THE PREVENTIVE MEASURES OF PANDEMICS ON CONSTRUCTION PROJECTS: LESSONS LEARNED FROM COVID-19'S IN SAUDI ARABIA

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Abstract

The COVID-19 pandemic had disastrous effects, particularly on construction projects, which resulted to work stoppage. Though, most construction industries explored preventive measures such as social distancing, working online, wearing personal protective equipment and upholding good hygiene to keep the construction projects back on track. This study thus aimed to examine the relationships between the current state of COVID-19 pandemic on the Saudi Arabia's ongoing construction projects and preventive measures based on the lessons learned from the pandemic. Accordingly, a purposive sample of 147 construction based professionals involved in selected projects within Saudi Arabia participated in the sirve. The results shows that COVID-19 preventive measures had significant impact on Saudi construction projects. Furthermore, project time was most significantly impacted by COVID-19 pandemic, followed by productivity, material management, human resources management, and project cost. Moreover, Pearson's correlation exhibits a significant positive correlation ($p<0.05$) amongst the perceived impact of the COVID-19 preventive measures and construction projects performance. Impact of Government supports and sector differences on COVID-19 preventive measures were also assessed. The t-test results showed that companies which received government supports were perceived to have less impact of COVID-19 measures. While, using ANOVA statistics, companies that provide service for both public and private sector appeared to have most impact of COVID-19 measures. Overall, this upholds the perception that lack of adherence to COVID-19 preventive measures could distort the whole construction process. It was thus recommended that construction industries should clinch on innovative and diverse use of technologies in the age of multi-faceted disruption.

Keywords: Construction professionals, Construction projects, COVID-19 pandemic, Inferential statistics, Kingdom of Saudi Arabia, Preventive measures.

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Introduction

In January 2020, the World Health Organization (WHO) officially proclaimed Coronavirus (COVID-19) a global pandemic. Since the WHO announced the first cases on 31 December 2019, COVID-19 has spread throughout the world. As at 30 Dec 2023, the WHO confirmed 772 million cases, and 6.98 million deaths (WHO, 2024). The Saudi Center for Disease Control (CDC) (2021) stated that the number of confirmed cases continued to increase reaching a high of 30,000 positive tests in June 2020, as shown in Figure 1. At July 1st 2021, over 487,592 cases had been confirmed with 7,819 recorded deaths (WHO, 2021) (Figure 1).

Accordingly, this pandemic not only impacted human health but also the operations of businesses and organizations, including the construction industry (Ogunusi et al., 2020). For instance, the UK Office for National Statistics (UK-ONS, 2020) reported that the country has not had a significant GDP decline since the 2008/2009 economic recession until the quarter of 2020 as a result of the COVID-19 pandemic, when the construction sector saw a 2.6% decline. In addition, South Africa faced severe labour shortages, a large national debt and low spending on infrastructure as a result of a faltering economy (Hughes, 2020). The Saudi construction industry also faced poor project management, decreased in workforce, disruption in supply chain, and poor financial management in 2020 due to the pandemic, and considerable decreased in state wealth as a result of reduced oil prices (Alsharef et al., 2021; Jallow et al., 2020). Similarly, research by the US – Saudi Business Council (USSBC, 2021) revealed that this led to lowest value of 80 billion Saudi Riyals in contracts that were awarded in 2020. In the fourth quarter of 2020, the USSBC Contract Award Index (CAI) dropped to 95.8 points, suggesting that nearly completed construction projects would probably come to a standstill.

No doubt, COVID-19's extensive effects have had an impact on Saudi construction projects. Consequently, the Kingdom of Saudi Arabia has developed measures to keep businesses and organizations, including the construction projects on ongoing (Alhammadi, 2022; Baveja et al., 2020). These measures include social distancing, working online, use of personal protective equipment and hygiene (Almutairi et al., 2023; Khalfan and Ismail, 2021). However, the effectiveness of these measures in Saudi construction industry has yet to be studied. Thus, this study seek to examine the relationships between the current state of COVID-19 pandemic on the Saudi Arabia's ongoing construction projects and the preventive measures based on the lessons learned from the pandemic. This will pave way for the KSA to reinvent by safeguarding the construction business in any global challenges.

As a result, the findings from pertinent literatures regarding COVID-19 and construction industry, and the preventive measures based on the lessons learned from the pandemic were presented in this study. The research methodology was then discussed, with an emphasis on the findings from the perspective of construction based professionals. The research conclusion and recommendation were summarized in the final section.

Literature Review

COVID-19 and Construction Context

The impact of COVID-19 pandemic on the world economy has been unmatched (Jallow et al., 2020). The worldwide financial shock, the duration of the recession that followed and the speed of recovery was partly influenced by government backed fiscal and monetary support, and partly by the adoption of new anti-COVID health regulations (Ogunusi et al., 2020). This situation has made a number of obstacles for the construction industry in specific, as can be seen in Figure 2. Though, before the pandemic, Dobrucali et al. (2022) specifies that ten countries accounted for 73% of the world's construction and infrastructure investment: Australia, China, France, India, Italy, Japan, Saudi Arabia, Spain,

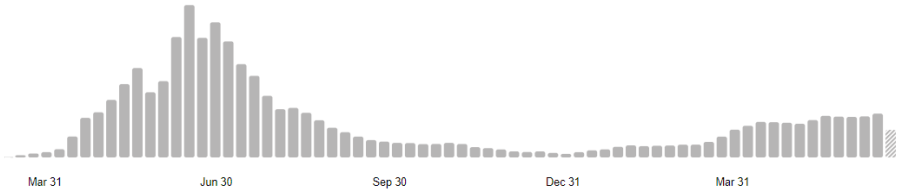

Figure 1. The number of confirmed cases in Saudi Arabia (WHO, 2021).

the United Kingdom, and the United States. During the pandemic, Jallow et al. (2020) estimated that the construction sectors in the Euro area will not return to pre-crisis 2019 levels until 2023. Al-Khaldi, (2021) forecast that COVID-19 will continue to have a noteworthy effect on the construction industry even after lockdown measures are loosened or removed (Figure 2).

Accordingly, the OECD calculated the Saudi Fiscal deficit, which is expressed as a percentage of GDP, and to be 4.5% in 2019, rising to 11.4% in 2020. The UK's budget deficit for 2020/2021 has a similar percentage equivalent to 11.8% of GDP. Moreover, only Qatar does not show a current account deficit since the onset of COVID-19. Furthermore, the Saudi performance is similar to that of Kuwait than Bahrain [-16.6%] and Oman [-16.9%]. Though, this deficits could not prevent project delay, but they were generally successful in avoiding the cancellation of construction projects. Besides, Ogunusi et al. (2020) asserted that the first wave of the pandemic in the Euro region reduced construction productivity by 25% to 30%. In countries such as Germany, the construction sector operated without significant disruption. However, there were significant restrictions on the activities of the construction sector in majority of other European countries, including France, Italy, Spain, Slovakia, and Ireland. On the other hand, the second wave of the pandemic was less disruptive to construction industries as the workforce had adjusted' to new health measures (Al-Khaldi, 2021).

However, construction industry is deemed critical to the completion of important public infrastructure which will help to revamp the local economies after COVID-19 (Gamil and Alhagar, 2020). Thus, Alhammadi, (2022) pointed to a set of universally applicable guidelines for construction workers on how to deal with the virus in the workplace. The Saudi government has committed to a support package of USD $13 billion worth preventive items, particularly aimed at their SMEs and private sectors (Gamil and Alhagar, 2020). This makes it possible for important construction projects to resume after lockdown.

The preventative measures to curtail the pandemic recommended by governments and the World Health Organization (WHO) include social distancing, constant hand washing, wearing of personal protective equipment (PPE), working on-line from home, Quarantine, border controls, isolation, and vaccinations. In addition to other hygiene measures, the Center for Disease Control (CDC) and WHO indicated that clean and protected work environments are crucial to restricting the spread of the virus. This is because construction workers have proved susceptible to infections. For example, a study in Los Angeles, reported that the construction workforce were reported to have higher numbers of workforce infections compared to transportation, manufacturing and even healthcare (Dobrucali et al., 2022). In another study of the US construction sector, Alsharef et al (2021) found the risk of the virus spreading among the workforce to be significantly high. Also, Almutairi et al. (2023) reported that when compared to other industries, construction workforces showed much higher hospitalization rates as a result of COVID-19. These studies confirm the necessity of controlling both the work-place and travel conditions to and from it.

Accordingly, Saudi is relatively successful in preventing the spread of the pandemic, which was aided by strict containment measures; early introduction of strict quarantine and curfews enforced by severe penalties for non-compliance. (OECD, 2020). In other countries, an initial lock-down was followed by a work from home policy where possible (Aryal and Mishra, 2020). Though, these measures interfered with project management, which led to projects delay. Alsharef et al. (2021) looked into the effects of COVID-19 in the US construction industry. They found that there were delays in the delivery of materials, shortages of both materials and workforce, lower productivity among workers, disruptions of cash flow and financial losses, and possible conflicts and disputes in the future. Rehman et al. (2021) examined the impact of COVID-19 on project performance in the UAE construction industry, and recounted materials and labour shortages, which they concluded that projects delay will be unavoidable. They also emphasized that "force majeure" clauses should be enforced in future to avert contract disputes. However, they stressed that UAE construction demonstrated flexibility in absorbing the impact of time and cost overruns through effective contractual modifications and state financial support, as well as resilience by adjusting to the new working norms. In Malaysia, Zamani et al. (2021) found that COVID-19 caused working and financial issues such as project timeline, reduced labour, and increased project cost. Amoah and Simpeh (2020) describe the adversities faced by South Africa's construction industry when implementing measures to curb the spread of COVID. Al-Khaldi, (2021) link low wages and unsafe workplace environments. Biswas et al (2021) studied the global economic impact of the virus and highlighted supply chain management, transportation and labour shortages as shared areas of difficulty for all affected countries. Ogunusi et al. (2020) studied the effects of the pandemic on EU industries, and found out that businesses with a high level of digital preparedness suffered the least. Dobrucali et al. (2022) recommended exploring robotics to lessen human interaction and the procedure of prefabrication and other off-site construction methods to restrict the pandemic's spread in the workforce.

From the foregoing, there is variation in compliance with, and the acceptance of the enforcement of COVID-19 guidelines. This is in agreement with Stiles et al. (2021) who examined the efficacy of anti-virus health directives and concluded that risk management regulations were clear and forceful, but methods of implementation and their efficacy vary according to culture, geography and the example set by elites. Though, the guidelines set depend on the degree to which COVID-19 has restricted construction projects performance. The evaluation of construction projects performance plays a key role in improving project management (Alhammadi, 2022). There is an extensive literature on the topic of what constitutes construction projects performance. However, there is no agreement upon the fundamental factors except the golden triangle of time, cost and quality. Moreover, most highly cited papers also takes time, cost, quality, site management, material management, human resources management and productivity as elements that constitutes construction projects performance (Construction Industry Institute (CII), 2011; Chan et al., 2004). It is based on these elements that construction projects performance will be evaluated in this study.

Preventative Measures of COVID-19

Most nation-states have followed WHO guidelines and implemented similar counter measures. It has been open to any state to follow WHO guidelines to protect a national resources or support a perceived weakness. In July 2020, the Saudi Centre for Disease Prevention and Control set out 51 preventative measures or protocols to protect and revive the construction sector. These protocols covers all economic and commercial activities, which share a common aim to restrict the spread of the virus. As a result, the Saudi Construction Sector Protocols are categorized into four aspects: social distancing, applying new hygiene, working from home, and wearing Personal protective equipment (PPE) (Alhammadi, 2022).

Social Distancing

The term 'Social distancing' describes efforts to stop the spread of COVID-19 by reducing direct physical contact between potentially infected and healthy people (Almutairi et al., 2023). These restrictions will involve finding new

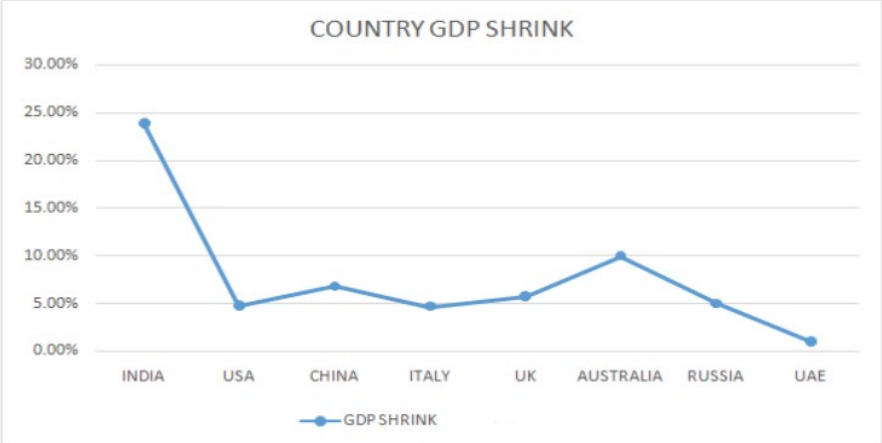

Figure 2. Percentage of GDP shrinks in construction sector (Biswas et al, 2021).

safe means of travel to work and new safe means of social interaction to remove uncertainty and make work productive and safe. Alsharef et al., (2021) described how US workers followed social distancing guidelines. This involve alterations to standard practice to avoid unnecessary staff interaction, three staggered shifts of workers, workers reported at different times to limit social interaction. Also, activities that attracted a crowd, such as the onsite sale of food and drink were suspended. The number of workers in the breakroom was restricted, and these restriction spaces were relocated to outdoor areas. Generally, there were few objections to the inconvenience of the new rules. Workers understood that creating the safe-spaces they wanted required cooperation with employers. Accordingly, the Saudi Construction Sector Protocols regarding social distancing are summarized as follows.

- Every queues locations should be clearly marked at least 1.5 meters to keep workers apart
- When working outdoors ensure 1.5 meters recommended is maintained between workers. While, when working indoors, there should only be one worker per 4 square meters. If this isn't feasible, task duration should be shortened and workers should always wear cloth masks.
- Define zones where workers who are more susceptible to infection such as those of 65 years of age or older, those with long term illness can avoid contact with others
- Keep workers who have a temperature of 38oC or higher in isolation, and prevent them from accessing areas

Applying new higiene

Immunologists agree that the virus is more likely to spread indoors where it is more likely to be stagnant. Thus, creating an airflow using doors and windows, and the need for workplace sanitization, achieved by frequent wiping of surfaces with a light disinfectant is advisable (Biswas et al. 2021). The strategic placement of sanitizer ensures high cleanliness standards. It also acts as a reminder to be alert to possible transmission in the workplace. Jallow et al. (2020) stated that as a protective measure, hand sanitisers have also been available throughout the site as well as in vans and work vehicles. The Saudi Construction Sector Protocols regarding new hygiene are potted below.

- Minimize the amount of materials that workers share among themselves (like drinking water dispensers, etc.).
- Regular cleaning of all frequently touched surfaces, both before and after each shift.
- Provide waste baskets and trash cans that can be used without touching them, and waste needs to be disposed of regularly.
- Make sure losed construction and maintenance sites have enough ventilation.
- Post notices of health and personal hygiene guidelines, as well as the most recent information on COVID-19 developments at the entrances and communal areas.

Personal protective equipment (PPE) procedures

The traditional protective clothing associated with construction such as; helmets, steel-toe capped boots and so on, has been supplemented with clothing to prevent transmission of the virus (Biswas et al 2021). Face-masks, gloves and the frequent use of a hand sanitizer are the three core elements of personal protective equipment. Alsharef et al., (2021) indicated that as construction work is by nature collaborative, wearing a face-mask gave workers a feeling of security in shared workspaces. The summarized points below are the Saudi Construction Sector Protocols regarding PPE (Alhammadi, 2022)

- No employee with a body temperature over 38C is permitted entry to the site
- Personal protective equipment in the form of masks and gloves should be mandatory at work. Forklift and crane drivers are not exempt.

Working on-line from home

As a protective measure, staff have been asked to work from home and most companies have embraced the arrangement as a means of keeping staff healthy and productive (Baveja et al., 2020). For instance, non-essential workers were encouraged to work from home, supervisors in the US were even asked to work from their vehicles, thus reducing the number of workers working in confined spaces. Alsharef et al. (2021) found that a considerable proportion of non-site professionals were able to transition to working from home. Nevertheless, Biswas et al (2021) argued that only a minority in the construction sector can work from home as only designing, planning or estimation and costing can be done with software at home. The points summarized below are the Saudi Construction Sector Protocols regarding working from home (Alhammadi, 2022)

- Where ever possible, allow administrators to work remotely from home.

Workers aged 65 years and over who are at higher risk of infection should stay at home and work remotely.

From the foregoing studies, the preventive measures based on the lessons learned from COVID-19 pandemic were identified. Thus, the driving force behind this study is the lack of information regarding the current state of COVID-19 pandemic on the Saudi Arabia's ongoing construction projects, with a focus on examining if the preventive measures contributed to the effect on construction projects performance.

Research Methodology

Research Design

Rehman et al. (2021) use qualitative evidence for their study on the effect of COVID-19 on construction project performance in the United Arab Emirates (UAE). However, in their study, most of the invaluable legal and accountancy records relating to UAE contracts and work-in-progress were not accessible, making accurate measurements of C-19's influence on project performance incomplete. Alsharef et al. (2021) relied solely upon qualitative evidence. While, Ogunusi et al. (2020) assessed the impact of the C-19 pandemic on EU industries, exploring both quantitative and qualitative evidence. Almutairi et al. (2023) based solely on quantitative evidence. However, when assessing issues such as performance and productivity, quantitative evidence is indispensable. Therefore, from the ongoing discussion on the evaluation of project performance as measured against the preventive measures of COVID-19 in Saudi construction industry, an exploratory approach based on up to date rich qualitative evidence from knowledgeable actors is particularly valuable if supplemented by additional quantitative data. This study seeks to measure the perceived impact of Hygiene, PPE, Social distancing on construction projects performances indices. The construction projects performance indices involve projects time, cost, quality, site management, material management, human resources management and productivity.

Participants

A total of 147 construction based professionals (Civil Engineers, Architects, Electrical and Mechanical Engineers working in private or public sector) participated in this study, and all participants were recruited using a purposive sampling method. Abdulaziz et al. (2019) corroborate this, stating that it is possible to gather more dependable data from effective respondents. The participants were approached using social media platforms (Whatsapp, Twitter, Facebook based groups) designed for construction-based professionals. The researchers made an advert online and relied on others sharing this advert with others. Only participants in management or a supervisory position were selected. Accordingly, the data showed that participants had different educational levels (PhD=4%, MSC=29%, BSC=67%), and had different professional backgrounds (Architecture=51%; Civil engineers=39%; Electrical engineers=4%; Mechanical engineers=3%; other=3%). Participants' experience also varied (0-5 years= 20%, 6-10 years =22%, 11-15 years = 32%, 16-20 years =18%, more than 20 years =8%). The participants also represented companies of different sizes (1-9 employees=11%, 10-49 employees=18%, 50-249 employees=12%, 250 or more employees =59%). The companies carry out projects/services for the public sector (39%), for the private sector (22%) or for both (39%). The participants also indicated various infection rates among employees (under 20% =13%, 20%-30%=26%, 40%-60%=28%, 60%-80%=19%, above 80%=14%). Overall, this indicates the data is collected from suitable categories of participants.

Validity and reliability

The questionnaire was written in Arabic and English and was based on previous qualitative research. The questionnaire was checked by five academics in the construction industry, thus achieved content validity. Following data collection, internal consistency was tested using Cronbach's Alpha. Cronbach's Alpha results revealed that every scale produced an alpha above 0.85, which demonstrated a good reliability.

Data Analysis and Discussion of Results

Overall Impacts of COVID-19 Preventive Measures on Saudi Construction Projects Performance

This study firstly sought to determine the overall impact of COVID-19 preventive measures on Saudi construction projects performance. The perceived impact was measured on a 5-points Likert scale (1=Insignificant; 2=Slightly Significant; 3=Moderately Significant; 4=Significant; 5=Highly Significant). Accordingly, the results shows that all four preventive measures (social distancing, applying new hygiene, PPE and working online) had significant impact on Saudi construction

projects. By arranging the overall impact based on mean scores as shown in Table 1, social distancing had the most significant impact (M=2.91, SD=1.12), followed closely by working online during the pandemic (M=2.71, SD=1.15), the application of COVID-19 Hygiene (M=2.53, SD=1.17) and the least impact was recorded for use of PPE (M=2.39, SD=1.15) (Table 1).

Impact of COVID-19 on Construction Project Performance Indicators

Furthermore, participants were asked to indicate the extent of COVID-19 pandemic impact on the construction projects performance indicators (project time, project cost, project quality, site management, material management, human resources management, and productivity). As presented in Figure 3, project time was most significantly impacted by COVID-19 pandemic (M=3.83), next is productivity (M=3.50), followed by material management (M=3.43), then human resources management (M=3.41), and project cost (M=3.34). The least impacted project performance indicators are site management (M=3.06), and project Quality (M=2.51) (Figure 3).

Pearson's Correlation Between the Current State of COVID-19 Pandemic on the Saudi Arabia's Ongoing Construction Projects Performance and the Preventive Measures

A correlation analysis using Pearson's r Correlation coefficient was conducted to assess the relationship between the perceived impact of social distancing, PPE, Hygiene and working online on construction project performance. Using the overall mean scores for each of the measures, Table 2 shows that there is a strong positive correlation ($p<0.05$) among the perceived impact of all four COVID-19 preventive measures. This indicates that the more significant one preventive measure has on construction project performance, the more impact the other preventive measure has (Table 2).

The overall results shows that all the preventive measures (social distancing, applying new hygiene, PPE and working online) of COVID-19 pandemic had significant impact on Saudi construction projects performance. This is in agreement with Dobrucali et al. (2022) who affirms the necessity of keeping clean and protected work environments, which is crucial to restricting the virus's spread. Construction workforces have proved to be susceptible to infections, as they are reported to have higher numbers of workforce infections compared to transportation, manufacturing and even healthcare. Though, these measures interfered with project management (Alsharef et al., 2021). Therefore, correlation analysis using Pearson's r Correlation coefficient was conducted to assess the relationship between the perceived impact of social distancing, PPE, Hygiene and working online on construction project performance. The findings shows that there is a strong positive correlation ($p<0.05$) amongst the perceived impact of all the COVID-19 preventive measures on the construction project performance. This indicates that the more significant one preventive measure has on construction project performance, the more impact the other preventive measure has. Conversely, there is need for governments' supports to get the construction industry back on track (Gamil and Alhagar, 2020).

Impact of Government support

Independent samples t-test was conducted to assess whether the supports from the government have reduced the impact of COVID-19 preventive measures. 59.5% of the participants indicated that their companies have received government support while 40.5% indicated no support. As presented in Figure 4, the t-test statistics showed that companies which received government support were perceived to have less impact of COVID-19 preventive measures. There was a significant difference between those who received support and those who did not in term of social distance impact [$t(146)=1.72$, $p=0.043$, $d=1.10$], hygiene impact [$t(146)=2.73$, $p=0.003$, $d=1.15$], PPE impact [$t(146)=2.24$, $p=0.026$, $d=1.14$], and average of total preventive measures impact [$t(146)=12.45$, $p=0.015$, $d=1.00$]. However, no significant difference in terms of work online impact [$t(146)=1.62$, $p=0.052$, $d=1.5$] (Figure 4).

Sector Based Differences

Participants explained that their firms provide services for the public sector (39%), for the private sector (22%) or for both (39%). This section looks at whether the impact of COVID-19 preventive measures varied across sectors. Using ANOVA statistics, it was evident that that there was a significant difference between the sectors and the perceived impact of social distance

Figure 3. Overall COVID-19 impact on construction projects performance indicators.

Table 1. Mean scores of impact of COVID-19 preventive measures on Saudi construction projects.

	Social Distancing			Hygiene			PPE			Working Online		
	M	SD	%	M	SD	%	M	SD	%	M	SD	%
PROJECT TIME	3.07	1.38	41.2	2.63	1.37	24.3	2.40	1.27	21.6	2.76	1.29	28.4
PROJECT COST	3.03	1.39	43.1	2.69	1.32	28.4	2.47	1.30	23	2.58	1.30	23
PROJECT QUALITY	2.49	1.33	23	2.36	1.25	20.3	2.28	1.29	21.7	**2.70**	1.26	27
SITE MANAGEMENT	2.86	1.32	32.4	2.49	1.28	23	2.41	1.26	23	2.72	1.40	28.4
MATERIAL MANAGEMENT	2.91	1.35	35.8	2.51	1.26	22.3	2.31	1.24	20.3	2.68	1.33	25.7
HUMAN RESOURCES MANAGEMENT	3.09	1.27	41.9	2.57	1.35	25	2.43	1.26	24.3	2.67	1.32	25.7
PRODUCTIVITY	2.93	1.35	37.8	2.47	1.32	24.3	2.42	1.26	23	2.85	1.38	32.4
OVERALL	**2.91**	**1.12**		**2.53**	**1.17**		**2.39**	**1.15**		**2.71**	**1.15**	

*% indicates the percentage of those who chose significant or highly significant impact

Table 2. Pearson's r correlation coefficient between the perceived impacts of each of the COVID-19 preventive measures on construction projects' performance.

	MEAN	SD	1	2	3	4
1.SOCIAL DISTANCING IMPACT	2.91	1.12	1	.016*	.016*	.046*
2. HYGIENE IMPACT	2.53	1.17		1	.044*	.019*
3. PPE IMPACT	2.39	1.15			1	.010*
4. WORKING ONLINE IMPACT	2.71	1.15				1

*. At the 0.05 level (2-tailed), correlation is statistically significant.

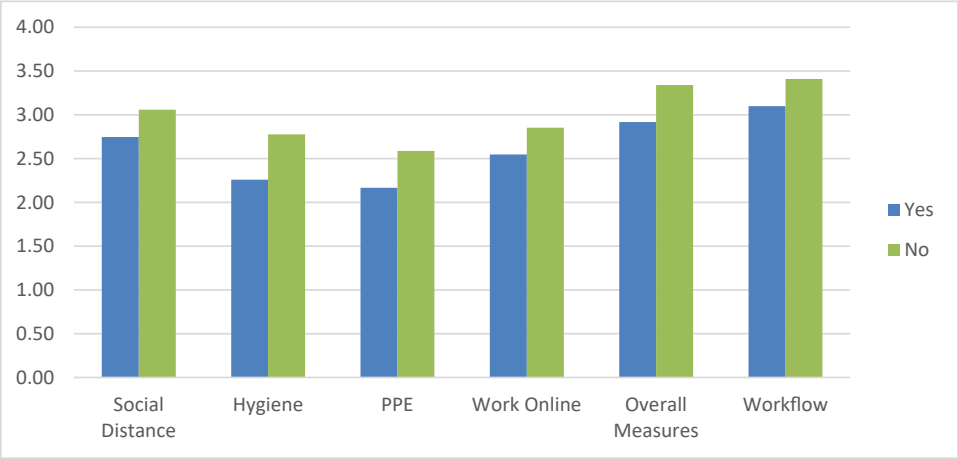

Figure 4. Impact of COVID-19 measures based on Government support.

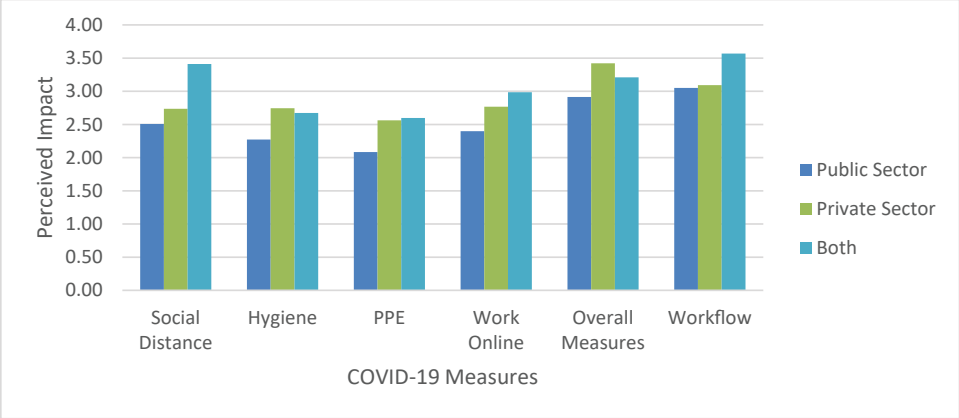

Figure 5. Impact of COVID-19 measures based on sector differences.

F(2,145)=11.45, p<0.001, η2=0.14. Companies that provide service for both public and private sector appeared to have the most impact, while the companies that provide service for the public sector only have least impact as shown in Figure 5. Bonferroni post-hoc statistics showed significant (p<0.05) difference between both sectors. Following the same pattern, significant difference was found between sectors and the perceived impact of PPE, F(2,145)=3.46, p=0.034, η2=0.05, working online F(2,145)=3.95, p=0.021, η2=0.05 and workflow, F(2,145)=5.23, p=0.006, η2=0.07. Post hoc statistics showed significant difference between those who provide service for both sectors and the public sector in both variables (p<0.05). When measuring for Hygiene F(2,145)=2.40, p=0.094, η2=0.03, and overall perceived impact of all COVID-19 measures F(2,145)=2.62, p=0.076, η2=0.03, no significant difference were observed (Figure 5).

Conclusion

Drawn from the results shows that all the four COVID-19 preventive measures (social distancing, applying new hygiene, PPE and working online) had significant impact on Saudi construction projects. Furthermore, project time was most significantly impacted by COVID-19 pandemic, followed by productivity, material management, human resources management, and project cost. Moreover, Pearson's correlation shows that there is a strong positive correlation (p<0.05) amongst the perceived impact of all the four COVID-19 preventive measures and construction projects performance. Impact of Government supports and sector differences on COVID-19 measures were also assessed. The t-test results showed that companies which received government supports were perceived to have less impact of COVID-19 measures. Also, using ANOVA statistics, companies that provide service for both public and private sector appeared to be the most impacted, while the companies that provide service for the public sector only were least impacted.

Overall, the KSA government's assistance initiatives have been crucial in getting construction sector back on track. Moreover, the results upholds the perception that lack of adherence to COVID-19 preventive measures could distort the whole construction process. In view of the above, it was recommended that construction professional/regulatory bodies should ensure adherence to COVID-19 preventive measures. Furthermore, construction industries should embrace innovative and diverse use of technologies in the age of multi-faceted disruption.

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