different places. The results show that the robustness of AutoCAD tool varies between 96% and 100%. The result demonstrate that the tool is robust from different aspects of operation offering easy to sue drag and drop facility and participants reported that most of the functionalities re flexible to execute within the tool.

Primavera

As shown in Table 1, the evaluation results of Primavera are generally not good as compared to AutoCAD, however, it is better in few perspectives which are important to note for the engineers. In terms of first evaluation aspect of Usability, the tool is rated 58.33% usable by the software project managers, 76.92% by the software designers, 88.89% by the software developers, and 71.64% by the faculty members of HEIs. Overall, Primavera is rated as 76.66% in terms of usability which is slightly feature boosted but yet below the expected usability level. In terms of second evaluation parameter of understandability, the primavera is reported as 75% usable by software project managers, 76.92% by software designers, 86.67% by software developers, and 70.14% by faculty members of HEIs. The important aspect to note here is that the tool is perceived more usable by the software developers as they are more familiar with the use of the tool than any other participant group. In terms of third aspect of precision, primavera has achieved 91.67% reported precision by the software project managers, 96.15% by software designers, 95.56% by software developers, and 91.04% by faculty members of HEIs. The results indicate that primavera works well with the correction functionalities and ensures that for engineering projects it is better than others with respect to precision angle. With respect to fourth aspect of functionality for engineering projects, primavera is reported 83.33% with key features by the software project managers, 92.3% by software designers, 93.33% by software developers, and 89.55% by faculty members of HEIs. In terms of last evaluation aspect of robustness, primavera is equally rated 100% by all participant groups. This clearly indicated the robustness of this tool and makes it preferable to adopt comfortable for working on any type of engineering project where robustness is key required aspect.

CATIA

As given in Table 1, the next tool CATIA in terms of usability received 83.33% score from software project managers, 80.76% by software designers, 91.11% by software developers, and 92.53% by faculty members of HEIs. The results show that CATIA is really useful as users provide a satisfactory ratio. According to the understandability aspect, the CATIA is found 91.67% usable by the software project managers, 92.03% by software designers, 95.55% by software developers, and 94% by faculty members of HEIs. Receiving more than 90% score from all participant groups shows that the CATIA tools is understandable while applying it to different engineering projects and explaining it in class rooms during engineering related lecturers. In terms of third variable of precision, the CATIA has received 91.67% score from software project managers, 96.15% from software designers, 97.78% by software developers, and 98.5% from faculty members of HEIs. The results show that the tool is with more precision than the others while working on modeling and design evaluation tasks of engineering projects. In terms of functionality aspect, CATIA has received 91.67% score by software project managers, 88.46% from software designers, 95.56% from software developers, and 77.61% from faculty members of HEIs. Whereas, in terms of robustness, the CATIA is rated with 91.66% score by software project managers, 100% from software designers, 97.78% from software developers, and 98.5% from faculty members of HEIs. This shows that the tool is much robust and preferable in this aspect.

Table 1.
Comparative analysis of software tools for engineering projects

Criteria	Participants	Results (in %)			
		AutoCAD	Primavera	CATIA	ZW3D
Usability	Project managers (N = 12)	75.00	58.33	83.33	66.67
	Software designers (N = 26)	76.92	76.92	80.76	73.07
	Software developers (N = 45)	84.44	88.89	91.11	84.44
	Faculty members (N = 67)	62.69	71.64	92.53	82.08
	Average (N = 150)	**72.66**	**76.66**	**89.32**	**79.99**
Understandability	Project managers (N = 12)	83.33	75.00	91.67	91.67
	Software designers (N = 26)	73.07	76.92	92.30	88.46
	Software developers (N = 45)	91.11	86.67	95.55	95.55
	Faculty members (N = 67)	79.10	70.14	94.00	88.05
	Average (N = 150)	**81.99**	**76.66**	**90.66**	**90.66**
Precision	Project managers (N = 12)	91.67	91.67	91.67	100.00
	Software designers (N = 26)	100.00	96.15	96.15	96.15
	Software developers (N = 45)	97.78	95.56	97.78	100.00
	Faculty members (N = 67)	100.00	91.04	98.50	95.52
	Average (N = 150)	**98.66**	**93.33**	**97.33**	**97.33**
Functionality	Project managers (N = 12)	91.67	83.33	91.67	83.33
	Software designers (N = 26)	88.46	92.30	88.46	80.76
	Software developers (N = 45)	86.76	93.33	95.56	88.89
	Faculty members (N = 67)	87.70	89.55	77.61	73.13
	Average (N = 150)	**87.86**	**90.66**	**86.00**	**79.99**
Robustness	Project managers (N = 12)	100.00	100.00	91.66	91.66
	Software designers (N = 26)	96.15	100.00	100.00	96.15
	Software developers (N = 45)	97.78	100.00	97.78	97.78
	Faculty members (N = 67)	100.00	100.00	98.50	97.01
	Average (N = 150)	**98.66**	**100.00**	**97.99**	**96.66**

ZW3D

As presented in Table 1, ZW3D in terms of its usability has received 66.67% score from software project managers, 73.07% from software designers, 84.44% from software developers, and 82.08% from faculty members of HEIs. While in terms of understandability, the tool has received 91.67% score from software project managers, 88.46% from software designers, 95.55% from software developers, and 88.05% from faculty members of HEIs. From the precision point of view, the tool is scored 100% from software project managers, 95.15% from software designers, 100% software developers, and 95.52% by faculty members of HEIs. In terms of functionality, this tool has been rated as 83.33% by software project managers, 80.76% by software designers, 88.89% by software developers, and 73.13% by faculty of HEIs. While with respect to the robustness parameter, the tool has achieved a score of 91.66% by software project managers, 96.15% by software designers, 97.78% by software developers, and 97.01% by faculty members of HEIs.

AGGREGATE RESULTS AND DISCUSSION

The aggregate results of all tools by all participants are presented in Figure 2. The results collectively present that all type of participant groups were agreed with the higher usability of CATIA as compared to all other tools under evaluation. Also, the results show that CATIA and ZW3D are better than others in terms of understandability with almost same rating. With respect to precision, AutoCAD is better than every other tool; however, it is important to note here that CATIA and ZW3D are also not much far and can be considered with very close precision to AutoCAD. In terms of providing required functionality, Primavera surfaces other tools while ZW3D is found to be offering least functionality than other tools. Similarly, Primavera is considered completely robust closely followed by AutoCAD.

The results portray that different tools are preferable depending on important attribute with respect to each project. It is also worthwhile to note that the better analysis of the internal factors is offered by software developers who are actually involved with working with these tools as compared to managers and faculty who are more looking at the tools with an external viewpoint. This also indicates that preference of different types of users also differ from each other. Therefore, it is important for the team members to discuss the choice of tool to be used for a certain project before the start of the project in order to work efficiently and effectively throughout the development process.

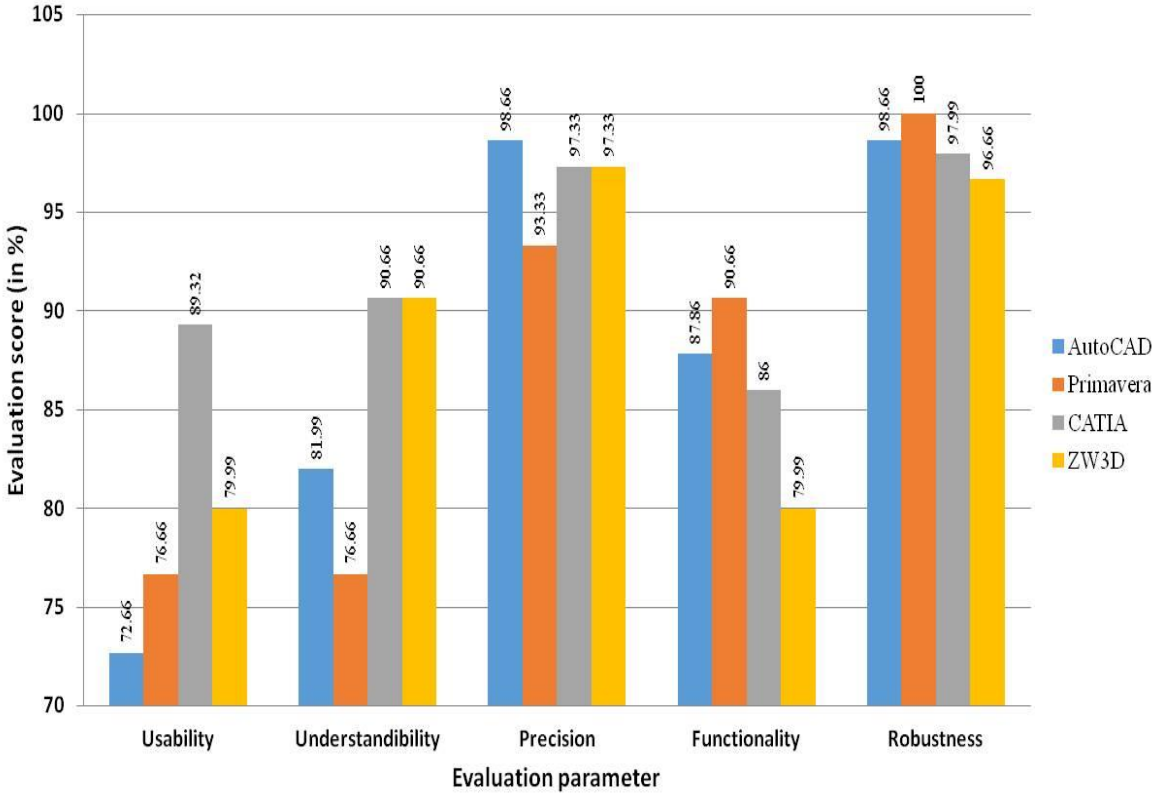

Figure 2.
Aggregate evaluation results of the study

CONCLUSION

This study is concerned with an extremely imperative and noteworthy issue of choosing right software tool for engineering projects according to the type and requirements of each project. The selection of right tool is always believed to be an important contributing factor towards the success of the project. Currently, there are a number of tools available to leverage for different

kinds of engineering related projects. Whilst, all the tools support basic functionalities, they differ with respect to domain specific functionalities. To aid in the literature on the topic and help the software engineers in choosing appropriate tool, this study has reviewed four major software engineering tools namely AutoCAD, Primavera, CATIA and ZW3D. These tools are included in the current study on the basis of their vast familiarity and worth in the market.

In this regard, a quantitative survey-based study was conducted herein with 150 practitioners with different level of engineering process related expertise. The participants were selected on the basis that who are currently working as professionals in different private and public sector organizations. The participants were software project managers, software designers, software developers, and faculty members of higher education institutions. In terms of tool features, 5 important factors were considered for the analysis and comparison of tool under study. The features include usability, understandability, functionality, precision and robustness. The data was collected through a 20-item questionnaire which was communicated to selected participants via an email. The results show that CATIA and ZW3D are better in terms of all aspects, however, AutoCAD is slightly better in terms of precision and Primavera is more robust than others.

POLICY IMPLICATIONS

The study offers insights into data driven software tools used for the development of engineering projects employed in Asian countries. The insights are useful for the engineers in choosing appropriate tool for each project. In addition, the insights extend the literature on the topic. Similarly, the results discussed herein are useful for the software tool developers to understand the weaknesses and strengths of each tool. This also aids the software tool developers to outline the needs and preferences of different types of the users and thereby understand the future need and design of such tools. Therefore, the findings can be leveraged to improve the existing tools and/or design and develop new required tools.

LIMITATIONS

The study has offered substantial insights for engineers in terms of software engineering tools. However, the results are based on views of 150 participants only. Thus, in future the research is required to be conducted on a larger sample belonging to different demographics and engineering fields to establish broader evidence. Also, more tools need to be added to the analysis and cross comparison with respect to different engineering domains needs to be undertaken.

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REFERENCES

Akanbi, T., & Zhang, J. (2022). Framework for developing ifc-based 3d documentation from 2d bridge drawings. Journal of Computing in Civil Engineering, 36(1), 04021031.
Akinbi, A., & Ojie, E. (2021). Forensic analysis of open-source xmpp/jabber multi-client instant messaging apps on android smartphones. SN Applied Sciences, 3(4), 1-14.

ANSYS. (2022). ANSYS Structural Mechanics Software. ANSYS. Retrieved from https://www.ansys.com/products/structures.

Araújo, S. O., Peres, R. S., Barata, J., Lidon, F., & Ramalho, J. C. (2021). Characterising the agriculture 4.0 landscape—emerging trends, challenges and opportunities. Agronomy, 11(4), 667.

Brown, A. R., & Johnson, M. P. (2020). A Review of Data-Driven Approaches in Construction Project Management. Construction Management and Economics, 34(5), 324-343.

Devendorf, M., Lewis, K., Simpson, T. W., Stone, R. B., & Regli, W. C. (2009). Evaluating the use of digital product repositories to enhance product dissection activities in the classroom. Journal of Computing and Information Science in Engineering, 9(4).

ESRI. (2021). ArcGIS: The World's Leading GIS Software. ESRI. Retrieved from https://www.esri.com/en-us/arcgis/products/arcgis-pro/overview

Hearn, D., Baker, M. P., & Baker, M. P. (2004). Computer graphics with opengl (Vol. 3): Pearson Prentice Hall Upper Saddle River, NJ:.

Li, Y., & Wu, Q. (2017). Integrated Project Control with Primavera P6 and BIM: A Case Study. Automation in Construction, 81, 22-34.

Lorenzoni, G., Alencar, P., Nascimento, N., & Cowan, D. (2021). Machine learning model development from a software engineering perspective: A systematic literature review. arXiv preprint arXiv:2102.07574.

McEliece, R. J. (2012). Finite fields for computer scientists and engineers (Vol. 23): Springer Science & Business Media.

Meyer, B. (2001). Software engineering in the academy. Computer, 34(5), 28-35.

Peccati, G., & Taqqu, M. S. (2011). Wiener chaos: Moments, cumulants and diagrams: A survey with computer implementation (Vol. 1): Springer Science & Business Media.

Richardson, R., & Director, C. (2008). Csi computer crime and security survey. Computer security institute, 1, 1-30.

Sepasgozar, S. M., Costin, A. M., Karimi, R., Shirowzhan, S., Abbasian, E., & Li, J. (2022). Bim and digital tools for state-of-the-art construction cost management. Buildings, 12(4), 396.

Smith, J. (2018). The Impact of Data-Driven Tools on Engineering Practice. Journal of Engineering Technology, 12(3), 112-130.

Thakur, N. S. (2013). Forensic analysis of whatsapp on android smartphones.

Vieira, M. A. M., Coelho, C. N., da Silva, D. j., & da Mata, J. M. (2003). Survey on wireless sensor network devices. Paper presented at the EFTA 2003. 2003 IEEE Conference on Emerging Technologies and Factory Automation. Proceedings (Cat. No. 03TH8696).