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ENGINEERING AND ADVISORY SERVICES FOR REBUILDING UKRAINE: STRATEGIES AND IMPLEMENTATION

Abstract: *The subject of the study is to assess the status quo of engineering and consulting activities, their regulatory framework and economic efficiency, and to consider prospects of such development in Ukraine. System analysis and comparative analysis of the international standards FIDIC and ISO/IEC 17024 are involved in the research methodology, statistical methods in determining the cost of engineering and consulting services. The study results confirm that implementing the standards for construction projects consulting support can significantly improve the quality and decrease risks related to such projects. It was found that integrating digital technologies and automation of engineering and consulting processes can significantly improve the management of construction projects but require additional investment and staff training. The study also points to the need to develop mechanisms for financing consulting services in construction, which will attract international investment and increase the efficiency of government infrastructure programmes.*

Keywords: *engineering and consulting support, construction projects, risk management, cost-effectiveness, digital technologies*

1. Introduction

Engineering and consulting support is key in implementing construction projects, ensuring their efficiency, compliance with technical standards and economic feasibility. Today, consulting engineers play an even more important role in the modern environment when infrastructure projects are more complex, and reconstruction should be carried out urgently, particularly in Ukraine. It does not need to be stated that qualified control is necessary at all stages of construction management, from planning to commissioning. Similarly, the absence of the standardisation of the relevant standards and its immaturity in the regulatory framework make the activities of consulting engineers in the national sphere quite tricky, so the quality of construction projects could be sacrificed for this reason.

It is known that the application of the international standards – FIDIC and ISO/IEC 17024 – in engineering and consulting can improve the quality of engineering and consulting services considerably, reduce risks and increase transparency in the construction sector (Nepomnyashchyy, 2018; EFCA, 2019; ICEG, 2024). Wang and Xu (2022) show the contributions of engineering and consulting support in terms of energy security, whereas Breyer et al. (2024) point out the necessity of integrating modern technologies within consulting activities.

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Nepomnyashchyy and Kharaim (2018) also indicate that the professional status of a consulting engineer in Ukraine is not adequately regulated, and both certification mechanisms should be reformed.

To this day, many unresolved issues regarding this topic have been given significant attention. In particular, Ukraine lacks comprehensive research on the cost-effectiveness of consulting support in construction projects, detailed mechanisms for financing such services, and a strategy for introducing digital technologies to these sectors. Moreover, the quality of engineering and consulting activities during post-war reconstruction is also open to the impact of international standards.

This study aims to review the current level of engineering and consulting support for construction projects, place their role in a perspective of building and construction efficiency, and identify the main challenges and prospects of development in this area in Ukraine. The first objective of the study is to characterise the specific standards of consulting support around the world; the second one is to investigate distinctive features of the regulation of the profession of consulting engineer; the third objective is to assess economic and technological factors influencing the efficiency of engineering and consulting services and thus to outline the directions of their improvement in the domestic conditions.

2. Literature review

Consulting engineering support for construction projects has been researched in different fields in different countries, such as regulatory, environmental, and economic aspects. Nepomnyashchyy (2018), Nepomnyashchyy et al. (2022) reveal details of the role of consulting engineers in project management, especially on consulting support and international instructions such as FIDIC. The analysis of personnel certification according to ISO/IEC 17024 also shows the need to harmonise Ukrainian legislation with the international requirements stated by Nepomnyashchyy et al. (2022).

Regarding the international context, the EFCA (2019) result reveals how some consulting engineering support helps optimise the costs and timing of European infrastructure projects. The ICEG study (2024) simultaneously identifies a need to adapt international standards to national ones. Current research also supports Ukraine's reconstruction projects, specifically in Orel et al. (2024), focusing on investment management and strategic planning in the country's recovery.

Khrutba et al. (2023) and Cansino et al. (2022) discuss the environmental sustainability aspects and the environmental impact of the construction projects; however, they stress the significance of an integration of the environmental standards on the construction. Medynska et al. (2024) explore the opportunities for investment support for waste management, which may be significant for the environmental component of reconstruction. Finally, research on state-of-the-art digital technologies used in construction and project management is also worthy of mention. Drach et al. (2023) and Oliynyk et al. (2020) conclude that STEM education and digital infrastructure can help train future engineering consulting professionals, which is important for upskilling in the construction sector. General trends in management and decision-making in strategic planning also apply to the reconstruction of Ukraine, according to McIntyre-Mills (2024).

The economic aspect of construction project management is examined by Papadopoulos (2021) and Radchenko et al. (2023) in evaluating the efficiency of public investment in the construction industry. Romanova et al. (2024) also point out the significance of marketing strategies in attracting new investors to a reconstruction project. Two kinds of papers focus on the legal aspects of construction and international regulations.

The construction of Energi facilities is analysed with the help of Oka (2024), which covers the legal issues concerning the use of nuclear energy. Security and regulatory issues in military and strategic facilities may apply to infrastructure security issues, according to McLean (2024). Capineri et al. (2020) discuss technical standards at the building safety level for developing modern approaches to risk management.

These engineering consulting activities on construction project management are considered to play an important role in modern research. For the international context, the guidelines from the Association of Professional Engineers and Geoscientists of Manitoba (2025) recommend how consulting engineers should relate with clients and how to evaluate consultant's engineering services. Breyer et al. (2024) contribute to the relevance of the work by discussing human factors and technology interaction in construction, as well as the particular contextual relevance in the digital transformation of project management.

Möller and Shim (2024) also consider the digital aspect of infrastructure projects and study the use of digital imagery in peacekeeping and how it could be used to reconstruct such critical infrastructure as a construction project. Nepomnyashchyy (2018) examines experience in developing professional training for consulting engineers in the Ukrainian context, based on the practice of the International Guild of Consulting Engineers in FIDIC training programmes development. Nepomnyashchyy & Kharaim (2018) discuss the organisational and legal aspects of the consulting engineer's activity within Ukraine. In the first study, the state regulation of engineering and consulting activities in construction is analysed, and in the second, the organisational and legal mechanism and prospects of improving the profession at a public policy level. The study by Nepomnyashchyy et al. (2022) expands on this topic by highlighting the role of consulting engineers as business entities, mainly in minimising risks in construction projects. The study by Wang & Xu (2022) focuses on the impact of energy diplomacy on the strategic management of construction projects, which is important in the context of energy infrastructure development. The paper analyses the economic and political mechanisms that can be applied to implementing large projects in the post-war reconstruction of Ukraine.

Despite existing research, the impact of artificial intelligence and automated systems on the activities of consulting engineers and the integration of international standards into Ukraine's state construction regulations remain unresolved.

3. Research methods

The presented study is an integrated approach (system analysis, comparative studies, statistical methods, expert evaluation). Regulatory framework, risk management, and cost-effectiveness involving system analysis and modelling were applied to identify relationships between key aspects of the engineering and consulting activities. Comparative international standards FIDIC and ISO/IEC 17024 facilitated apparent identification and quantitative estimation of the differences between the certification and activities of consulting engineers in Ukraine and abroad. Data from international organisations, including EFCA and ICEG, were analysed to ascertain statistical techniques in which the cost of engineering and consulting can be represented in a country. The construction project efficiency was evaluated based on the average consulting service costs and key economic factors that can affect it. The combination of these methods results in a comprehensive analysis of engineering and consulting support in construction projects and the recommendations for improvement of these practices in Ukraine.

4. Results

Construction projects need engineering and consulting support to ensure the projects' efficiency, quality, and risk management. It is shown that in implementing international standards, FIDIC or ISO/IEC 17024, consulting engineers' regulation and professional certification is significantly increased. Consulting engineering activity is regulated by poorly developed legislation in Ukraine, which requires further reforms to be brought by international standards. The study also emphasises that digital technologies and automation should be integrated with project management and decision-making processes. In addition, it is also necessary to strengthen financial mechanisms to support consulting services to attract international investments and improve the efficiency of infrastructure projects.

A consulting engineer is a specialist organisation that specialises in the design and construction of facilities and provides organisational and advisory support. The main goal of the consulting engineer is to provide comprehensive support to a customer while implementing projects, namely, risk management, quality and cost control, and the organisation of relationships between participants in the construction process (Nepomnyashchyy, 2018).

This is an integral part of international practice in the field of construction in international forms of construction contracts; international standards have been established for the provisions of the role of consulting engineer, including international documents of the International Federation of Consulting Engineers (FIDIC) defining the standard form of construction contract and responsibilities of a consulting engineer (Nepomnyashchyy et al., 2022).

The term consulting engineer is regulated within Ukraine by the Law of Ukraine, “On Regulation of Urban Development”, which defines a consulting engineer as a duly qualified person engaged in projects and rendering consulting services in construction works (Nepomnyashchyy, 2018).

Under the conditions of profitability, the activity of the business entity being a consulting engineer should be carried out by certified specialists in the professional sang 'the consulting engineer (construction)' who meet the professional standard and have passed the appropriate certification (Nepomnyashchyy et al., 2022). According to the international standard ISO/IEC 17024, which is responsible for the certification procedures of personnel in the construction field, the qualification requirements of consulting engineers are stipulated. It harmonises the Ukrainian professional certification system with international practice. Furthermore, a consulting engineer is responsible for a considerable set of functions determined by the client's contract, including consulting, technical, managerial, legal, and control activities (Nepomnyashchyy & Kharaim, 2018).

The ability of the consulting engineer to adapt to modern technological and management challenges is also an important factor in the effectiveness of his activities in fulfilling regulatory requirements. With the increased digital tools, including building information modelling (BIM) systems and automated project management platforms, we can forecast the risk more accurately and achieve better coordination among construction stakeholders. Consulting engineers play an even more significant role in the post-war construction of Ukraine, as they supply quality control and guarantee compliance with international standards. Simultaneously, problems of insufficient professional training of consultants and the absence of precise financing mechanisms for consulting services need additional reform. Such improvement in the professional level of consulting engineers in Ukraine could be achieved through expanding cooperation with international organisations and adopting best international practices. Therefore, in the further development of this sector, the improvement of the regulatory environment and the

introduction of modern project management methods are the key factors.

Figure 1 shows the cost of consulting engineer services in a percentage of the total construction cost for the countries of the European Union. The data shows the cost of engineering consultancy services for different regions and the national construction standards. Along with open economic sources, data was collected based on international reports, notably the European Federation of Engineering and Consulting Associations (EFCA, 2019). This was done by analysing tender documents and contracting practices to obtain the average cost of the engineering and consulting service in the construction sector. The countries were selected as they possessed a significant share in the overall construction sector in Europe and statistical data. Other sources of information, such as analytical studies and international standards, such as FIDIC and NEC, define the tasks of a consulting engineer. The schedule is a basis for calculating the cheapest cost of services in the following projects, particularly while considering the conditions of Ukraine's reconstruction.

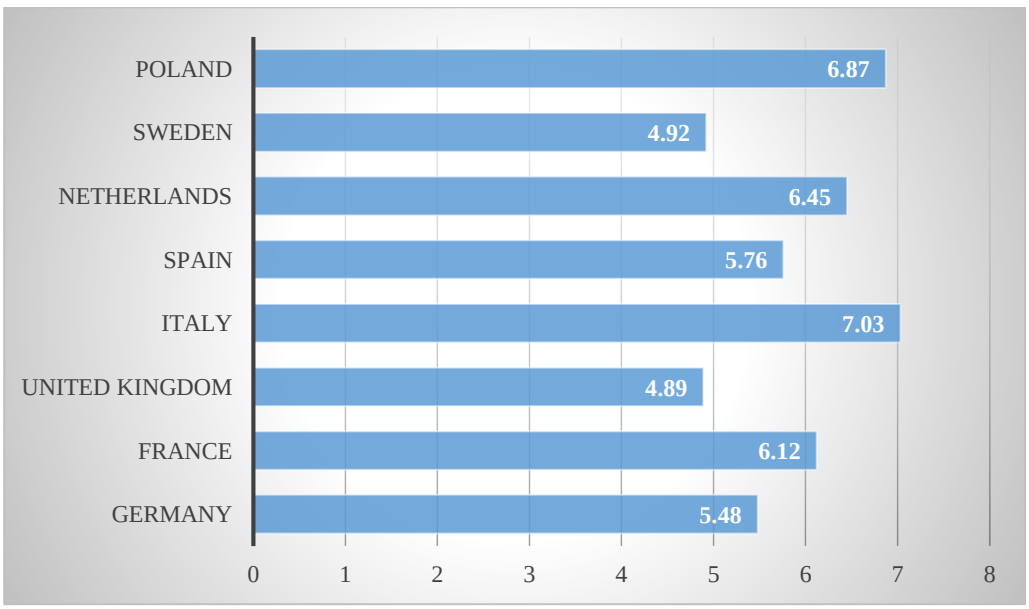

Figure1. Cost of services (% of total construction cost)

Source: developed by the author based on: (European Federation of Engineering Consultancy Associations, 2019; Association of Professional Engineers and Geoscientists of Manitoba, 2025; International Consulting Engineers Guild, 2024; Orel et al., 2024)

The cost of consulting engineer services in EU countries is analysed, and the minimum fee is kept at 4.89% (UK) and the maximum of 7.03% (Italy). This implies a significant difference in price depending on the country, regulation and level of economic development of the construction industry. Regarding European engineering and consulting services markets, the average cost of consulting engineer services among the surveyed countries is a typical indicator of 5.94%. This shows a balanced distribution of costs, with 5.76% being the median value, which means almost no bias towards higher or lower values. This shows some price heterogeneity in the market because the difference between the highest and lowest prices is 2.14 percentage points. The relative

percentage difference between these figures is 43.73%, which indicates the possible impact of the local regulatory framework, certification costs and competition among engineering companies.

The standard deviation of the values is 0.76%, which indicates moderate variability among the countries represented. This confirms that in most cases, the cost of consulting engineer services is 5% to 7%, which aligns with the average figures included in international methods for determining the cost of construction services.

Major infrastructure projects worldwide are, to a great extent, implemented using engineering and consulting services. They assist in effective budget management, quality of work control, and risk reduction. Many international projects, such as those in the transport and energy sectors, have been implemented with the support of consulting engineers. Successful cases where such services have guaranteed construction efficiency are presented in the table 1. The table 1 contains successful international projects with consulting engineering support.

Table 1. Successful international projects with engineering and consulting support

Project	**The role of a consulting engineer**	**Efficiency**
Crossrail (Elizabeth Line), United Kingdom	NEC contract management, technical supervision, construction coordination	Reduced budget overruns by 12%, reduced implementation time by 8 months
Grand Paris Express, France	Development of project documentation, control of budget and deadlines	Optimising costs by 6%, improving construction safety
Motorway A2, Poland	Control of construction works, optimisation of costs and contractors	Improved road surface quality and reduced costs by 15%
HS2 high-speed train system, UK	Project monitoring, engineering support and risk management	Minimising environmental risks and meeting all deadlines
Three Gorges Dam, China	Geotechnical analysis, hydro-technical monitoring and construction quality control	Controlling water levels, preventing accidents, reducing operating costs

Sources: EFCA (2019), Nepomnyashchyy & Kharaim (2018)

The projects reduce financial and time costs through engineering consulting, secure quality technical control, and efficiently manage contracts. The table shows that consulting services reduce risks and improve infrastructure project safety. This experience proves that consulting engineers can participate in technical solutions and strategic construction projects, including rebuilding Ukraine (Treffers, 2023).

International construction project performance using engineering and consulting services is illustrated in the graph shown in Figure 2. This is a good example of how such services bring down costs, shorten the time it takes to deliver, and improve the overall quality of the building. This study includes five major infrastructure projects in different countries where consulting engineers have participated to succeed in the project. The data were obtained from international reports of the European Federation of Engineering and Consulting Associations (EFCA, 2019) and the FIDIC studies and case studies of Nepomnyashchyy and Kharaim (2018). We take into account those leading performance indicators, which are cost savings (%), time reduction of implementation (%) and quality improvement (%). The data source was analytical reports and project evaluations based on the practical experience of engaging consulting engineers. For clarity, the data is presented as a combined graph: a bar graph for cost and time reduction and a line graph for quality improvement.

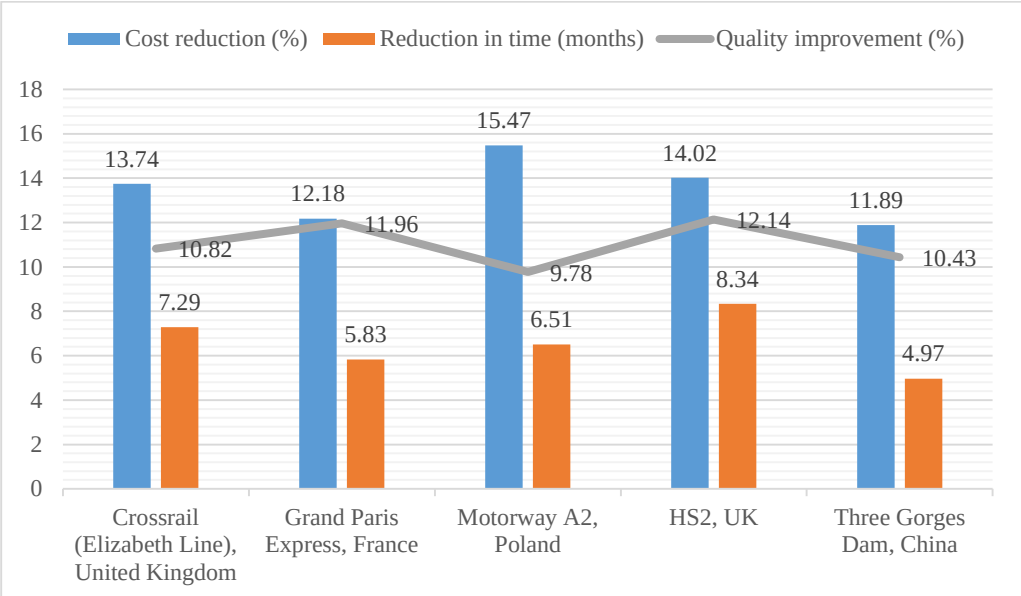

Figure 2. Efficiency of engineering and consulting services in international projects
Sources: EFCA (2019), Nepomnyashchyy & Kharaim (2018), FIDIC (2021)

Analysis of the graph shows that **the most significant cost reduction** among the projects studied was recorded in the construction of the **A2 motorway in Poland (15.47%**), which is explained by effective contractor management and control of resource use. At the same time, the **Three Gorges Dam in China** achieved the lowest cost reduction **(11.89%**) due to the complexity of the hydraulic works and the need to comply with strict safety standards. **The HS2 project in the United Kingdom** showed the most significant **reduction in** implementation **time (8.34 months)**, resulting from optimised contract management and coordination. Since the Three Gorges Dam project is very complex and its safety procedures were rather lengthy, the project experienced the most minor reduction in time (4.97 months). It can be concluded that the most significant rate was HS2 (12.14%), which confirms the positive impact of consulting engineers on compliance with International construction standards. However, there is the least improvement in quality on the A2 motorway (9.78%) due to the orderliness of effectiveness over enhancement of technical performance. Overall, engineering consultancy services are confirmed to significantly influence the definitions of cost optimisation, time control, and quality improvement on international projects.

The distribution of the leading roles a consulting engineer plays in international construction projects is depicted in the diagram in Figure 3. It also shows which functions have the most influence on infrastructure project efficiency. Assessment of the international experience of consulting engineers involved in the construction of large projects where the consulting engineers' computed activities contribute to cost optimisation, time control and high-quality assurance has been carried out. It is based on the data used by international project management standards, such as FIDIC and NEC, and studies carried out by EFCA (2019). The percentage ratio between the four main activities of a consulting engineer, that is, determining cost, understanding risk, coordinating with the contractor, and

providing technical supervision, is considered. The values result from analysis of successful international cases in the transport, energy and engineering construction areas. So, the diagram is presented as a pie chart that will help you visually see how functional responsibilities are distributed.

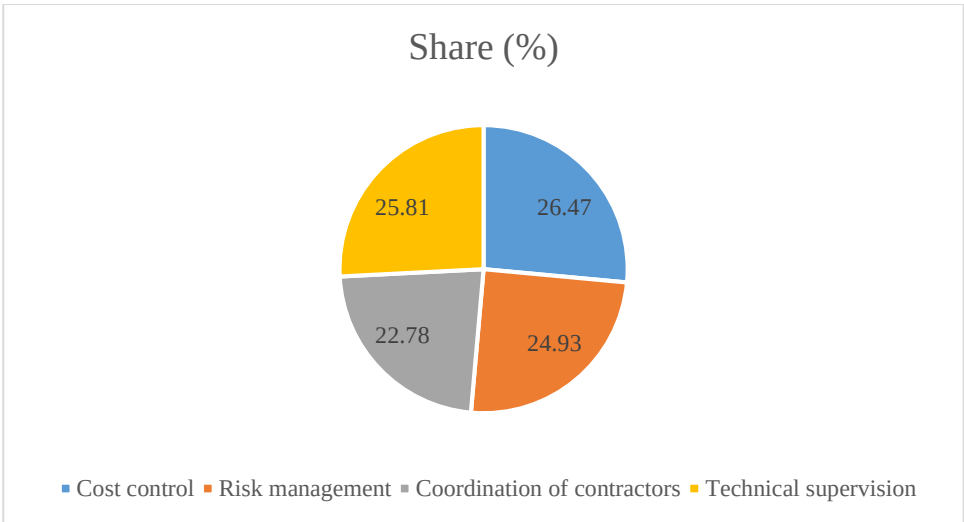

Figure 3. Distribution of roles of a consulting engineer in international projects
Sources: EFCA (2019), Nepomnyashchyy & Kharaim (2018), FIDIC (2021)

The functions of a consulting engineer are analysed, and it is found that cost control is the largest share (i.e., 26.47%). This confirms that managing financial resources and any cost overruns are important. Technical supervision (25.81%) comes second to the most important function as it confirms the principal role of consultants in ensuring that constructions satisfy international standards and technical requirements. Risk management (24.93%) ranks third in importance, as a consulting engineer anticipates potential project threats and develops strategies to minimise them, which is especially important for complex infrastructure projects. The smallest share is accounted for by contractor coordination (22.78%), which is explained by the fact that the clients themselves or general contractors can partially perform this function. However, in significant projects, this role is still important in ensuring proper interplay between all participants in the construction process. The analysis confirms that the consulting engineer carries out many tasks to increase building efficiency, stable financial state and project execution quality.

The consulting engineer is an important part of construction projects, not only directing the efficiency of the projects but also complying with regulations and controlling the technical and financial sides. They engage in minimising risk, improving the quality of work, and optimising the usage of resources. Such specialists frequently coordinate processes, manage contracts and supervise to meet construction schedules in international practice. By doing so, their activities enhance the transparency of the implementation of the project and prevent cost overruns and delays. Due to the present issues in the construction industry, it is becoming essential for the strategic development of infrastructures to have engineering and consulting support.

Functions of a consulting engineer. A consulting engineer is a person who performs qualified complex technical, financial and legal support of a construction project. He is

responsible for cost control, scheduling compliance, and managing risk to avoid cost overruns and disruption. He also coordinates contractors and suppliers to create an efficient environment where participants can interact. For example, technical supervision ensures construction works follow international standards and regulations. In large-scale infrastructure projects, as in any project, safety and quality are also the responsibility of the consulting engineer in which they take part.

The advantages of contracting the works out to a consulting engineer. Consulting them (engaging a consulting engineer) saves some of the money. This is used to ensure the use of money rationally and minimise financial losses, which reduces the total cost by 5% – 15%. If the construction processes are appropriately managed, delays are reduced, and penalties and additional costs are avoided. Reducing the risk of accidents and defects is particularly important for the long-term operation of the facility as they contribute to high-quality work control. Furthermore, international standards must be followed by the consulting engineer in order to attract investment and grant funding. In addition, independent expert supervision contributes to the transparency of construction processes, which is an important factor for public and private customers.

Then, construction projects are implemented with a consulting engineer's contribution and should, in this case, be economically, periodically and in terms of safety. It helps to cut down on unjustified costs, makes full use of the resources, and ensures that the project meets international best practices. For Ukraine's post-war reconstruction, engineering and consulting services can be a strategic tool to develop the country's critical infrastructure. It cannot be described as a simple, lucrative solution, but it is a prerequisite for successfully implementing large investment projects. Implementing modern engineering standards will contribute to the industry's sustainable development and increase the competitiveness of the Ukrainian construction sector.

5. Discussion

A confirmation of engineering consulting support as a component of construction project management is to optimise cost and quality control and to mitigate risks (Nepomnyashchyy et al., 2022; EFCA, 2019). While there are differences in the approaches to regulating the consulting engineer profession, it is unclear how they have been attempted in different countries. Nepomnyashchyy and Kharaim (2018) study underlines the necessity of tuning Ukrainian legislation to international standards. APEGM (2025) calls for elaborating an exact set of rules for the administration of consultants and clients.

Other countries' practices in the certification of consulting engineers are compared with those of Singapore and found to vary. It is stated by EFCA (2019) that the professional standards ISO/IEC 17024 and FIDIC are given much attention in the EU and North America. This aspect is problematic in Ukraine because the legal regulation of consulting engineers requires improvement (Nepomnyashchyy & Kharaim, 2018). Not only, however, in the field of engineering consulting does technological progress have a significant influence but also on engineering consulting. Berey et al. (2024) argue that humanity's interaction with technology in modern construction should be considered, and Möller and Shim (2024) analyse how digital technologies can improve infrastructure project management. Nepomnyashchyy et al. (2022) also emphasise that training Ukrainian consultant engineers to fulfil international standards and develop professional education is necessary.

What's even more, opinions on the economics of consulting engineering are also conflicting. In the context of postwar reconstruction, Wang & Xu (2022) state that due to the connection between construction projects' engineering and consulting

activities and energy security and diplomacy, it is especially applicable to Ukraine. In contrast to the study conducted by Nepomnyashchyy et al. (2018), the problem it highlights is the need for some mechanisms of funding construction consulting services to enhance project efficiency.

Prior studies show that engineering and consulting support is important during construction project implementation. However, very little research has been done on its legal and regulatory framework and cost-effectiveness. Mechanisms for adapting international standards to Ukrainian legislation and improving the educational and certification system for consulting engineers must be created. Future research should be directed at understanding the effects of digital technologies on consulting activities and other potentially viable business models to finance consulting services in public and private projects.

6. Conclusion

The study found that engineering and consulting support is essential in successful construction project management and ensuring maximised costs, reduced risks, and improved infrastructure undertaking quality. It is shown that implementing FIDIC and ISO/IEC 17024 international standards makes an important contribution to harmonising the Ukrainian certification system of consulting engineers. However, the study also showed great variety in regulating the professional activity of consulting engineers in different countries, and this needs to be corrected, whether it is regulatory or legal. The second important point is the digitalisation of consulting services to facilitate project management but with the increased dependence on investments in staff training in technology adaptation. The novelty of the results is that the necessary problems of certification and legal status problems of consulting engineers in Ukraine are revealed, and some of the essential economic and technological factors that influence their efficiency are defined. The study's practical significance is in its ability to contribute to developing policies for improving consulting support in the country's reconstruction after the war, as almost any construction project is supported by consultants. The study's limitations include the lack of empirical data concerning the effectiveness of different models of engineering consulting in Ukraine, which need to be analysed and statistical indicators obtained. Further research is needed to develop state incentives for engineering consulting services, provide a more detailed analysis of the utilisation of digital technologies in the engineering consulting field, and assess the influence of international standards on the efficiency of construction projects in Ukraine. Also, the construction sector's public administration, in terms of engineering and consulting, supports integration with that sector, which is necessary to study and evaluate the consequences of the quality of infrastructure projects as well as stimulate international investment.

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