Examining the Resilience of Construction Supply Chains to Disruptions Triggered by Covid-19 in Abuja, Nigeria

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Received: 25/02/2024 **Revised: 19/03/2024** **Accepted: 24/05/2024**

Disruptions are a concern to construction practitioners because it hinders work flow and construction activities. Research into disruptions in construction work tends to focus on the causes of disruptions in the flow of materials or labour. Another theme in the literature focuses on the relationship between disruptions and the performance of sectors in construction. However, investigations that examine the resilience of construction supply chains to incidents of disruptions are limited. This study aims at examining the resilience of construction supply chains to disruption triggered by Covid-19 in Abuja. The study adopted a survey approach, and data was obtained from structured questionnaires administered online to 90 stakeholders and 70 participants involved in different aspects of construction responded. The study found that contractual disputes and scarcity of materials ranked highest as the effects of disruption and that construction practitioners adapted to the disruptions majorly by reducing the number of material requisitions or by integrating equipment to cater for the shortage of workers. The study argues that members of construction supply chains responded to disruption triggered by Covid-19 with changes and adapted the way they worked or operated as acts of resilience.

Keywords: Construction activities, Disruptions, Resilience, Supply chain, Project

https://dx.doi.org/10.4314/etsj.v15i1.5

INTRODUCTION

Construction supply chains often suffer from disruptions to work flow at different stages in a project. The scale and consequential knock-down-effect of such disruptions are a concern to construction practitioners because construction activities provides employment to a large section of the population (Amucheazi & Nwandem, 2020; Chiang *et al*., 2015). This indicates that disruptions are significant phenomenon in construction management and raises questions on the effects and measures taken to recover from disruptions in construction work.

Some authors present disruptions in construction work as delays in work flow. For example, Mello *et al*. (2015)conceptualized disruptions in supply chains as delays in building. Other authors conceptualise disruptions as interruptions in construction work. For example, Arashpour *et al*. (2014) examined interruptions in construction due to reworks. Recent authors present disruptions as restrictions to construction work due to unforeseen circumstances or events. For example, Ghosh and Hamad (2021) conceptualised disruption as restricting circumstances in prefabrication. These authors show that the concept of disruption is debatable

Two major themes dominate the discussions on disruption in the construction management literature. First, some authors assume that disruptions is caused by construction issues or incidents between stakeholders in construction (Han *et al*., 2009; Kikwasi, 2012). Another theme in the literature assumes that there is a relationship between disruptions and the performance of construction work (Arashpour *et al*., 2014; Thomas & Saud, 2022). However, investigations that examine the resilience of construction supply chains to incidents of disruption are limited. This study aims at examining the resilience of construction supply chains to disruptions triggered by Covid-19 in Abuja. More specifically, the objectives of the study are to examine the level of disruptions triggered by the Covid-19 outbreak (2) to evaluate the relative effects of disruptions triggered by Covid-19 on construction supply chains (3) to examine the adaptive measures adopted by construction practitioners during the Covid-19 outbreak.

LITERATIVE REVIEW

Causes of Disruptions in Construction Work

Several authors assume that disruptions in construction work is caused by issues or incidents between stakeholders in a project. For example, Han *et al*. (2009) interviewed project managers in a railway project in Korea to trace the critical cause of disruptions, and found that the most delayed segment was due to five issues: a route change, disagreements that halted construction activities, structural design changes, prolonged approval permits. They claimed that lessons learnt from engineers can help to better prepare or respond to potential causes of disruptions. In the same vein, Kikwasi (2012) focused on the main causes of disruptions in construction projects and obtained the

views of clients, consulting firms, regulatory boards and construction firms on the causes of disruptions. They found that the main causes of disruptions are: design changes, delays in payment to contractors, information delays, funding problems, poor project management, compensation issues and disagreement on the value of work done. These social issues resonate with the findings in Han *et al*. (2009) study. Kikwasi (2012) argued that the causes of disruptions put construction projects at great risk. Similarly, Okpala and Roslan (2019) focused on the major factors that contribute to disruption in construction projects from project parties in Serdang and found that financial difficulties were the most significant factor that caused disruption. They claimed that disruption can be minimised through increased knowledge and competency of stakeholders and effective government policies. This claims aligns with Kikwasi (2012) stance that disruptions can be curtailed with more knowledge. It can be seen that the above authors assume that disruption is caused by issues or incidents between stakeholders and argue that knowledge or lessons from projects can help to minimize or avoid disruptions in future projects or successive construction activities. However, these studies fail to consider the effects or measures taken by supply chain members to recover from disruptions.

Relationship Between Disruptions and Performance

In contrast to studies that focus on the causes of disruptions, other studies assume that there is a relationship between disruptions and the performance of construction. For example, Arashpour *et al*. (2014) examined the relationship between disruptions caused by rework and time performance in residential construction. They used mathematical models and event simulation to compare the outputs of different call-back time frames of rework and their impact on a house completion time and found that infrequent interruptions with long rework have more negative effects on house completion times compared with frequent interruptions and short rework which lengthens the house completion time. They argued that the frequency or duration of disruption caused by rework significantly affects house completion times and therefore should be considered in construction scheduling. In the same vein, Thomas and Saud (2022) focused on the impact of disruption on the performance of construction workers in India and found that Covid-19 disrupted various construction sectors. They claim that Covid disruptions led to severe labour shortages, financial crisis and delays in delivery. Similarly, Chang *et al*. (2023) focused on the impact of disruptions on the supply of construction materials in Singapore through information gathered from published articles and found that Covid-19 disrupted transportation and labour supply. They claimed that the construction sector struggled to keep up with the rapid changes caused by Covid-19, resulting in lengthy delays. This claim resonates with the argument of Arashpour *et al*. (2014) and Thomas and Saud (2022) that disruptions affects sectors of construction leading to delays. It can be seen that the above authors assume that there is a relationship between disruptions and the performance of construction activities. These authors argue that disruptions significantly impact the supply of materials, availability of labour and time frame of construction activities.

After Disruptions

Studies on disruption in construction activities tend to limit their analysis on the causes or link with performance, however, investigations that examine the effect or response of individuals or groups in construction to certain disruptions has not been fully considered. According to Bode *et al*. (2022) managers tend to respond to disruptions with either a proactive, reactive or adaptive response. A response can be described as actions or inactions taken to cope with interruptions in work flow and this includes technological, financial and managerial decisions to limit the impact on the business (Dergiades *et al*., 2022; Pu *et al*., 2021; Zhang *et al*., 2023). The implication is that the nature of response taken by practitioners in the construction supply chain to recover from disruptions is likely to involve technological and financial measures. The capacity of construction supply chains to withstand the level or effect of disruption can be considered according to Chen *et al*. (2024) and Chih *et al*. (2022) as resilience. The discussions that follows examines the effects and adaptive response of stakeholders to disruptions to work flow in construction supply chains.

Effects of disruption on construction supply chains

Construction supply chains suffered heavy restrictions due to the outbreak and lockdown associated with Covid-19. The restrictions led to multiple disruptions in work flow or network that transforms building materials into finished projects (Kaipia, 2009; Manu & Knight, 2020). This is an example of the effect of disruptions on supply chains. Nigeria recorded its first case of Covid-19 in February 2020 (Osuizugbo, 2020). This prompted the government to take stringent measures to curb the spread of the virus (Ozili, 2021). Examples of those measures that were taken include restricted working hours, social distancing, lockdowns and travel restrictions (Biswas *et al*., 2021; Sierra, 2022). These measures caused disruptions on construction supply chains and the consequence of those measures include worker shortages, material shortages, temporary halts in production, transportation restrictions, delays in the supply of materials, manufacturing slowdowns due to health or safety protocols (Abdillah *et al*., 2022; Umar, 2022). These restrictions impeded workflow at

construction sites that affected five key process in construction such as planning construction work, sourcing of construction materials, fabrication of construction components, transportation of components or sub-components and assembling on site (Cheng *et al*., 2023; Jin *et al*., 2018; Olubajo *et al*., 2017).

Futhermore, the measures taken to control the outbreak of Covid-19 led to several negative effects on construction activities. For example, Osuizugbo (2020) and Ajide *et al*. (2020) discovered that the lockdown and restrictions associated with Covid-19 led to multiple effects such as delays in material delivery, scarcity of construction materials, increased cost of construction materials, labour shortages, restrictions in vehicular movement, contractural disputes and regulations about gatherings that were purnishable. The implication is that work flow in construction supply chains were interrupted and suffered from heavily disruptions. Other consequences of the disruptions triggered by Covid-19 is that the financial viability of construction firms were affected (Abdillah *et al*., 2022; Oladimeji, 2022). These authors show that investigating the effect of disruptions on the construction supply chain offers insights on the patterns of responses to disruptions.

Adaptive responses of construction supply chains to disruptions

Some authors present resilience as the capacity to withstand difficulties. For example, Olubajo *et al*. (2019) challenged the assumption that resilience to difficulties in construction can be improved by merely improving the way that construction programmes are designed. Other authors present resilience as the ability to recover from difficulties. For example, Abidin and Ingirige (2018) conceptualised resilience as a dynamic capability to recover from disruptive events. Recent authors present resilience as the ability to cope or adapt. For example, Wieland and Durach (2021) and Chen *et al*. (2024) focused on the ability of construction firms to adapt or adjust to new set of conditions. These authors show that the concept of resilience is arguable.

In response to disruptions, professionals in the construction can adapt or adjust the way the work as an act of resilience. Seven adaptive measures were identified from studies by Abdillah *et al.* (2022), Amucheazi and Nwandem (2020), Chang *et al*. (2023), Ghosh and Hamad (2021) and Chen *et al*. (2024) as ways that professionals or firms could adapt to recover from disruptions. They include: having alternative suppliers or sources for material, reducing the number of material requisitions, acquiring and adopting new technologies, changing or restructuring their procurement strategies, integrating equipment to cater for shortage of workers, adjustment of working hours and contract reviews that involves an extension of time. These adaptive measures, however, are options and does not always imply that they were adopted.

RESEARCH METHODOLOGY

This study adopted a descriptive survey approach to address the study aim and objectives. Abuja was chosen as the study area because there are likely to be supply chain participants involved in construction and because construction supply chains were potentially affected by the Covid-19 outbreak. The decision to focus on disruptions triggered by the Covid-19 is because the Covid-19 outbreak was universal and there is a potential that majority of the respondents involved in construction activities were affected. A random sampling technique was employed to allow for representation from various members of the construction industry and an online structured questionnaire (i.e. Google form) was adopted to obtain data from construction supply chain participants. After sharing the online questionnaire to 90 stakeholders, a total of 70 responses was obtained and the requisite data on the level, effects of disruption as well as the adaptive measures adopted by participants to disruption. The level of disruption was measured using a 5-point Likert scale: 1= least disrupted 2= slightly disrupted 3= moderately disrupted, 4= disrupted and 5= severely disrupted. This was analysed using a mean score and ranked. The effects of the disruption were measured using a 5-point Likert scale: 1= least significant 2= slightly significant 3= moderately significant, 4= significant and 5= very significant. This was analysed using a mean score and ranked. The adaptive measures were measured using a 5-point Likert scale: 1= least adopted 2= slightly adopted 3= moderately adopted, 4= adopted and 5= highly adopted.

RESULTS AND DISCUSSION

Characteristics of Respondents

The profile of the respondents is presented in Table 1. Table 1 showed that 24% of the respondents were suppliers. 33% of the respondents were contractors. The table also showed that 13% of the respondents were factory managers and 16 % of the respondents are project managers. Table 1 further showed that 11 % of the respondents were subcontractors and 3 % of the respondents were public officials in construction. The implication is that a higher percentage of the respondents are private sector professionals in construction. The table also showed that 27% of respondents had less than two years of experience. 30% of respondents had between two to five years working experience, while 31% of respondents had between six to ten years' working experience. Table 1 further showed that 11% of respondents had working experience that was above ten years. The implication is that a higher percentage of the respondents were not new entrants into the construction as more than 72 % had at least two years and are most likely to have experienced one form of disruption. Table 1 showed that 31.4% of respondents

engaged in building projects only, 14.2 % of the respondents engaged in landscaping projects only. The results further showed that 25.7% of respondents engaged only in civil engineering project and 28.6 % engaged in both building and civil engineering projects. The implication is that combinations of building and civil engineering projects dominate the type of construction works carried out in Abuja.

Table 1: Respondents characteristics

Item	Description	Freq.	Perc. (%)
Role in organization	Suppliers	17	24
	Contractors	23	33
	Factory Manager	9	13
	Project Manager	11	16
	Subcontractors	8	11
	Public officials in construction	2	3
	Total	70	100
Working experience	Less than 2 years	19	27
	2 -5 years	21	30
	6 - 10 years	22	31
	Above 10 years	8	11
	Total	70	100
Type of project	Building projects only	22	31.4
	Landscaping projects only	10	14.2
	Civil engineering projects only	18	25.7
	Building and Civil projects	20	28.6
		70	100

Level of Disruptions due to the Covid-19 Outbreak

Table 2 showed that planning construction activities experienced moderate levels of disruption amongst others with a mean item score of 2.46 and ranked 1st. The implication is that developing or implementing construction plans were the most disrupted activities due to the Covid-19 outbreak. Table 2 also showed that the process of assembling construction components on construction sites also experienced moderate levels of disruption amongst others with a mean item score of 2.30 and ranked 2nd. The implication is that the processes that involved assembling of construction components in the construction supply chain were disrupted by the outbreak of Covid-19. Table 2 further showed that the fabrication of components experienced moderate levels of disruption with a mean item score of 2.09 that ranked 3rd. The implication is that the process of fabricating construction components was disrupted, and this affected the work flow in the construction supply chain. Table 2 also showed that the process of sourcing for materials was slightly disrupted with a mean item score of 1.80 that ranked 4th. The implication is that the process of ordering and receiving delivery of raw materials to fabricate on site or offsite were hindered or disrupted by the outbreak of Covid-19. Lastly, Table 2 showed that the process of transportation and delivery experienced moderate levels of disruption with a mean item score of 1.64 that ranked 5th. The implication is that conveying construction materials to construction sites were hindered or disrupted as a result of the outbreak of Covid-19. These findings aligns with Osuizugbo (2020) findings that understanding disruptions in the construction sector is multifaceted.

Table 2: Level of disruptions on key processes due to the Covid-19 outbreak

Key process in construction	Mean item score	Rank	Decision
Planning	2.46	1st	Moderately disrupted
Fabrication of components	2.09	3rd	Moderately disrupted
Material Sourcing	1.80	4th	Slightly disrupted
Transportation and delivery	1.64	5th	Moderately disrupted
Assembly on Site	2.30	2nd	Moderately disrupted

Effects of Disruption on Construction Supply Chains during COVID-19

Table 3 showed that contractual disputes ranked 1st among the effects of the disruption caused by Covid-19 with a mean item score of 2.23. The implication is that restrictions in construction supply chains due to Covid-19 led to multiple breaches in the terms of contracts between clients and construction practitioners. Table 3

also showed that scarcity of construction materials ranked 2nd amongst the effects of disruption triggered by Covid-19 with a mean item score of 1.97. The implication is that the control measures that followed Covid-19 led to the demand for construction materials outweighing the supply which interrupted work flow on construction sites. Table 3 further showed that regulatory changes ranked 3rd amongst the effect of the disruption caused by Covid-19 with a mean item score of 1.91. The implication is that the restrictions due to Covid-19 led to the enactment of rules and legislations to control the number of people that can gather at construction sites and social distancing altered the way construction process were implemented. Table 3 showed that labour shortages ranked 4th amongst the effects of disruption caused by Covid-19 with a mean item score of 1.87. The implication is that the control measures that followed Covid-19 led to a fall in the availability of supply of construction workers at construction sites and in fabrication of components which indirectly affected the progress of construction work. Table 3 further indicated that delays in material delivery ranked 5th amongst the effects of disruption caused by Covid-19 with a mean item score of 1.79. The implication is that material supply was limited or interrupted as a result of the control measures or casualties caused by Covid-19. Table 3 showed that an increase in material costs ranked 6th amongst the effects of disruption triggered by Covid-19 with a mean item score of 1.69. The implication is that the cost of construction material rose because of the increasing demand amidst a limited supply. Lastly, Table 3 showed that restricted vehicular movement ranked 7th amongst the effects of disruption caused by Covid-19 with a mean item score of 1.66. The implication is that several control measures put in place led to limited vehicular movement which interrupted construction processes and work flow at construction sites. These findings aligns with Chang *et al.* (2023) position that the Covid-19 outbreak led to shortages and increase in construction costs.

Table 3: Effect of disruption on Construction supply chains due to COVID-19

Effect of disruption	MIS	Rank	Decision
Increased material costs	1.69	6th	Slightly Significant
Delays in material delivery	1.79	5th	Slightly Significant
Restricted Vehicular Movement	1.66	7th	Slightly Significant
Scarcity of construction material	1.97	2nd	Slightly Significant
Labour Shortages	1.87	4th	Slightly Significant
Regulatory Changes	1.91	3rd	Slightly Significant
Contractual Disputes	2.23	1st	Moderately Significant

Adaptive Measures to Disruptions Triggered by COVID-19

The results in Table 4 showed that a reduction in number of material requisitions ranked 1st among the adaptive measures with a mean item score of 2.47. The implication is that a higher volume of members in the construction supply reduced or halted the amount of construction materials they purchased or planned to purchase in response to the disruption caused by Covid-19 to reduce the risk of disappointment or loss. Table 4 also showed that integrating equipment for the shortage of workers ranked 2nd among the adaptive measures with a mean item score of 2.36. The implication is that members of the construction supply chain integrated equipment to their work processes to cater for the shortage of construction workers as a response to the disruption caused by the Covid-19.These restrictions are similar with the findings of Biswas *et al*. (2021) study. Table 4 further showed that acquisition and adoption of new technology ranked 3rd amongst the adaptive measures with a mean item score of 2.20. The implication is that members of construction supply chains purchased and engaged digital technologies more frequently in their work process as a response to the disruption caused by Covid-19. Table 4 also showed that an adjustment in the working hours ranked 4th among other adaptive measures with mean item score of 2.10. The implication is that members of the construction supply chain opted to work less hours in response to the disruption caused by Covid-19. Table 4 showed that restructuring procurement strategies ranked 5th amongst other adaptive measures with a mean item score of 2.06. The implication is that members of the construction supply chain changed their approach or strategy of getting construction work done as a response to the disruption caused by the Covid-19. Table 4 further showed that getting an alternative supplier/material sourcing ranked 6th amongst the adaptive measures with a mean item score of 2.00. The implication is that members of the construction supply chain changed their suppliers or where the sourced construction materials as a response to the disruption triggered by Covid-19. Lastly, Table 4 showed that a lot of contracts were reviewed with time extensions which ranked 7th amongst other adaptive measure with a mean item score of 1.96. The implication is that members of the construction supply chain changed or agreed to change the terms of their contract with extensions in time as a response to

the disruption triggered by Covid-19. These findings aligns with Chang *et al*. (2023) and Wieland and Durach (2021) argument that stakeholders in construction need to put more effort in adapting to the unfamiliar obstacles and challenges to ensure resilience.

Table 4: Adaptive Measures of Construction supply chains

Adaptive measures	MIS	Rank	Decision
Alternative supplier/material sourcing	2.00	6th	Slightly adopted
Reduction in number of material requisitions	2.47	1st	Moderately adopted
Acquisition and adoption of new technology	2.20	3rd	Slightly adopted
Restructuring of Procurement strategies	2.06	5th	Slightly adopted
Integrate equipment for shortage of workers	2.36	2nd	Slightly adopted
Adjustment of Work Hours	2.10	4th	Slightly adopted
Contract Review: Time Extensions	1.96	7th	Slightly adopted

CONCLUSION

This study aimed at examining the resilience of construction supply chains in Abuja to disruptions triggered by Covid-19. The objectives of the study were to examine the level and effects of disruption due to the Covid-19 outbreak as well as adaptive measures adopted by construction practitioners during the Covid-19 outbreak. The study found that planning and onsite assembly ranked highest as the two key construction activities with the highest levels of disruption. The study also found that contractual disputes and scarcity of materials ranked highest as the two effects with higher outcomes due to the disruption triggered by Covid-19 and that construction practitioners adapted to the disruptions majorly by reducing the number of material requisitions and integrating equipment to cater for the shortage of workers. The results do not suggest that disruption triggered by Covid-19 had no effect on construction supply chains. Rather, the analysis reveals that members of construction supply chains responded to disruptions triggered by Covid-19 with changes and adapted the way they worked or operated as acts of resilience.

A limitation of this study is that it did not give the respondents the opportunity to fully express themselves. This study contributes to the literature on disruption in construction by examining the patterns in effects and response to disruption. The study has significant implications for construction practice as disruptions are not things that professional are usually prepared for, therefore, the findings of this study is useful in enabling professionals to develop resilient approaches to tackling unplanned issues or incidents in construction works. The study's outcomes have practical implications that will provide insights for policymakers, construction firms, and supply chain members to enhance preparedness and resilience against future disruptions.

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