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COVID-19 Struggle and Post-COVID-19 Recovery: Exploring the Governance, Success, and Digital Transition in Construction Projects in Serbia

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Abstract: Construction, one of the largest global economic sectors, has been severely challenged by the economic uncertainties brought on by COVID-19. Since 2020, pandemic-related disruptions and remedial measures have made its historically low performance even more difficult. As a result, recent research mainly addressed these negative consequences on the construction sector. In contrast, this paper aims to identify mitigation strategies recognised as good practices on construction projects in Serbia, in addition to detecting disruptions and quantifying their effects on cost and time overruns. A particular emphasis is given to how the pandemic hastened digital transition and encouraged the adoption of modern project management practices. The research was carried out through a survey of two rounds, conducted one year apart, to obtain an in-depth overview. The findings indicated that, although it had an impact on construction projects, the pandemic was not particularly harmful, because of widely used remedial measures and modern project management techniques. However, the pandemic did not modernise project implementation substantially nor significantly increase the use of cutting-edge digital technologies. Nevertheless, it encouraged project managers to think about introducing new approaches in project management, where digitisation is the new normal. The research findings may indicate to academia and practitioners what strategies may assure a project's implementation even in enormously changed conditions, such as during a pandemic.

Keywords: coronavirus; construction industry; digitisation; project overruns; productivity; workforce shortages; mitigation strategies; questionnaire survey; structured interviews

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1. Introduction

In 2020, the world experienced a challenge not recorded in recent history—a health crisis due to the COVID-19 pandemic. Almost all levels of social life have changed fundamentally and significantly. The most visible and immediate changes affected the health system, the global economy, ordinary people's way of life, education, and work. The global economy has suffered significant losses. The International Monetary Fund (IMF) estimated that global gross domestic product (GDP) fell by an average of 4.3% in 2020, the worst decline since the Great Depression [1]. The construction industry plays a vital role in global economic growth. According to European Construction Industry Federation (FIEC), in the European Union (EU) the construction industry has a share of 11.1% of the GDP and 10% of total employment, and counts more than 18 million employees [2].

Furthermore, the construction industry creates new jobs and provides solutions to social and environmental challenges such as poverty and homelessness, global warming, and the depletion of natural resources, making a profound impact on society and the environment. At the same time, this industry is characterised by low productivity, and slow innovation and digitalisation [3,4]. Because of this, the entire industry and its connected sectors (real estate developers, material, equipment and software suppliers, etc.) are more sensitive to economic uncertainties. Hence, it is reasonable to assume that the construction sector and its operations will likely be among those most affected by the

COVID-19 pandemic. Indeed, the global construction sector contracted by 4.3% in 2020, compared to a decline of 2.7% in 2009 caused by the latest global financial crisis [5]. The industry is mainly hit by lockdown orders, workforce shortages, supply chain disruptions, and financing strains.

Even though both 2021 and 2022 indicate signs of recovery, the construction industry still needs to recover fully. When comparing indices in January 2022 and January 2021, production in construction increased by 4.1%; however, in January 2022, the production level was only 1.9% higher than in February 2020 [6]. Workforce, material, and equipment shortages in the post-COVID period were the leading causes of slow growth and low productivity. Even though the employment rate in the EU in the third quarter of 2021 was 3.2% higher than before the pandemic, the construction sector remained one of the most affected by workforce shortages [7]. At the beginning of 2022, around 31.4% of managers reported that production was limited by the imbalance between the workforce demand and supply, while 28.6% reported material and equipment shortages [7]. As a source of controversy, increased public investments, supported by the EU's Recovery and Resilience Facility (RRF) instrument, are expected to impose even greater pressure on the workforce and material market. Therefore, to avoid further decline in production, the construction industry's stakeholders should consider short-term (immediate) and long-term measures. Digitally enabled project delivery may be one of them. In this regard, it would be interesting to determine how the COVID-19 pandemic affected project delivery and production in the construction sector, what the consequences have been, and whether it has encouraged the use of digital technologies to mitigate risks during project implementation.

Since the COVID-19 outbreak in 2020, numerous studies have investigated various facets of the COVID-19 pandemic in the construction industry, such as project performance, mitigation strategies, legal aspects, workforce, supply chain issues, etc. Aside from the implementation of health and safety guidelines [8–12], the majority of research efforts examined the effects of the pandemic and its remedial measures on the success of projects in developed [8,13–16] and developing countries [17–24], with the United Kingdom and Malaysia leading the effort. To investigate the crucial effects of the COVID-19 pandemic on a global scale, King et al. (2022) analysed 519 papers and performed 40 interviews with practitioners from architectural, engineering, and construction companies. The five impacts that stood out globally were decreased demand for construction works, reduced foreign investments and number of public projects, decreased productivity, and interruptions in the supply chain. The latter two impacts recurred in all analysed countries [18].

Project productivity was either directly hampered by the companies' responsibility to comply with all mitigation strategies or affected by the inability to acquire key resources due to these strategies. In most countries, companies were obliged to provide their employees with a safe workplace and comply with all necessary protective and hygiene measures against the COVID-19 virus [9,25]. In addition, the measures introduced to combat the pandemic included partial or complete closure of companies and construction sites [9,11,13,15]. Even with reduced construction activity, the construction sector faced significant workforce shortages [17]. Many sick people among the workers, both on the construction site and in the offices, and the restrictions imposed on the number of people allowed in open and closed spaces, led to changes in the project scheduling activities [9]. The inability of employees to reach the workplace because of the restrictions on movement or the constrained capacity of the transportation system was another factor contributing to the workforce shortage [16].

The COVID-19 pandemic affected the mental health of the workforce in the construction industry as well [26]. Many workers stayed at home due to psychological aspects, the fear of infection, household challenges such as home-schooling children, etc. [11]. Some authors even claim that the diversity of the workforce was affected and that the pandemic had more impact on vulnerable demographic groups (women, elders, or minorities) [27].

Aside from workforce-related problems, the construction industry experienced significant difficulties procuring and delivering the necessary materials to the site [15–17,20,21].

Certain manufacturers suspended the production and distribution of materials due to delays in importing raw materials from China and other nations [15]. The imposed restrictions that caused supply chain companies to downsize their workforce also contributed to the shortage of materials and difficulty in predicting delivery times [15]. These disruptions in the upstream supply chain affected the price fluctuation (price increase) of the specific resources on the market.

These workforce and material shortage problems led to delays in project implementation and placed an additional financial burden, which directly impacted the project implementation. For instance, in one of the rare studies that quantified the pandemic impact on projects in Malaysia, Olanrewaju et al. (2021) determined that compliance with COVID-19 prevention measures may increase project budget and workforce shortage by up to 20% and 40%, respectively, and may reduce the productivity at the site by 50% [24]. For this reason, contractors were forced to invoke contractual provisions entitling them to an extension of time and financial compensation. However, a proper interpretation of contractual provisions constituted a significant challenge [28], requiring the development of further recommendations and guidelines from relevant organisations such as the International Federation of Consulting Engineers (FIDIC) [29].

On the other hand, several researchers claimed that the COVID-19 pandemic has a positive side, since it has provided the necessary impetus for the transition toward a more human-centred working environment, either through improving workforce well-being [30] or the creation of social values [31]. Simultaneously, companies benefitted from the pandemic by reducing overhead costs, managing crises, and preparing for resilience, using lean principles, reducing paperwork, and increasing the use of digital technologies on projects [25,32,33].

These contrasting implications of the COVID-19 pandemic demand further location-specific research into the pandemic's effects on construction projects, particularly on the economies in transition, such as Serbia, which are characterised by a significant proportion of public expenditures in investment projects. Concerning this, the current body of knowledge would significantly benefit from quantifying these effects on the planned budgets and schedules. Additional research and identification of long-term pandemic effects and strategies, particularly those that modified existing construction practices and supported the creation of social values and resilience against current and future crises, are also required. Finding more sustainable project management practices that consider a wide range of stakeholders and their values is crucial for organisations, especially during times of crisis when these values are more likely to be neglected. In these circumstances, sustainability becomes more difficult to achieve, making research that addresses at least one of the sustainability aspects—economic, environmental, or social—very valuable. Additionally, a focus on digitisation as one of the potential measures to tackle both consequences of the COVID-19 pandemic and low productivity in the construction sector would be highly appreciated.

To this extent, the purpose of this paper is threefold. Firstly, the following paper aims to contribute to the knowledge base by conducting an in-depth analysis of the implementation of investment projects and construction companies' activities under the newly emerging market conditions. Specifically, it aims to study the short-term and long-term effects of the pandemic on the construction sector in Serbia, to identify significant project disruptions caused by COVID-19, and to quantify their impacts on the planned schedules and budgets. The introduced health and safety measures and general guidelines for suppressing infection at construction sites have also been comprehensively overviewed. Secondly, the study aims to identify lagging remedial measures recognised as good practices in the construction companies' operations and management, which may help establish a safe and efficient working environment for implementing more sustainable project management strategies during pandemics. Finally, the extent to which the pandemic contributed to adopting modern project management techniques and methods and accelerated the digital transformation in the Serbian construction industry was also investigated.

2. Materials and Methods

2.1. Research Approach

The general study approach was aimed at collecting and analysing data on the implementation of construction projects in Serbia during the COVID-19 pandemic from carefully selected experienced professionals through several levels of research. A longitudinal study was designed through exploratory surveys and structured interviews to determine how construction professionals assessed the influence of COVID-19 and to what degree these impacts persisted as long-term effects. The study focused on detecting and categorising significant disruptions of construction projects, quantifying their effects on project schedule and budget, and identifying suitable measures and strategies to be implemented to minimise the adverse impact of the pandemic. This was carried out through a two-round survey of experienced professionals directly involved in construction project implementation. The surveys were conducted one year apart to obtain a comprehensive overview of the impact of COVID-19 on the project's success. Both rounds had to be carefully chosen since the pandemic timeline was inconsistent and manifested in waves. The first round was conducted during a more severe pandemic wave, which required data to be collected quickly and efficiently. Accordingly, the first round consisted of a questionnaire survey, which was the most convenient and cost-effective way of gathering information. In contrast, the second round was conducted during a less severe pandemic wave and involved a structured interview with the focus group.

The entire research process includes several steps: (1) reviewing the available research studies; (2) designing the pilot questionnaire; (3) testing the pilot questionnaire with the focus group; (4) distributing the revised questionnaire; (5) collecting, processing, and analysing the survey data; (6) designing questions for the structured interview and selecting focus group participants; (7) collecting, transcribing, and analysing interview data; and (8) result summarising and transiting findings into final research conclusions.

As a first step, a detailed literature review had to be carried out in order to determine the complete set of potential project disruptions, the most significant consequences, and possible mitigation strategies for projects in Serbia. A search of the Scopus scientific database was conducted using the keywords "pandemic", "COVID-19", "SARS-CoV-2", "corona", "construction projects", "building", "construction industry", and "building sector". Considering the nature of the disruptions caused, the search for available examples in the literature was limited to the past three years, from 2020 to 2022, and included articles and conference papers. Even though this search produced 569 documents, only 67 dealt with the effects that COVID-19 had on construction projects. The content analysis of these documents was executed through four steps. The collection of scientific articles was organised into sections based on the perspectives from which COVID-19's effects have been observed, and according to the kinds of pandemic-related disruptions and remedial action. In the next step, for each category, the frequency and direction (positive or negative) of appearance, strength towards a particular direction, and the amount of space assigned to the text were identified. A reliability verification of the data, measured through the consistency of the observations, was carried out throughout the process. In the final step, a pilot questionnaire was developed to formulate questions and possible answers, and define the measurement scale of these answers. The questionnaire included different types of responses: multiple choice with different ranges of predetermined options: open-ended, Likert scales, "yes" or "no", and "fully" or "partially".

After creating the pilot questionnaire, qualitative research was conducted with a focus group of distinguished academic experts and business executives. Before surveying a broader scale of professionals, the focus group was employed to refine the questions and prospective responses. Several questions were redesigned and regrouped during this process to reduce misunderstanding, duplications, and blank answers. The focus group also defined the target respondents. They were experienced engineers and other professionals engaged in one of the construction projects in Serbia during the pandemic.

The redesigned survey questionnaire was distributed to the targeted professionals. A statement assuring respondents' anonymity, a description of the survey objectives, instructions for filling it out, and a link to the questionnaire were included in a distribution email. Subsequently, answers were collected, processed, and analysed.

The first-round survey results further helped design the second-round survey, i.e., the structured interview questions posed to the focus group. In this second round, the pandemic's effects were investigated within the same projects as in the first-round survey. The same experts who were invited to the first round of the survey received an email invitation with a Zoom link. Only those who participated in the first survey and were firmly motivated were asked to participate in the interview. The interviews were arranged to obtain more details and deeper insights into the implementation of projects during COVID-19 from a one-year time horizon and to anticipate the lasting impact of COVID-19 on the construction industry in Serbia.

In particular, the objective was to determine which of the previously implemented measures were recognised as good practice and, as such, persisted on projects after the lifting of all health and safety measures. This research segment also aimed to determine the extent to which the COVID-19 pandemic helped the construction industry, which is typically regarded as slow to adopt change, slow to adopt and implement modern management techniques and tools, and slow to move towards digital transformation as the next in construction.

2.2. Questionnaire and Interview Structures

The first-round questionnaire survey is divided into 60 questions and organised into 7 groups. The first two groups aimed to establish the background of the respondents and the profile of the projects. The first group included questions about academic background, years of professional experience, job position, and role on the project. The second group included questions designed to establish a profile of the projects, including the type, location, and size of the project, as well as contract amount (budget, contract price, or value) and completion time.

Within the third group of questions, the respondents were asked to identify the significant project disruptions caused by the pandemic and to assess their impacts on planned projects' budgets and schedules. They were also asked to identify measures introduced to mitigate the negative consequences of the pandemic. The fourth group of questions aimed to examine the existence of other non-pandemic-induced disruptions on projects and their adverse outcomes. This was undertaken because construction projects, which are implemented in normal circumstances, are highly complex and fraught with risk and uncertainty emanating from multiple sources, with potentially damaging consequences.

The fifth group of questions was introduced to reveal additional disturbances during the pandemic which were considered significant. In this group of questions, the general attitudes and impressions of the respondents were investigated, because it was considered difficult for them to reliably determine their impact on the project budget and schedule for most of the disruptions. In addition to workforce productivity and supply chain disruptions, cash flow difficulties, contractual provisions, availability to public services and authorities, proactive actions of companies in a state of emergency, workforce market, and general slowdown in economic growth were examined.

The sixth group of questions aimed to determine whether prescribed preventive health and safety measures were implemented and whether general guidelines and instructions for preventing infection at construction sites were followed. The most commonly introduced measures and consistency in the application were identified.

Finally, the seventh group of questions was focused on project management and governance during the pandemic. These questions sought to investigate whether, and to what extent, the pandemic increased the scope of work in head offices, especially for the employees in the planning sector, and whether, and to what degree, new project management processes or techniques were introduced. Additionally, this set of questions

aimed to examine whether companies have made strides in introducing digital technologies and tools in project management to mitigate the pandemic's impact on projects.

The second round of the survey, i.e., structured interviews, covered three topics. After a time gap of one year, discussions were held with the interviewees on lagging safety and health measures, modern management methods and digital technologies, and future normality in construction in Serbia.

3. Reliability Analysis

As mentioned, the first-round questionnaire survey is divided into 60 questions and organised into seven groups. Of the 60 questions, 16 were included in the first 2 groups, which aimed to establish the background of the respondents and the profile of the projects. The remaining 44 questions within the remaining 5 groups were of the following types: 10 multiple-choice questions with different ranges of predetermined options, 6 open-ended questions, 15 Likert scale questions, 12 "yes" or "no" questions and 1 "fully" or "partially" matrix question.

Before further data analysis, reliability tests were carried out to determine the consistency and reliability of the survey. Cronbach's alpha is a popular technique for assessing a survey's reliability by determining the average correlation or internal consistency among variables in a survey. Cronbach's alpha is most commonly used as a reliability test for a questionnaire or survey of multiple Likert-type scales and items. In this context, one survey question represents one item. The value of Cronbach's alpha (α) ranges from 0 to 1, where 0 indicates no reliability of the study instrument and 1 indicates the internal consistency of the reliability for all the variables from multipoint and/or dichotomous formatted scales or questionnaires [34]. There are several reports about the acceptable alpha values, ranging from 0.70 to 0.95 [35–37]. The general rule is that the α value cannot be less than 0.70 to conclude that the scale is reliable [38]. Additionally, Cronbach's alpha should only be computed for items that measure the same construct (perceived task value) using the same format or scale. Therefore, separate tests were conducted for the following types of question scales: a test for 15 multipoint Likert scale questions, a test for 12 "yes" or "no" scales, and a test for a matrix question with 17 questions in a row with "fully" or "partially" scales. All reliability tests were carried out in the software package SPSS Statistics version 27. The obtained Cronbach's alpha values are presented in Table 1.

Table 1. Reliability statistics.

Type of Question	No. of Items	Cronbach's Alpha
Likert scale	15	0.883
"yes" or "no"	12	0.806
"fully" or "partially"	17	0.880

Each group evaluated the concept of the COVID-19 pandemic's impact on project success. The group of 15 Likert questions intended to identify the most severe project disruptions and assess their qualitative and quantitative impact during the COVID-19 outbreak. These questions dealt with determining direct and indirect construction site disturbances. Items 1 and 2 addressed the direct impact of the workforce, items 3 and 4 addressed the direct impact of equipment, and items 5 and 6 addressed the direct impact of materials on project implementation and cost increases. Items 7 and 8 examined qualitative and quantitative construction site productivity, while items 9 and 10 examined material delivery and payment consistency. The following questions addressed indirect implications such as the labour market (item 11), public service work (item 12), proactive company action (item 13), construction site disinfectants (item 14), and department engagement for planning (item 15).

An overall Cronbach's alpha value of 0.883 was obtained for these 15 Likert scale questions. Most of the items appeared worthy of retention, resulting in a decrease in the

alpha if deleted. The exception was item 14, measuring equipping the construction site with disinfectants. The deletion of item 14 increased the alpha to 0.886. As such, the removal of this item was considered, and its corrected item-total correlation was further analysed. The corrected item-total correlation shows how much the item correlates with the overall questionnaire score, which was 0.240 for this item. Given that the value of Cronbach's alpha increased when the item was deleted, and the correlation is less than the minimum value of 0.30, which is not acceptable [39], the item was excluded from the survey.

Identifying problems and situations on the construction site caused by COVID-19 was conducted through 12 questions with a binary scale. In the case of binary (dichotomous) scale items, a particular case of Cronbach's alpha named the Kuder–Richardson 20 (KR-20) formula is used. However, in SPSS Statistics, there is no special option for the KR-20 formula. Instead, Cronbach's alpha conducted with dichotomous variables is interpreted as a KR-20 value. An overall Cronbach's alpha value of 0.806 was obtained for 12 "yes" or "no" scales. The majority of items appeared worthy of retention, resulting in a decrease in the alpha if deleted. The exception was two items whose deletion increased the alpha to 0.815 and 0.808. The corrected item-total correlations for these two items were 0.069 and 0.282, respectively. As such, these two items were excluded from the survey.

In particular, the items that were examined in this group start from productivity drop, suspension of work, additional shifts, materials, and equipment and formwork issues, and progressing to other COVID-related issues. The removed items were those answers related to whether other COVID issues led to the suspension of work (item 11), and if some problems and situations were not mentioned (item 12).

A matrix question with 17 items in a row with "fully" or "partially" scales was focused on government-imposed health and safety measures; in particular, on the issues regarding organising the site (items 1–3), transportation and entrance to the site (items 4–6), meetings and communications (items 7–14), and hygiene, health, and safety measures (items 15–17). Cronbach's alpha was 0.880 for these 17 items. For two items, it was found that removing each separately from the matrix question improved (increased) Cronbach's alpha value in both cases. These improvements were 0.883 in both cases. These items related to meetings and communication issues; in particular, the removed items examined the application of bulletin boards for information (item 13) and information via SMS messages (item 15). The corrected item-total correlation for these two items was 0.269 and 0.178, respectively. As a result, these two items were left out of the survey. Altogether, all three reliability tests obtained Cronbach's alpha values greater than 0.7, indicating that the used scales are reliable.

4. Results

4.1. Respondents' and Projects' Profile

The main distribution channel for the first-round survey was the Serbian Chamber of Engineers mailing list, which gathers engineering professionals from various academic backgrounds. In total, the designed questionnaire was distributed online via email to 300 addresses of professionals with different experiences and roles in construction projects in Serbia. After a data filtering process, 65 responses were found to be valid, resulting in a response rate of 22.3%, which is comparable to other surveys conducted in the construction industry [17,18,40]. The response rate for structured interviews was significantly higher: 65% of participants from the first round of the survey participated in the second survey. During the interviews, the participants were not asked to provide their personal data. Respondents' and projects' profiles were generated based only on responses from the survey in the first round. Respondents' profile data are summarised in Table 2.

Although the respondents come from different disciplines, including architecture, mechanical engineering, geodesy, and law, most have an academic background in construction (85%). Over half (55%) of respondents have more than 10 years of professional experience, with a considerable proportion (42%) possessing more than 20 years.

Table 2. Respondents' profile (n = 65).

Profession	%	Work Experience (Years)	%	Project Role	%	Sub-Sector	%
Construction	85	Over 20	42	(Sub)Contractor	74	Buildings	71
Architecture	9	Less than 5	28	Consultant	27	Roads, railways, airports	26
Mechanical	3	Between 5 and 10	17	Supervision	27	Hydrotechnical structures	17
Geodesy	2	Between 10 and 20	13	Designer	14	Geodesy	5
Law in construction	1			Client/Investor	12		

Throughout their careers, respondents held several different project-related and facility-related positions. However, most worked on projects as contractors or subcontractors in the building sector, at various management levels ranging from site and project managers to company owners. A considerable number of consultants, supervisors, designers, and investors also participated, ensuring a varied picture of the causes and effects that respondents faced on the projects in which they were engaged. Finally, the gender balance of the respondents was 70:30 in favour of male respondents, indicating that men still dominate the construction sector in Serbia.

The construction projects were distributed over the entire territory of Serbia, with 25% of the projects concentrated in and around the capital city and region of Belgrade. The rest of the projects were evenly distributed in the remaining 24 regions, with each containing two or three projects. Because there were no projects and respondents from the regions of Kosovo and Metohija (or Kosovo under United Nations resolution 1244), these regions were excluded from the study.

Most projects (60%) had government involvement and were particularly important to the Republic of Serbia. The projects' monetary scales were significantly different. Around 60% were valued at up to EUR 10 million, while a sizable portion of projects (15%) were worth more than EUR 100 million. Other projects' characteristics, such as completion and size, are identified in Table 3. Given that the investigated set of participants and projects have a heterogeneous structure and encompasses the entire area of Serbia, the authors could derive general findings from the topic analysis that could be applied to the whole construction sector in Serbia.

Table 3. Projects' profile (n = 65).

Type	%	Size				Completion Time	%	Estimated Budget (10^6 Eur)	%
		Buildings (10^3 m^2)	%	Infrastructure (km)	%				
Infrastructure	31	<0.4	2	<10	6	<1 month	3	<2	28
Residential	26	0.4–2	15	10–50	8	1–6 months	20	2–10	31
Industrial	18	2–8	14	50–200	0	6–12 months	31	10–20	9
Commercial	18	8–20	14	>200	5	1–2 years	29	20–50	11
Mixed Use	3	20–50	15	Bridge	3	2–3 years	14	50–100	6
COVID hospital	3	>50	18			>3 years	3	>100	15
Landfill	1								

4.2. Pandemic Profile in Serbia and Research Periods

At the beginning of the pandemic, a very strict lockdown was imposed in Serbia. This meant restricting the movement of people for a certain period during the day, travel restrictions in some places, and the closure of several businesses and schools. All of this was intended to suppress the further spread of COVID-19 and to protect citizens. To reduce the negative impact on its construction sector, the Serbian Chamber of Commerce issued general guidelines and instructions for preventing infection at construction sites [41]. The instructions mandated introducing hygiene measures and limited the number of individuals allowed in the same area simultaneously. Instructions also recommended using multiple routes for movement on the construction site and that the application of digital technology on and off the construction site be maximised.

While conducting this research, Serbia experienced seven waves of the pandemic (Figure 1). The first case of COVID-19 was reported on 6 March 2020, followed by the first death on 20 March 2020, and a subsequent rapid increase in the number of cases [42].

After 60 days following the first registered case, the country experienced its first wave of infection, counting more than 10,000 infected people and 203 reported deaths (3 per 100,000 inhabitants [42]). From early June to mid-September 2020, the country experienced a second wave with a similar incidence rate to the first. However, the third wave from October 2020 to January 2021, and the fourth wave from mid-February to the end of April 2021, produced significantly higher incidence rates, with up to 8000 cases per day (or 117 per 100,000 inhabitants) [42].

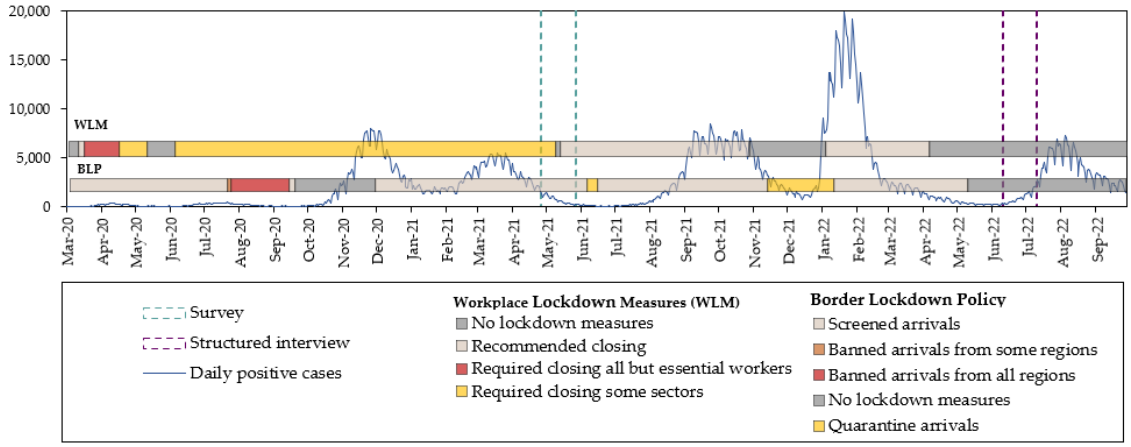

Figure 1. Timeline of daily cases and pandemic countermeasures implemented in Serbia.

After a period of low pandemic severity, the fifth wave, of similar strength to the fourth, occurred, but with a significantly more extended incidence period, from the end of July to the end of December 2021. The sixth wave quickly followed, lasting from the beginning of January 2022 to the middle of March 2022 and infecting up to 20,000 people per day (or 291 per 100,000 inhabitants) [42]. As of mid-September 2022, when this manuscript was written, Serbia has confirmed a total of 2,327,601 registered cases of COVID-19 (or 34,009 per 100,000 inhabitants) and 16,855 reported deaths (or 246 per 100,000 inhabitants) [42]. Even though the pandemic is still active, the epidemiologic situation is stable, with a further decreasing COVID-19 incidence rate in all parts of the country. Figure 1 displays the profile of the pandemic in Serbia and the implemented response measures in more detail.

The first-round survey was carried out in May 2021, immediately after the fourth wave. This period was characterised by the implementation of strict measures to mitigate the consequences of the pandemic. During the first wave, the government declared a national state of emergency [43]. It imposed a lockdown, restricting the movement of citizens on weekends and between 5:00 p.m. and 5:00 a.m. throughout the week, with a total ban on movement for senior citizens. Borders, public areas, parks, and shopping malls were closed, while grocery stores and pharmacies remained open. When compared to the pre-COVID case scenario, the effectiveness of the measures led to a reduction in movements throughout Serbia of about 80% [44]. The government relaxed the curfew during the second wave, although weekend curfews remained. However, this was repealed since it triggered social tensions. Restrictions on business hours in specific sectors and the number of people indoors, and online classes for schoolchildren remained during the third and fourth waves.

The second-round survey, i.e., structured interviews, was carried out between June and July 2022, three months after the end of the sixth wave and following a considerable decline in the number of infected people over a longer period and the removal of all health and safety measures. Even though the period between the first and the second survey was significantly intense regarding the number of people affected, due to milder forms of the disease and social-economic tensions, response measures were relaxed. After the sixth wave, all economic sectors resumed normal operations, the restriction on the number of people allowed indoors was lifted, and facemask wearing, social distancing,

and other previously implemented measures to prevent the spread of the disease were reduced to recommendations. On 3 May 2022, the Serbian government cancelled the state of emergency and removed all control measures and restrictions related to COVID-19 for entry into Serbia [45].

4.3. Implementation of COVID-19 Health and Safety Measures on Construction Sites in Serbia

Results from the first survey revealed that most government-imposed health and safety measures were respected to a large extent in most Serbian construction sites. More than 75% of the respondents confirmed that the measures were either completely implemented (25%), to a considerable extent (28%), or half-heartedly (23%).

A closer look at the particular measures showed that those implemented included those intended to prevent the virus from spreading by reducing contacts and improving hygiene, health, and safety at the sites. The first was either organising the site or transportation to and from the site, scheduling breaks, limiting the number of workers in one location, and restricting access to non-working staff. In addition to opening new entrances and exits, companies provided transport to the sites for all workers and transported workers with COVID-19 symptoms to local health centres. Meetings were held outside whenever possible or indoors with limited attendance. Measures were also supported by digital tools, which served as a platform for meetings or means to distribute notifications about the virus spread, the number of infected workers and remedial measures imposed.

The hygiene-related measures included personal protective equipment, disinfectants, and cleansers for most sites. These actions not only improved the site's hygiene but also improved the situation, preventing work stoppages caused by numerous worker illnesses.

A detailed list of measures is presented in Figure 2. Their levels of implementation varied from fully to partially implemented; at least 32% of the respondents believed that all the specified measures were fully implemented, while at least 31% believed that all the measures had been partially implemented. Interestingly, 57% and 66% of respondents considered that digital tools' potential for internal and external meetings was not fully exploited and that these tools might be used more.

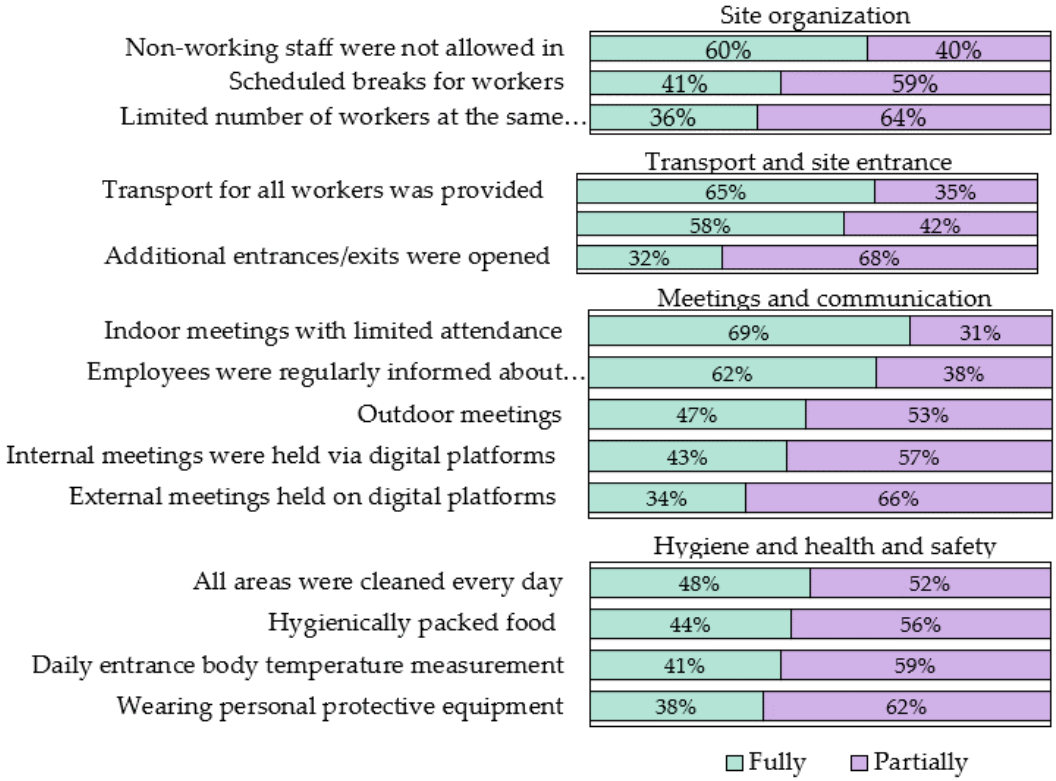

Figure 2. The application of health and safety measures on the construction projects in Serbia.

4.4. COVID-19-Related Disruptions and Consequences on the Projects' Schedule and Budget

4.4.1. COVID-19-Related Project Disruptions

This section highlights the major project disruptions brought on by the pandemic and the requirements by the government to implement health and safety measures to prevent the spread of COVID-19. The majority of answers to this set of questions related to problems with key project resources, workforce, materials, and equipment. The consequences of their shortages or price fluctuations, which then affected the success of project implementation and led to time and cost overruns, were also examined (Figure 3).

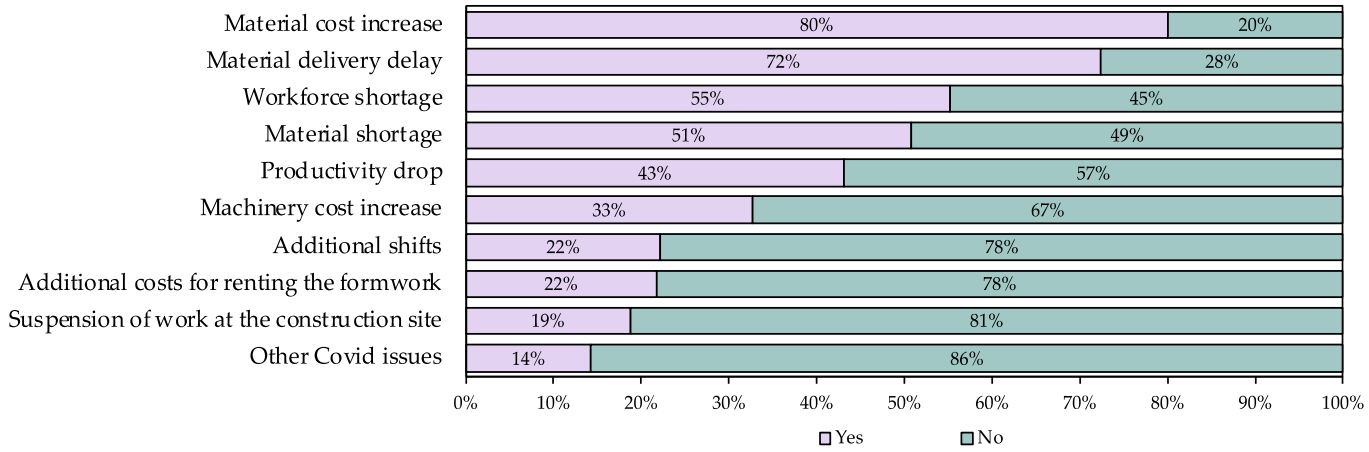

Figure 3. COVID-19-related disruptions on the construction projects in Serbia.

Material-related issues were the most often reported problems caused directly by the pandemic, including material cost increase (80%), delays in delivery (72%), and material shortages (51%). These were followed by workforce-related issues: shortages (55%), productivity drops (43%), and the introduction of additional shifts (22%).

In addition to the abovementioned problems, 14% of respondents felt that project performance was threatened by other issues related to the COVID-19 pandemic. These include a lack of workforce in managerial positions, problems in accommodating non-corporate workers, difficulties obtaining permits to move during curfews, the workforce's fear of infection, the closure of public services, and poor organisational skills of the management under new circumstances.

A deeper insight into the material-related issues revealed that a significant number of projects faced the problem of price fluctuations. The respondents highlighted steel as a material whose cost increased up to 100% compared to the time before COVID-19. They also discovered that the costs of concrete, cement, polystyrene, pipes, and other materials had also increased. The shortage of materials, which was confirmed at nearly half of the construction sites, was mainly due to these price increases and delays in materials deliveries caused by specific entry requirements and severe movement restrictions during certain periods of the day, imposed by the government.

Workforce shortages caused by infected workers occurred in almost all projects (89%). Between 52 and 58% of those surveyed reported 10 infected workers per day as the most frequent rate in all 4 waves that affected Serbia (Figure 4).

However, due to different project sizes and participants, the respondents were asked to estimate the proportion of infected workers in the total number of participants. Around half of them (57%) reported that the number of infected workers in all waves did not exceed 10% of the total number of scheduled workers per day. A substantial proportion of respondents (12%) reported that the number of infected workers was between 10 and 30% of the total number of workers. According to 4% of the surveyed, the share of infected workers in some construction sites in Serbia also went from 30 to 50% or more of the total number of scheduled on-site workers per day. In this context, it is essential not to ignore

that around a third of the respondents (27%), probably those without managerial positions or in companies with a lack of information flow and openness, did not know the number of affected workers.

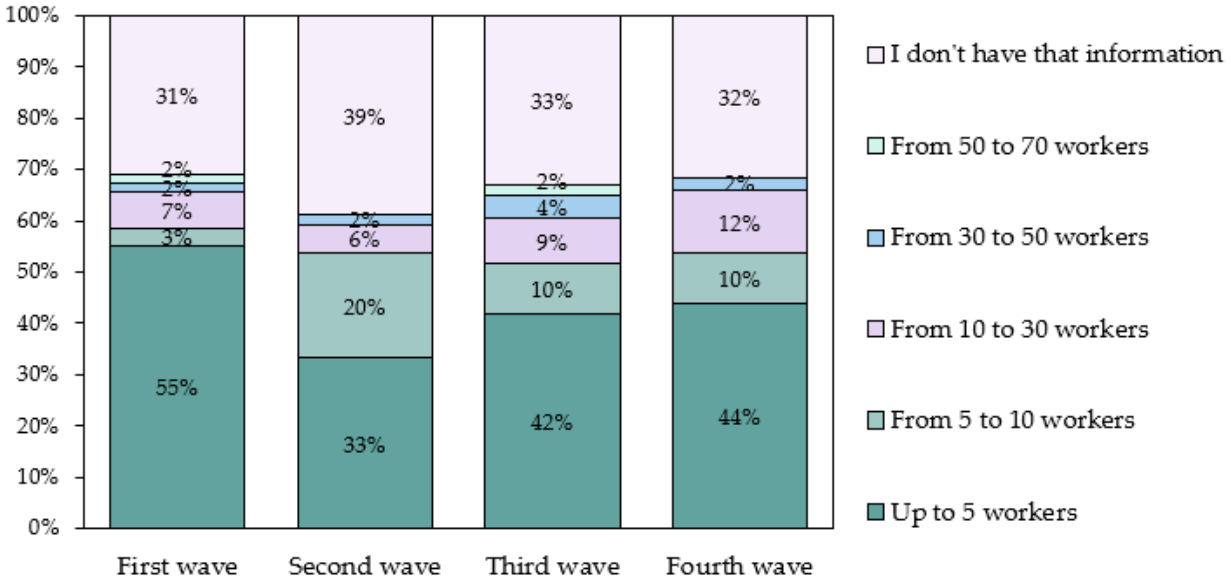

Figure 4. Number of COVID-19-infected workers in each wave.

Almost half of the respondents reported that they had experienced a shortage of skilled labour during the pandemic. Another aspect of workforce challenges was expressed through the productivity drop, which was reported by 38% of the respondents. Only 3% of respondents stated that productivity had declined significantly; the other respondents thought there had been a medium decline in productivity, with 50% believing it had decreased slightly. The psychological effects of workers' fear of illness and the subsequent absence from work can be used to explain a decline in productivity in addition to a skilled labour shortage. These psychological effects further led to using workers outside their expertise, out of sequence, and in numerous stop-and-go operations. In this context, the survey results indicated that about one-fifth of the projects had to introduce additional shifts on construction sites.

Lastly, most of the respondents did not have a problem with the higher cost of leasing or renting equipment; only a small number of respondents (26% of the total) replied that they had a problem with the additional equipment cost.

4.4.2. Effects of COVID-19-Related Disruptions to Time and Cost Overruns

This section qualifies and quantifies the implications of the main difficulties mentioned above on the anticipated time and cost required to execute the project. First-round survey results confirmed that problems within the material supply chain, workforce, and equipment affected the project schedule. This was reported by 73%, 64%, and 36% of respondents, respectively. Notably, almost half of the respondents reported that material-related and workforce-related challenges had the same impact (limited to moderate) on project timelines. In contrast, only 32% reported limited to moderate levels of influence for equipment-related issues (Figure 5). However, it should be noted that the projects surveyed were mostly buildings with a small number of entirely mechanised activities, which is not the case for civil engineering projects.

Considering that time overruns on a project almost always imply an increase in the project costs [46], the respondents were asked to qualify and quantify the same issues in terms of cost overruns. Similarly, as with the time overruns, the respondents considered that the cost overrun for all disruption categories was not substantial. Between 37 and 47% of the respondents (47% for workforce, 37% for materials, and 38% for equipment) consider

these issues' influences limited or moderate, and only between 3% and 27% indicated their impacts as important or very important (Figure 5).

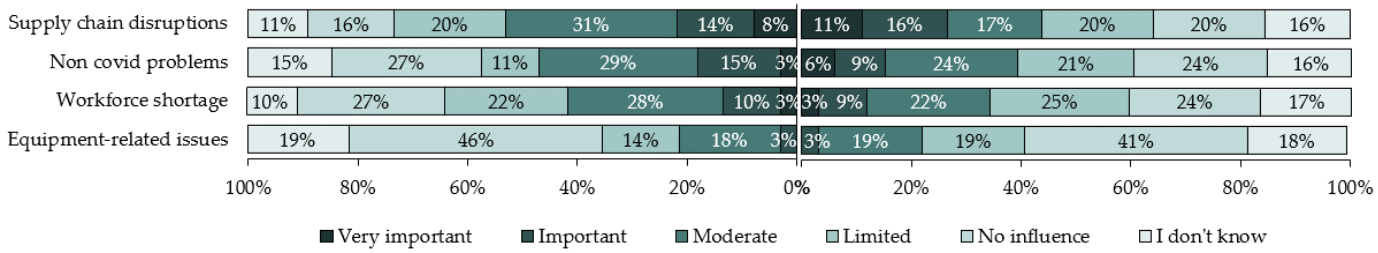

Figure 5. Consequences of COVID-19 and non-COVID-19-related disruptions on the projects' schedules (left) and budgets (right).

Comparing the results, it can be seen that the project disruptions were broadly consistent in the effects on the projects' budgets and schedules. For instance, 27% of the respondents believed that the material-related problem had an important or very important impact on the cost overruns. In comparison, a somewhat lesser percentage of respondents (22%) declared that material-related problems had the same impact on time overruns. In total, 12% of respondents cited the workforce issue as having a very critical or significant impact on cost overruns, and 13% of respondents cited this issue as having a very critical or significant impact on time overruns. Considering that the construction projects are technically, technologically, organizationally, financially, and legally complex, and frequently accompanied by disruptions, it was reasonable to assume that there would be disruptions not caused by COVID-19. To this extent, more than 80% of the respondents considered that non-COVID-19 issues did not significantly disrupt projects. However, the respondents were asked to distinguish them. Although about half of them stated that these issues caused time and cost overruns, only 18% of respondents stated that non-COVID issues had an important or very important impact on project schedules. In comparison, 15% reported important or very important cost overruns.

When asked to quantify the negative impacts that occurred up to that time on the project schedule, one-third of the respondents (34%) believed their projects had time overruns of up to 30 days, 21% said they had overruns of between 30 and 90 days, and 8% of the respondents confirmed they had overruns of more than 90 days. However, 25% of the projects with no time overruns were recorded. Given that such estimates are frequently provided to external experts, 12% of respondents did not know the days that potentially delayed the completion of projects at the time of the survey.

Similarly, when asked to quantify the increase in costs related to the project contracted value, 48% of respondents indicated that the cost overruns were less than 5% by the time of the first round of the survey, 17% of the projects noted a 10% increase, and 14% of the projects examined indicated an increase of more than 10%. Not insignificantly, there were 18% of projects where no cost rise was reported. About three per cent of responses indicated that no data were available.

4.4.3. Compensation for Time and Cost Overruns Caused by COVID-19

Due to the nature of the construction contract and the complex division of risks and responsibilities between the client and contractor, the compensation for cost and time overruns caused by COVID-19 could not be quickly and easily settled. Even though most projects had experienced disruptions in project schedules and budget overruns, not a single request for compensation was initiated in 55% of the projects. The remaining projects either used FIDIC claims or other available claim mechanisms to start the time and cost compensation procedure.

Table 4 shows that half of the claims for additional time (50%) and a quarter of claims for additional costs (22%) are still outstanding, further supporting the fact that reaching an agreement between both parties in this process is complex and time-consuming.

Further, the data showed that on 11% of projects, cost reimbursements were mostly rejected. Furthermore, additional time requested was fully granted (20%) more often than cost reimbursement (11%), but overall resolved and granted cost reimbursement claims (67%) outnumbered claims for additional time (50%). Despite the small number of settled claims, it cannot be said that clients will more likely grant cost over time claims, but it can be concluded that they are aware of the pandemic's influence on project timelines and costs and are willing to grant contractors additional time and expenditures. A few entirely accepted claims indicate that justifying COVID-related claims is challenging. Furthermore, the small number of initiated claims compared to recorded disturbances indicates that many disputes have yet to be initiated.

Table 4. An overview of claims for compensation of time and cost overruns due to COVID-19.

Claim Status	Outstanding	Mostly Rejected	Partially Accepted	Mostly Accepted
Additional time	50%	0%	30%	20%
Additional costs	22%	11%	56%	11%

Mostly rejected—rejected in more than 90% of the cases requested; partially accepted—accepted in the range of 10 to 90% of the cases requested; mostly accepted—accepted in more than 90% of cases requested.

4.5. Other Challenges on Construction Projects during the Pandemic in Serbia

The respondents' general attitudes and impressions about other essential factors for the successful implementation of the project during the pandemic, in addition to already isolated hindrances, were recognised as the most important factors, in addition to the actions of companies and public authorities, the offer of the construction market, the workforce market, and the regularity of payments (Figure 6). The respondents differed in their assessments of how successfully some of the activities above were implemented during the pandemic. A large percentage of respondents (71 and 51%) evaluated the proactive actions of the company and regularity in payments as either excellent or good. The adequate action of the company is not surprising because the construction sector is subject to many influences and constant risks. Hence, the project participants were ready for an up-to-date reaction and working in the new situation.

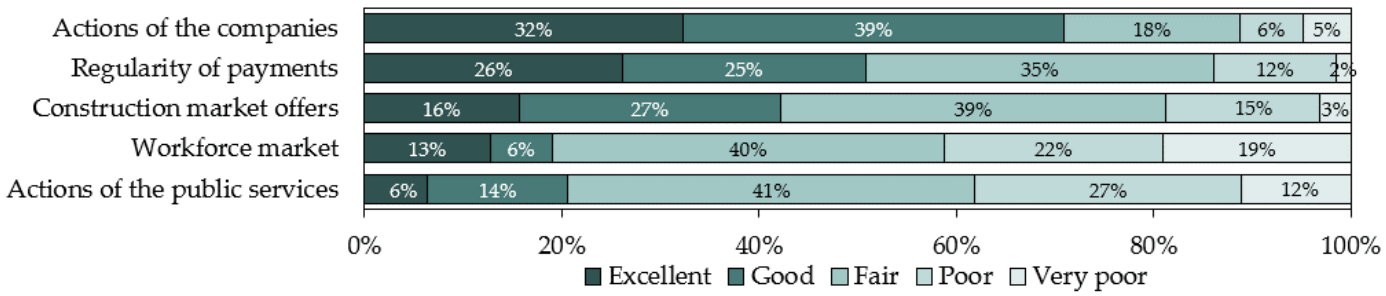

Figure 6. Other COVID-19-related challenges and the size of their impacts on the construction projects in Serbia.

In contrast, the workforce market and the activities of authorities and public services during the pandemic were negatively evaluated. About 80% of those surveyed thought the workforce market was seriously impacted by the pandemic and that public authorities inadequately addressed its effects. Interestingly, 43% of the respondents considered that the offers of the construction market were unaffected by the pandemic.

4.6. Project Management and Governance during the Pandemic

The pandemic not only disrupted the construction site organisation but also had a substantial impact on the head office. According to the first-round survey, 64% of respondents confirmed their workload at head offices had increased. However, only 23% of them indicated that the increase was significant.

In particular, meeting management, operational planning, general project management, project progress management, and productivity management were the activities whose intensity had grown. However, 16 to 25% of respondents recognised the increase of their work intensity, in addition to 5% that stated these activities were newly implemented (Figure 7). This should be analysed with the result that 32 to 39% of respondents lacked knowledge of these head offices' methods of operation. This proportion of No information responses is a direct result of the profile of the respondents, the majority of whom were employed directly on the building site.

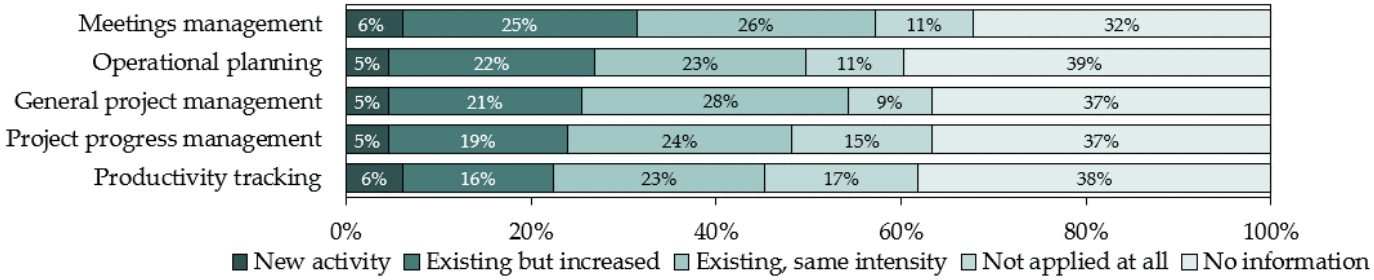

Figure 7. Head office workload intensity of project management activities during COVID-19.

When asked which project management techniques were used during the pandemic to mitigate the effects of COVID-19, the respondents revealed that few contemporary management approaches and processes were utilised. They identified building information modelling (BIM) technology (20%) and methods for delay analysis (20%) as the most used ones, followed by lookahead planning and earned value method (EVM). BIM was mostly used to visualise the progress of the work, while EVM was used to measure project performance. Lookahead planning was used to ensure that the most efficient and proper scheduling protocols were in place for the coming period. Various methods for delay analysis were utilised in claim management processes. Other techniques used to mitigate COVID-19 disruptions are listed in Figure 8. Additionally, the survey showed that 42% of construction projects did not use modern management techniques. The total value exceeds 100% because some respondents confirmed the application of multiple methods on their project.

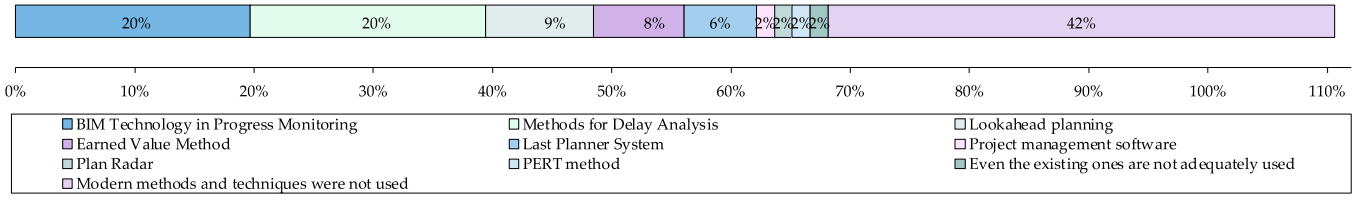

Figure 8. Modern project management techniques applied to mitigate the effects of COVID-19.

Regarding the use of digital tools in the construction industry, only 29% of respondents indicated that digital platforms were introduced for project reporting and communicating, but opinion on their benefits was divided. Half felt the use was beneficial, and the other half believed that the application of digital tools had not improved their projects. Surprisingly, 58% of respondents indicated that no new digital tools were introduced in the preceding period.

4.7. Long-Term Effects of the Pandemic on Construction Projects in Serbia

4.7.1. Remaining Consequences and Measures after Lifting All COVID-19 Restrictions

There was a prolonged period with nearly no infections following the sixth and most severe wave of the COVID-19 pandemic in Serbia, which ended at the beginning of May 2022. During this interval, Serbia has started lifting and relaxing all the measures. With this relaxation, business practices gradually returned to their previous state.

To that extent, the second segment of this research—structured interviews—examined whether it was possible to resume previous practices completely and whether the COVID-19 outbreak provided an opportunity to test out, evaluate the efficacy and eventually adopt alternative business models for the construction industry in times of crises.

Although most previously imposed health and safety measures were revoked, people were advised to follow them. At least 5% of the interviewees confirmed that all measures, once set, were applied at the same level, and on the other hand, at least 8% confirmed that all measures were cancelled (Figure 9).

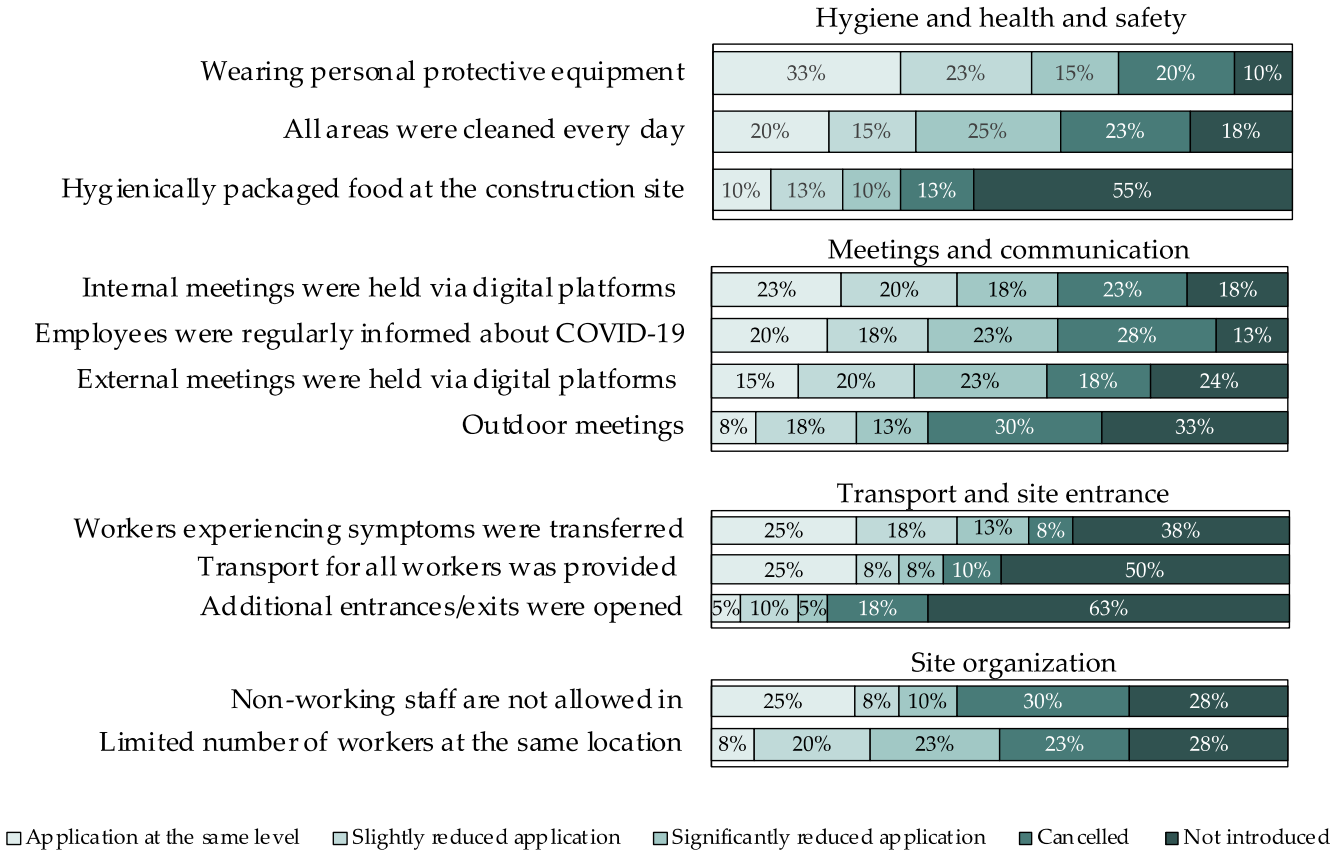

Figure 9. Remaining health and safety measures after lifting all COVID-19 restrictions.

Between 15 and 43% of participants confirmed that implementation of the measures was slightly or significantly reduced in their sites. When looking at individual measures, at the time of the second-round interview, the ones that were implemented mainly at the same level or at a slightly reduced level as previously were the wearing of personal protective equipment (56%), internal meetings via digital platforms (43%), transport of workers with symptoms (43%), and regularly informing employees about COVID-19 (38%).

The interviews revealed that disruptions (mentioned in Section 4.4.1.) caused by the first extremely severe COVID-19 wave that hit Serbia at the end of 2020 remained. Even in the middle of 2022, the interviewees reported that the primary obstacles to the successful completion of construction projects were workforce shortage (30%), material price fluctuations (25%), reduced productivity (18%) and supply chain disruptions (10%). According to more than 80% of respondents, these issues have persisted during the entire period. Similar to 2020, project payments were not a pressing concern, other than for 2% of the respondents (Figure 10).

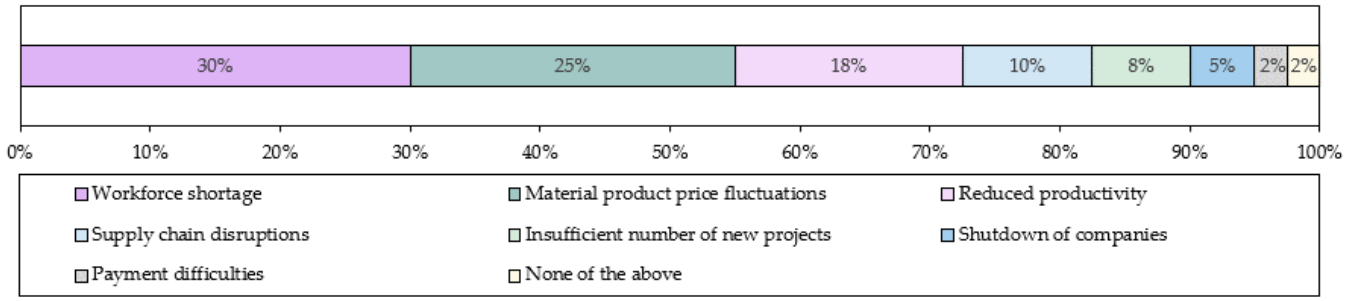

Figure 10. COVID-19-related consequences on the projects' schedule and budget.

According to the second-round interview results, some participants confirmed that to mitigate these long-term COVID-19 impacts, companies either maintained or improved the application of previously introduced mitigating actions. Between 5 and 30% of the participants reported that all the introduced actions were retained throughout the entire period and that their use had improved (Figure 11). When including companies that only maintained these measures and did not improve them, this range was from 12 to 38%, depending on individual actions. In particular, most projects retained communication via digital platforms, 38% at an improved or the same level, but 76% at some intensity, while the home office has remained at some intensity in 46% of projects.

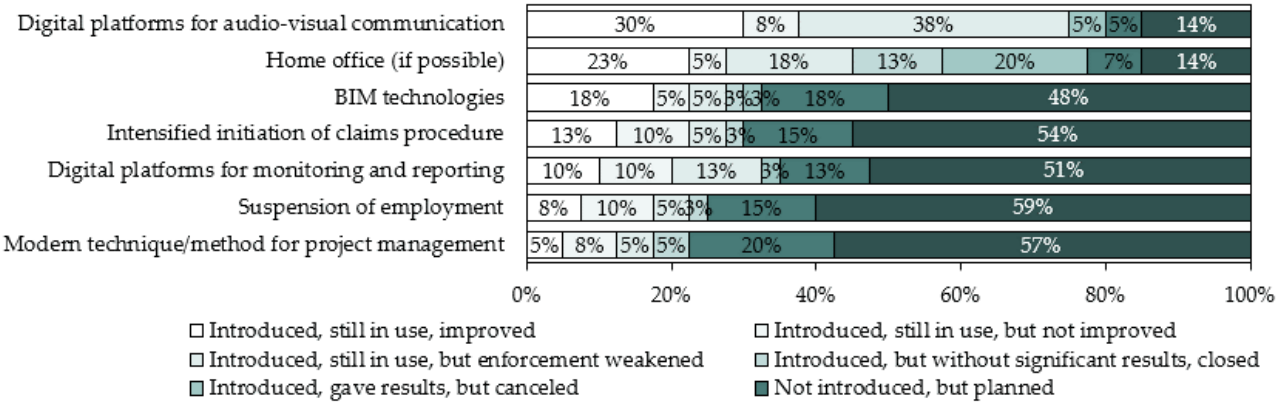

Figure 11. Previously introduced mitigating measures remained after lifting COVID-19 restrictions.

On the other hand, BIM technologies, digital tools for project monitoring and reporting, and intensified contract management activities slowly took over the construction industry. However, the interviewees' opinions are divided; between 10 and 18% stated that these practices were introduced during the COVID-19 pandemic, and their application is now intensifying. Alternatively, 10 to 23% of respondents said their usage had not improved or had even decreased. The majority, around 50%, stated that these practices were not introduced but planned. Similarly, while most of the respondents recognised the need for modern planning and control methods, such as the Last Planner System, EVM, and project management software such as Plan Radar, only 18% use these methods to some extent in their companies.

Even though the pandemic reduced the number of available jobs in other countries, suspension of employment was not a standard business practice in Serbia. Consequently, about 74% of respondents reported that they did not use this measure in previous waves of COVID-19 and did not use it currently. Compared to the first-round survey results, aside from digital communication tools and remote work, none of the other measures examined has been kept and implemented at significant levels.

The measures that were recognised among the interviewees as good and, as such, recommended as necessary practice in project implementation, are separately depicted in Figure 12. Among these measures, more than one-third of the participants identified

the introduction of digital technologies as the most important, with enormous potential to contribute to project success in uncertain conditions such as during the pandemic. The measures that followed aim towards a human-centred environment and well-being. A better workforce allocation, organisation, and working environment, and increased well-being were recognised among 26% of participants as beneficial. A remote working environment for off-site employees was also one of the favoured measures.

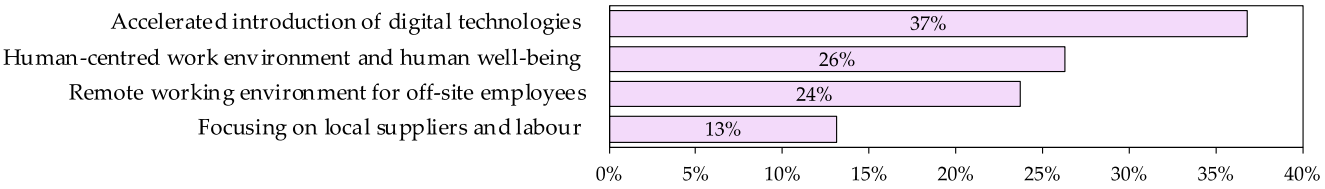

Figure 12. Construction project best practices for future crises.

4.7.2. Is Digitization the Next Normal in the Construction Industry?

The COVID-19 pandemic significantly changed the construction industry. The virus spread and the introduction of health and safety measures forced companies to develop strategies to mitigate the impacts on project schedules and budgets. However, implementing mitigation strategies is common in construction projects as they are frequently carried out in complicated environments and are extremely vulnerable to external factors. For this reason, interviewees were asked to differentiate and assess mitigation strategies implemented in response to the COVID-19 pandemic (Figure 13). In addition to the implemented measures, allowing remote work and imposing health and safety measures, the responses indicate that the COVID-19 pandemic has highly or entirely contributed to the increase in the implementation of digital tools in communication (63%). A sizable proportion of respondents, 51%, believe that the pandemic accelerated the adoption of new digital project management tools and, in the same proportion, also contributed to better organisation of the work environment. In addition, the findings demonstrated that while the pandemic improved workplace organisation and human resource allocation, it did not move companies in Serbia toward the domestic market for goods and labour. Despite the shortages, 44% of respondents stated that COVID-19 did not influence their decision to prioritise local labour and supplier markets. The respondents' opinion regarding the use of online monitoring is divided. Half of them think that the pandemic had no impact, while the rest still believe that it triggered the use of online monitoring in their companies.

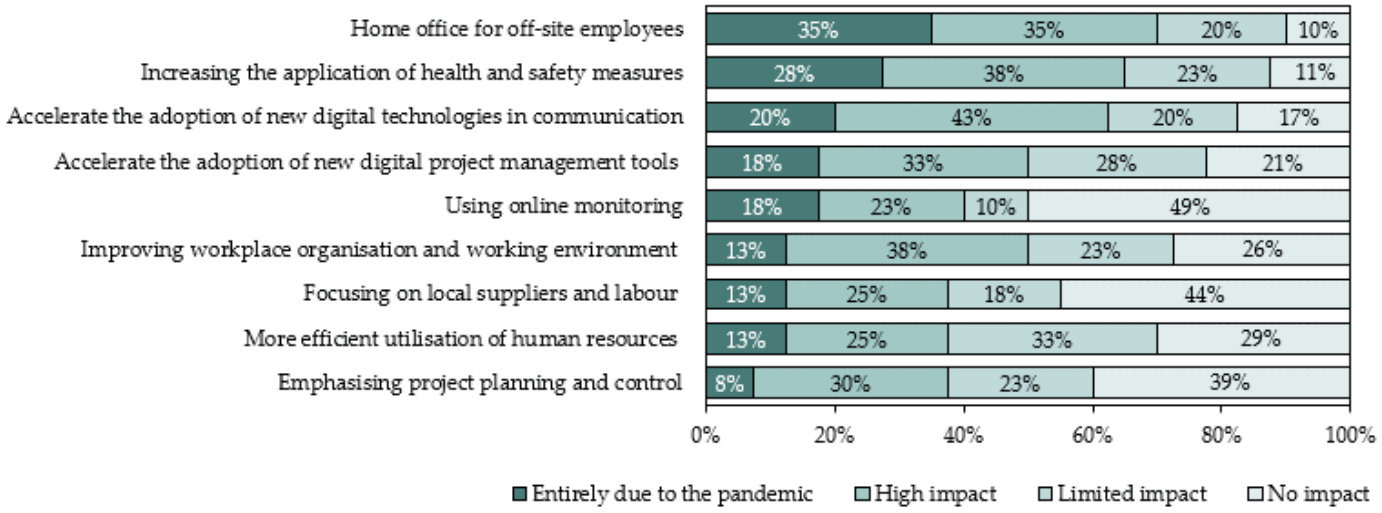

Figure 13. Response strategies attributed to the COVID-19 pandemic.

After identifying and assessing the difficulties the COVID-19 pandemic posed for construction projects in Serbia, the management's efforts to keep project execution on schedule and within budget, and determining which of the measures remained as best practice, the question of the future of the construction industry arises. Discussing how this future will look was one of the key components of the structured interviews. To this extent, about one-third of the participants predicted that digital technologies would be the primary means for communication, planning, monitoring, and controlling the implementation of investment projects in the coming years in Serbia. Only about 12% of the participants believed that reducing paperwork would become the new norm. Interestingly, even though about one-third of the respondents witnessed the positive effects of remote working during the pandemic and would recommend them as good practice, just 12% of them believed this would become the next normal within the industry. Finally, complete digitalisation and emerging technologies such as live stream monitoring of projects and blockchain technologies are out of reach in the near future in Serbia.

5. Discussion

The findings from the first survey indicated that the government restrictions and health and safety guidelines were implemented significantly. According to more than 75% of the respondents, hygiene, health, and safety, and efforts supporting social distancing, such as restricted access to non-working staff, meetings with limited attendance, transportation provided for all employees, regularly informing about COVID-19, etc., were the most widely introduced. Most of these measures coincide with measures adopted worldwide as a response to the pandemic; for instance, UK sites reported increased housekeeping, additional shifts, resequencing of works, reorganisation of site facilities and routes, and restricted site access [8–10].

Both the virus' spread and the measures implemented to prevent it affected the implementation of projects in Serbia. This was confirmed by more than half of the respondents. Similar to previous studies [15–17,21,24], construction projects in Serbia were mainly disrupted by material-related problems such as material shortages, price fluctuations, and delayed deliveries. In contrast to prior research, where workforce shortages ranged from 30 to 90% [12], according to half of the respondents, the number of infected workers per day in Serbia did not exceed 10% in all waves. However, even with this small percentage, the productivity drop was inevitable, and it was confirmed on more than a third of the projects. Fortunately, the productivity drops in Serbia were mainly labelled as moderate in contrast to construction projects in Malaysia [24], which reported a productivity drop of 50%. The reasons for this may lie in Malaysia's high percentage of skilled labour shortages, reported as 40% during the pandemic [24].

The survey results revealed that 34% of the investigated projects had time overruns of up to 30 days, while 21% of the examined projects had time overruns between 30 and 90 days. Given the fact that the duration of most of the investigated projects (60%) had been between 6 and 24 months, the pandemic-related disruptions may delay the completion of between 4 and 25%—or even up to 50%—of projects in Serbia. Similar percentages are also reported in the United States (US) (28%) and UK (40%) [24].

When asked to quantify the cost overruns, about 65% of the respondents indicated that the cost overruns were less than 10%, mainly attributed to material price fluctuations and costs related to time overruns. These overruns are two times lower than Malaysian findings [24]. In addition, compared to other countries, Serbia's economic disruptions could be characterised as mild to moderate, with a GDP decrease of 5.2% in 2020. In contrast to the US and EU's economies, which have shrunk by 6.1 and 7.8%, respectively, or India and the UK's GDPs, which shrunk by 10.2 and 10.7%, respectively [47], Serbia was less affected by the pandemic.

Even though most of the projects experienced time and cost overruns, not a single request for compensation was initiated in 55% of the projects. The reasons for this are numerous. First and foremost, contractual aspects are difficult to interpret and it is difficult

to quantify the pandemic-related consequences. Therefore, it is unsurprising that 50 and 22% of requests for time and cost reimbursement, respectively, are unresolved. The finding that 50% and more of the submitted requests were granted to some degree demonstrates that the clients are aware of the pandemic's impact on projects and are willing to provide remuneration. However, the low percentage of fully granted requests suggests that many disputes regarding the amount of cost and time reimbursement can be anticipated. Considering that most of these requests should be settled through contractual instruments, time-consuming disputes are more likely to occur when contractual procedures are less specific, liability is not clearly shared, or contractual provisions are ambiguous or insufficient. In this aspect, Serbia's construction sector has room for improvement.

When it comes to other disruptions, most of the previous studies reported delays in payments and decreased number of new jobs as one of the biggest challenges caused by the COVID-19 pandemic [17–19,22]. This was not the case in Serbia, where these problems were identified as insignificant. The large participation of government and public funds, which financially helped mitigate COVID-19 consequences, can explain this. However, most respondents believed that actions by public authorities, particularly those oriented toward the workforce market, might be improved. For instance, in Australia [31], regional governments increased the number of infrastructure projects to help the national economy and introduced new procurement policies aimed at creating social values for vulnerable demographic groups.

Despite the increased workload and activities imposed by the government, most respondents believed that their companies' responses were appropriate. Unfortunately, most of these responses relied on traditional project management procedures, i.e., about 40% of projects did not use any innovative management techniques or digital technologies. The remaining projects primarily used BIM (18%) to visualise the project status and delay analysis techniques (18%) to quantify a time impact on the project. Additionally, the use of BIM intensified during the pandemic. Serbia is not far behind other European countries in the application of BIM technology; for example, in the Analytical Report on Digitalisation in the construction sector, France reported that 38% of construction companies use BIM, while Poland indicated that only 12% of construction companies do [4]. This has even greater significance when one considers that BIM adoption across the EU is linked to the legislative framework in place, while it is not in Serbia.

Unfortunately, a sizable portion of respondents stated that their companies do not currently have plans to implement strategies such as the Last Planner System, EVM, or any additional project management software, such as Plan Radar. Digitising in construction, in terms of electronic commerce, digital administration, blockchain technologies in contract management, and live stream construction performing, are far removed from business as usual at Serbian construction sites, according to more than 50% of the experienced professionals interviewed. Similar to United Arab Emirates (UAE) [33] and Nigeria [48], according to 76% of the respondents, the pandemic increased the use of digital tools primarily for communication among the project actors.

Even if it does not lag substantially behind in the deployment of BIM technology, a small part of the Serbian construction sector remains sceptical of the benefits that digitalisation might offer: 15% of responders fall under this category.

Finally, it cannot be argued that digitalisation and modern management methods have been widely adopted in Serbian construction. Additionally, the pandemic did not successfully eliminate a traditional barrier to implementing digital technologies: resistance to change. However, the pandemic enhanced the awareness of digital technologies, their applications, and their advantages, as most participants consider digitising and modern project management technologies as the next normal in the Serbian construction industry.

Respondents also indicated that measures towards a human-centred working environment and human well-being, such as remote working, are good practices implemented during the pandemic. At the same time, only a small percentage of them evaluate these practices as something that should be the future normality in construction in Serbia, thus

further highlighting the significant room for improvement of a human-centred approach at the construction sites.

Finally, to increase project resilience and develop more sustainable project management strategies in times of crisis, the companies in Serbia should consider modifying their corporate, risk, and resource management practices. For instance, shifting site organization toward less labour-intensive operations and off-site construction is crucial in establishing economic sustainability. Another strategy should be to properly allocate contractual risk, leaving no possibility for ambiguous or unclear contractual provisions. When social sustainability is in question, companies should focus on raising social value for workers and other stakeholders, creating better working environments, and enhancing employee engagement. Unfortunately, despite the widespread availability and accessibility of digital tools, Serbian businesses have not yet fully realised their potential for enhancing sustainability in their project management practices.

Looking at the regional level and beyond, the impact of the COVID-19 pandemic is highly heterogeneous, with significant differences in countries' vulnerability and policy responses. Extending the research to countries in the region and beyond would provide examples of effective policy responses and a forward-looking perspective on developing more resilient regions. The same qualitative research methods, i.e., questionnaire surveys and structured interviews with a focus group, may provide feasible alternatives for research design and data collection in other countries. However, certain variations in the questionnaire may arise based on country regulations, organisational culture, and construction practices. For instance, in countries with a long-term lockdown, there should be a greater emphasis on social aspects owing to long-term absence from work and financial implications for companies and beyond.

To better understand the discussion and further support the conclusions, an advanced statistical analysis has been performed. A Spearman's rank correlation coefficient was run using the software package SPSS Statistics version 27. Spearman's rank correlation coefficient is a nonparametric (distribution-free) rank statistic proposed to measure the strength of the association between two variables. The strength of the correlation is reflected in the r_s coefficient, which can take values from +1 to -1, where zero indicates no association between variables, +1 indicates a perfect positive, and -1 indicates a perfect negative association of variables. Correlation matrices were calculated according to the same question that groups identified for the alpha coefficient calculations. In the group of 15 questions with the Likert scale, strong and very strong correlations (0.6 to 1.0) were found between the variables relating to the workforce, material, equipment, and productivity issues. In contrast, these issues are very weakly or weakly correlated with indirect disruptions such as labour market, payment consistency, and department engagement for planning. Similar correlations were found among the variables in the binary group of questions. Moderate to very strong (0.4–1.0) correlations were found between productivity drop, workforce materials, and machinery issues, while suspension of work, additional shifts, and formwork issues were correlated as weak or very weak (0.0–0.4). Correlations between 17 items of a matrix question focused on government-imposed health and safety measures were found to be weak or very weak in most, with no great numbers of moderate and higher correlations. This was expected, because the companies did not impose the measures as a package, but each measure was separately decided, so one measure did not implicate the other.

However, a weak correlation was found between a certain number of variables among the different groups of the questions. This includes the correlation between the application of epidemiological measures and the number of sick workers at the sites (0.29), indicating that even though the companies followed almost all imposed measures, the spread of the virus was difficult to control. A weak correlation was also found between the project cost and time overruns, and the introduction of digital technologies (0.33 and 0.28, respectively), supporting further the observation that the pandemic did not significantly increase the use of cutting-edge digital technologies.

6. Conclusions

The COVID-19 pandemic has affected society as well as the economy of every country. Stability in the construction industry, one of the largest global economic sectors, has undoubtedly been disrupted, and the entire chain has struggled to adapt to the sudden changes. Extensive studies have been carried out since the pandemic's earliest stages (back in 2020) to investigate the disruptions brought on by the pandemic and its remedial measures. Their effect on projects' success, appropriate strategies, and contractual provisions that could be used to mitigate and compensate for the adverse effects was also focused on. This paper aims to expand knowledge with an in-depth analysis of the short-term and long-term effects of the pandemic on the construction sector in Serbia. To this extent, the disruptions during construction project implementation caused by the COVID-19 pandemic were identified, and their consequences on projects' budgets and schedules were quantified. The study also investigated measures and guidelines to mitigate these adverse effects, with the additional objective of determining the ones which may help establish a safe and efficient working environment for implementing projects during this and future pandemics. In this context, a particular emphasis was placed on how the pandemic influenced the adoption of modern project management practices and accelerated the digital revolution in the Serbian construction industry.

The research was carried out through a two-round survey. The first round was an online questionnaire among participants in 65 construction projects, and the second was structured interviews with a focus group of 40 participants. The surveys were conducted one year apart to obtain a comprehensive overview of the short and long-term impacts of COVID-19 on the projects' success. Descriptive statistics were primarily used for the quantitative examination of the data.

The general conclusion is that the COVID-19 outbreak had a significant impact on the operation of the construction sites in Serbia but did not significantly jeopardise projects' success. One might say that the volume of pandemic-related disruptions was minimal because construction companies were prepared, as external events frequently influence their projects. Thus, Serbia is not lagging in results regarding the success of the fight against the negative consequences of the pandemic, at least when comparing the economy's growth.

COVID-19 initially caused a workforce shortage in Serbia, resulting in decreased productivity, project delays, and increased costs. The reduced workforce on construction sites and in offices necessitated more detailed planning, more frequent meetings, and, to some extent, expanded the scope of work for the employees. Specific barriers in importing and exporting goods caused material problems, such as price increases and delivery issues, which further impacted procurement delays, costs, and workload. Increasing sick leave among workers increases overall business costs. Viewed comprehensively, additional statistical analysis supports this conclusion by identifying moderate to very strong correlations between workforce, materials, machinery, and productivity issues.

Based on the aforementioned research, the study allows one to infer increasing trends in requests for compensation claims. In general, and over the long term, more inferences, such as the following, are feasible: Companies will focus more on risk assessment and response, particularly in the area of force majeure. Contractual provisions will likely be one of the means that companies would prioritise to better protect their interests in the event of a dispute. In addition, one can anticipate a greater allocation of human resources and budget for the processes of planning and control of project implementation.

Construction is an industry constantly planning and replanning, so proactive action by companies in the event of a pandemic was an expected reaction; nevertheless, there is room for a more human-centred working environment. Additionally, the pandemic has not yet wholly modernised project operations in Serbia by incorporating cutting-edge digital technologies. This is also supported by the correlation analysis findings, which indicated weak correlations between digital technologies and cost and time overruns. Nonetheless, it has prompted project management structures to consider remote control of the construction site, digital administration, digital commerce, live stream monitoring of

the construction site, and the multidimensional application of BIM technologies, paving the way for digitisation to become the next normal in Serbian construction.

Finally, this study's findings may help stakeholders shape better employment and work environment strategies and reconsider how to increase human well-being at construction sites and offices, thus creating social values. Future research should focus on identifying specific actions that may be adopted to strengthen community cohesion. In addition, the research offers the management of construction companies in Serbia a clear message for expanding the use of digital technologies, starting with raising awareness of their importance. More research is required to establish the specific implementation route and all relevant factors.

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