The Impacts of Bullwhip Effects on Supply Chain and Construction Project's Performance

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ABSTRACT

Today's construction businesses have been characterised by the use of science and technology in operation and huge competitiveness resulting from the effect of globalisation that has necessitated a free business market environment beyond borders. The situation has forced even local construction firms to struggle to find an alternative to reduce the increasingly overwhelming challenges resulting from increased client demands and desires. The bullwhip effect is among the identified challenges that affect supply chain management throughout the construction projects. The bullwhip effect is the phenomenon that shows how the small changes at the demand end of a supply chain are progressively amplified for operations further back in the chain. As a result, this study aims to investigate the impact of bullwhip effects on construction projects and supply chain performance. Eighty-two (82) respondents were randomly selected from road construction projects in Tanzania, where the supply chain is well practiced. Data were collected using a semi-structured questionnaire and descriptively analysed using the Statistical Package for Social Science (SPSS-24) to obtain the statistical information presented using descriptive information such as frequencies and percentages. The study's findings have identified nine bullwhip effect causes and eleven bullwhip effects that significantly and positively influence the supply chain performance of construction projects. Therefore, the findings recommend that the bullwhip effects, which pose challenges to both the construction firm and the sector as a whole, should not be ignored. However, the study suggests that further research is necessary to determine the role, necessity, and impact of technology within a construction supply chain, particularly in terms of its potential to mitigate the bullwhip effect.

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1.0 Introduction

The construction sector is believed to be the fundamental contributor to global socio-economic development, as it facilitates a crucial role in infrastructure improvement and employment creation; it contributes to both the gross domestic product (GDP) and gross fixed capital formation (GFCF) of all nations and enhances economic growth [1]. Moreover, the sector stimulates other economic sectors by providing shelter, creating a favourable working environment, and boosting domestic consumption [2]. Despite its fundamental and promising importance, the sector is confronted with uncountable challenges that have for decades limited the growth of local firms and the construction industry in particular. Of the many previously published papers on the construction sector performance, almost all have maintained findings mentioning the same overwhelming and never-ending challenges to local contractor firms. The challenges that local contractor firms face include a lack of appropriate strategies for firm development [3]; historically low and poor productivity and performance; and a shortage of skilled, competent, and experienced labour. Furthermore, it includes low technology adoption and use, as well as inappropriate and non-value construction processes. Additionally, it includes time and cost overruns, failure to achieve value for money, low profit gain, and poor financial performance [4]. Furthermore, it encompasses a lack of resources, such as finance, skilled human resources, and local quality materials [5]. It also includes late payments to contractors, improper and ineffective existing procurement systems that result in the selection of incompetent contractors [6], and severe competition from foreign firms. [7].A person or a construction company can't get an edge over its opponents or competitors just by being better at being efficient, effective, designing, and building things. This is because globalisation has made the global construction market very competitive. Instead, the firms must establish a series of efficient and value-added supply chains, starting from the sourcing of raw materials and continuing through procurement, marketing, and distribution to the construction sites, which serve as their final customers. Supply chain management (SCM) is gaining significant global attention in business due to its ability to play a significant role in various sectors such as manufacturing, transportation, services, fast-moving consumer goods, medical, water, and goods [8]. Strategically aligning business goals with trading partners across the entire value chain is the fundamental importance of SCM. However, firms that fail to implement effective Supply Chain Management (SCM) may unintentionally experience the "whiplash or whipsaw" effect. Most local construction firms in Tanzania are increasingly recognising various challenges that can negatively impact their project performance while neglecting or ignoring others. One challenge that cannot be ignored is the bullwhip effect, as its impacts have received minimal attention. As a result, this study aims to investigate the impact of bullwhip effects on construction projects' planning and supply chain performance.

2.0 Literature Review

2.1 Supply Chain Management

Supply Chain Management (SCM) was grounded in the concept of integration, coordination, and management of functional units. Its interests increased gradually in the 1990s, when numerous organisational executives realised they could not compete effectively while isolated from their suppliers or other entities in the supply chain. However, they realised that the strategic business processes across the supply chain should be successfully coordinated, integrated, and managed properly when one needs to determine the critical success of one's enterprises. More importantly, the increased interest in construction aimed to improve the coordination of various subcontractors and suppliers in the construction supply chain. Despite the popularity of SCM in academic and business contexts, there has been a significant misperception about its definition. Scholars and academicians have considered various elements when defining supply chain management (SCM) [9]. While some view SMC as an operational term involving raw materials and product flows from one point to another, others view it as a management philosophy, and some view it as a management process or an integrated system [10]. Over the past ten years, numerous scholars have conducted extensive research on Supply Chain

Management (SCM) and its applications, resulting in a variety of definitions of SCM, as evidenced by various works of literature [9]. Lambert et al. (1998) defined a supply chain (SC) as an alignment of firms that bring products or services to market [11]. According to Lambert et al. (1998), a supply chain (SC) is a core activity of any firm that involves the delivery of goods and services to customers. The supply chain includes goods manufacturers, suppliers, transporters, warehouses, wholesalers, retailers, intermediaries, and customers, to mention a few. Jack (2004) defined a supply chain as a series of decision-making and execution processes, along with the flow of materials, information, and money between various stages of the supply chain, all aimed at meeting the final customer requirements [12]. [12]Moer, Chopra & Meindl (2001) added that despite the role played by the manufacturer and supplier, the supply chain entails other potential attributes for its success, such as the logistics flows containing transporters, warehouses, retailers, and consumers. Furthermore, the success of the supply chain depends on a variety of factors, including new product development, marketing, operations, distribution, finance, and customer satisfaction [13], among others. The effects of supply chain management (SCM) are clear in how profitable it is, which is measured by how well deliveries are made, including how quickly and reliably they arrive. There are fewer or reduced stock-outs, faster inventory turns, more sophisticated quality products, increased information availability, on-demand insight, anticipated order cycles, and a reduction in time-to-market. Furthermore, it includes reducing inventory and transportation costs; reducing indirect and direct labour costs; and increasing sales and margins.

2.2 Role of Supply Chain on Construction Industry

The advancement of technology has made construction firms pay more attention to customer needs, quality design response, cost-effectiveness, and construction time. Realising supply chain management has enabled these results. Supply chain management (SCM): Construction firms can reorganise and integrate the production process by eliminating redundant activities and leaving only valuable processes. These processes can aid in the simultaneous implementation of multiple projects, reducing unnecessary waiting time and consumption and ultimately accelerating construction progress [14]. Since construction projects are carried out for a long time under resource constraints, involving multiple participants who must go through planning, design, procurement, construction, maintenance, and operation, which leads to numerous challenges. Complexities and challenges necessitate an effective management method. Therefore, the SCM philosophy is believed to provide a solution to the challenges in a timely manner. The construction supply chain is defined as a construction supply network based on a long-term partnership of competent technical experts who can continuously improve the engineering quality of construction projects. The SCM on construction projects helps to reduce uncertainties through information sharing, reduce construction costs, and reduce risks through integrated management and coordination of the supply chain. Furthermore, a construction firm's supply chain typically facilitates connections between project participants, such as clients, material suppliers, consulting and/or design firms, the construction team, and workers. It combines subcontractors and equipment-leasing firms into a functional chain structure. Furthermore, it controls capital, information flow, and logistics. As a result, the SC is customarily initiated from the purchase of construction materials and equipment to the completion of the project and then applied during construction maintenance.

2.3 Bullwhip Effect on Construction Project

Forecasting mistakes can cause the bullwhip effect, which is the opposite of what you might think. It can happen anywhere in the supply chain and make changes in the flow of goods even more noticeable. Commonly, the term can be referred to as the distortion of the information when orders move from downstream firms to the supplier. The bullwhip effect always tends to cause an increased or decreased level of variability in the distribution of orders, which affects performance. Every construction project's success requires a smooth flow of resources that depends on the effective flow of order information from contractor to subcontractor or supplier. The distorted information or diversity of orders from one part of the supply chain to the other may lead to losing consequences in terms of cost, time, quality, or substandard safety, and an increase in inventories. Moreover, an increase or decrease of delivery possibilities, poor planning of the future capacities, poor transport, and logistics lead to disturbances in the production schedule, unavailability, or raise of the high cost of plant and equipment to be hired, and raise of labour cost with low production [15], to mention a few.

Various factors, including time constraints, supply order decisions, the quality of demand information for the supply, inherent delays, a lack of communication, disorganisation, order batching or accumulation, price fluctuations driven by promotions, and inadequate periodic planning systems, have been identified by several researchers as leading to bullwhip effects at various stages of the supply chain. The problems in the supply chain were caused by a number of things, such as limited time, decisions about what to order, the quality of demand information for the supply, delays that are unavoidable, a lack of communication, disorganisation, order batching or accumulation, price changes caused by promotions, and not having good periodic planning systems [16]. Thus, it is mentioned that small changes on one side of the system can result in a great influence on the other side and hence tend to reduce the efficiency and effectiveness of the supply chain.

2.4 Performance

The current global construction competition faces numerous challenges due to increased customer needs and the advancement of science and technology. These challenges have largely forced contractor firms to adjust their strategies and strive to improve their performance [17].Conversely, only firms that have made an effort to modernise and innovate their value activities and processes are guaranteed to achieve sustainable performance. The term performance has been noted to be a synonymous concept. This has led various researchers to develop a contradictory perspective based on the interchangeability of terms such as efficiency, effectiveness, competence, growth, improvement, and success [18]. The conflicting and/or multidimensional performance concept was recognised by Tatjana (2012), who noted that, across various definitions she had reviewed in different literature, all had shown a common characteristic related to efficiency and effectiveness [19].According to Grüning (2002), performance is defined as the ability of an organisation to achieve its intended goals by realising expectations influenced by previously set objectives [20]. Furthermore, Krause (2005) defined performance as the degree of achieving objectives based on an organisation's essential characteristics for relevant stakeholders [21]. In the past, construction firms' (CF) success was judged by how well they stuck to their budgets and schedules, how well they met quality standards and specifications, how safe they were, and how well they took care of the environment [22]. The later emerging vision said it had a very broad definition that included many ways to measure performance, with customer and employee satisfaction being two important factors [23]. As a result, the satisfaction of other people involved in the construction project, like suppliers, logistics, and distributors, has been taken into account during the evaluation of performance success [24].Supply chain performance measurement (SCPM) is the process of qualifying the efficiency and effectiveness of the supply chain. SCPM is important in supply chain development, particularly in the manufacturing industry, but there is no evidence to support its application in the construction industry. It was noted by Neely (1994) that SC performance measures should be linked with organisational management strategies [25]. According to Morgan (2004), performance measurement always enhances business management and performance improvement because it provides the necessary information for management feedback for decision-makers [26]. Chan (2003a) said that measuring performance all the time is a good way to change the company's goals and redesign its business processes, which helps to make SCM better [27]. Depending on various eras, the SCPM variables have varied with time. The initial phase of the measurement variables, which spanned from the early 1880s to the 1980s, focused on financial measures such as profit, return on investment, productivity, quality, flexibility, and production management. The second one focused on time and inventories that include demand fulfilment, order cycle time, order completeness, delivery reliability, delivery performance, lead time, level of defects, responsiveness, stock-out frequencies, inventory levels, inventory investment, order fill rate, total order cycle time, total response time to order, and other things. Even so, Gunasekaran et al. (2001) said that it is more important to keep studying SCM measures and metrics [28] because there isn't a balanced way to find supply chain performance measures, and there isn't a clear separation between metrics at the strategic, tactical, and operational levels.

3.0 Methodology

3.1 Sampling Population

The study's sampling population consisted of contractor firms that participated in road construction projects in Mbeya, Dodoma, and Mwanza and had at least five years of experience in such projects. Based on their project value, only fifteen (15) road construction projects were selected. The participants included engineers, quantity surveyors, surveyors, procurement experts, suppliers, storekeepers, and subcontractors from both local and overseas contractor firms. However, other participants hold the higher administrative positions in their firms.

3.2 Data Collected

This study adopted the mixed (quanti-quali) method of data collection. Both quantitative and qualitative data were gathered from primary and secondary sources. While the primary data were collected from study participants using the structured questionnaire prepared in both English and Swahili for easy understanding, the secondary data were sourced from different published sources, including journals, conference proceeding papers, articles in periodicals, research reports, and official websites relevant to the study. However, twenty (20) questionnaires that involved senior staff, such as the project manager, contract manager, subcontractor manager, and head of sections or department, were administered through a face-to-face interview approach. However, the remaining 87 questionnaires were distributed to respondents for self-administration.

3.3 Sample Size and Sampling Procedure

One hundred forty-seven (147) people were randomly sampled. Yamane provided a simplified formula for calculating the study's sample size.

$$(\boldsymbol{SampleSize}\ (\boldsymbol{n}) = \frac{\boldsymbol{N}}{(\mathbf{1} + \boldsymbol{N}(\boldsymbol{e})^{\mathbf{2}}}$$

Where n is the minimum sample size, N is the population size, and e is the desired level of precision/an acceptable margin of error assumed at a 95% confidence level for this study. When this formula is applied to the above sample, we get a sample size of 107 $(\boldsymbol{Approx})$.

3.4 Data Analysis

SPSS-24 software was used for data entry, coding, and editing, as well as for descriptive and inferential data analysis. During analysis, a continuous average rating with proposed ordinal values (1 to ≤ 1.8; 1.81 to ≤2.6; 2.61 to ≤3.4; 3.41 to ≤4.2 and 4.21≤5) representing strongly not important, not important, moderate, important, and strongly important, respectively, was used to translate the respondent's opinion. Neither absolute quantities nor equality intervals between them were intended. However, before further data analysis, SPSS software was used to perform data reliability that tested the internal reliability of the 5-point Likert scale to check whether the questionnaire tool used provided equivalent results at different sets of tests. Moreover, data reliability for the observed variables was computed and checked using the standardised Cronbach's alpha formula.

Standardized Cronbach's formula $(a) = \frac{\mathbf{kr}}{(\mathbf{1+(k-1)\,r})}$

Where: a= Reliability Estimate, k= Number of impact factor loading (12), and r= Average Correlation (given as 0.652).

$$a = \frac{12(0.652)}{(1 + (12 - 1)0.652)}$$

$$a = \frac{7.824}{8.172} = 0.96 \text{ Approx}$$

The calculated (a) yielded a reliability value of approximately 96%, which defines the data precision level.

Furthermore, to attain the intended study objective, respondents were given a full list of factors that cause bullwhip and the bullwhip impacts on a construction project and supply chain as sourced from literature and asked to rank them in order of their significant importance and impacts. The respondents were given an ordinal five-point Likert-like scale, ranging from 1 (strongly) to 5 (strongly). Agree 5-strongly Disagree was used to capture the degree levels of impacts. Therefore, the analysis and discussion of the results were carried out.

4.0 Result and Discussion

4.1 Respondent's Demographic Information

A return of sixty-three (63) questionnaires was filed, resulting in 77.6% of the total administered questionnaires. A thorough data checkup identified only one questionnaire not well attended. Thus, 82 questionnaires were used for data analysis. The majority of respondents (54.88%) had working experience of more than ten years. The majority (37.8%) possessed a degree, 25.61% were master's graduates, and 2.44% hold their Ph.D. certificates. The findings suggest that data was collected from a knowledgeable and experienced person. Furthermore, respondents included 24.39% engineers, 12.20% quantity surveyors, and 7.32% surveyors. Procurement and storekeepers occupied 18.29% each; 15.85% were suppliers of various goods and services, and 3.66% were subcontractors. The information gathered from the respondents (Table 1) was sufficient to support the validity and suitability of the chosen study representatives.

Table 1

Respondents Characteristics

Item	Class	Frequency	Percentage Response (%)
Working Experience	≤5	14	17.07
	6-10	23	28.05
	11-15	26	31.71
	≥16	19	23.17
Educational Level	Certificates	9	10.98
	Diploma	19	23.17
	Degree	31	37.80
	Masters	21	25.61
	PhD	2	2.44
Occupation	Engineer	20	24.39
	QS	10	12.20
	Surveyor	6	7.32
	Procurement Expert	15	18.29
	Storekeeper	15	18.29
	Supplier	13	15.85
	Subcontractors	3	3.66

4.2 Causes of Bullwhip Effects

Before venturing to identify the bullwhip impacts on construction projects and supply chain performance, it was important to understand the causes of bullwhip in supply chain management through respondents' opinions. The relative importance index (RII) with a five-point Likert scale was opted to show the effectiveness of causes as represented in (Table 2). Relative Importance Index was computed in reference to the formula: Relative Importance Index (RII) = $\Sigma W/AN$ Where W defines the Likert scale weight (I-5) given by respondents, A is the Likert scale highest score weight (5), and N is the total number of respondents (82). However, the top five causes were considered for explanation.

Table 2
Causes of Bullwhip Effects

Causes of Bullwhip Effect	Respondent's Frequency (N)					Total(N)		RII	Rank
	5	4	3	2	1		ΣW	ΣW/AN	
Poor position of inventory	41	23	15	3	0	82	348	4.24	3
Inflated orders	36	19	26	1	0	82	336	4.10	6
Lead time variability on information orders	46	19	17	0	0	82	357	4.35	1
Price fluctuation	33	25	19	4	1	82	331	4.04	7
Poor or no use of technology in supply chain	27	33	19	3	0	82	330	4.02	8
Large orders result in more variance	38	26	17	1	0	82	347	4.23	4
Demand forecast & updating error	29	35	17	1	0	82	338	4.12	5
Poor up-down coordination	42	22	16	1	1	82	349	4.26	2
Product promotion	26	32	23	1	0	82	327	3.99	9

Findings in Table 2 indicate that lead-time variability on information orders scored the highest rank among the main causes of the bullwhip effect in the supply chain, followed by poor up-down coordination and communication. The findings align with those of Buchmeister *et al.* (2008), who observed the impact of production lead-time on the supply chain. Moreover, poor inventory ranked third, large order variance ranked fourth, and demand forecasting and updating errors ranked fifth.

4.3 The Bullwhip Impacts on Construction Project

Ranking for identification of bullwhip impacts was facilitated by the descriptive analysis and one-sample t-test used to compute the mean score. Using SPSS, eleven (11) impacts were ranked based on descending mean score, standard deviation, T-values, and confidence interval (CI) for each impact (Table 3). These scores were above the acceptable stated value of 3.41, indicating potential impacts that could contribute to supply chain management failure. However, if two or more impacts fall within the same scale mean value, one with a lower standard deviation is highly ranked.

Table 3
Bullwhip Impacts on Construction Project

Impacts		Mean	Std. Deviation	T-Values	95% Confidence		Skewness	Kurtosis
					Lower	Upper		
Reduced productivity & profitability	BICP1	4.59	1.74	30.203	3.839	4.452	-0.48	-0.59
Late project completion	BICP2	4.41	1.28	27.282	3.340	4.204	-0.39	-0.52
Cause project schedule delay	BICP3	4.35	1.63	23.692	3.693	4.118	-0.48	-0.53
Rise of disputes among project executors	BICP4	4.23	1.51	24.562	3.340	4.084	-0.51	-1.63
Led to mistrust among project participants	BICP5	3.99	1.43	22.749	3.384	4.099	-0.32	-0.83
Inefficiencies on production schedule	BICP6	3.82	1.74	26.638	3.039	4.050	-0.43	-1.93
Incur extra cost	BICP7	3.71	1.63	24.583	3.584	3.997	-0.37	-0.83
Poor customer service levels	BICP8	3.56	2.43	3.190	3.809	-0.26	-1.02	-0.84
Challenges & difficult decision making	BICP9	3.51	2.42	3.190	3.819	-0.26	-1.02	-0.64
Causing missing sub-optimal production	BICP1	3.44	1.73	21.493	3.402	3.739	-0.31	-1.29

The findings of the study have revealed the top four ranked as extremely important impacts with a mean above 4.2 (as defined in the Likert scale, section 2.4). Reduced productivity & profitability (mean = 4.59), late project completion (mean = 4.41), cause of project schedule delay (mean = 4.35), and rise of disputes among project executors (mean = 4.23) were ranked among the most significant impacts highly significantly affecting the construction project performance. This result aligns with the findings acknowledged by [29]. Moreover, the construction projects and performance were noted to be affected by the last six ranked bullwhip impacts, with the mean (3.99 to 3.44) interpreted as an important impact.

4.4 The Bullwhip Impacts on Supply Chain

The misleading or distorted information from one end of a supply chain to the other has been noted to convey various impacts that continuously lead to remarkable inadequacies in any construction project. The findings of the study have distinguished various impacts, as analysed from the respondent's opinion (Table 4).

Table 4
Bullwhip Impacts on Supply Chain

Impacts		*Mean*	*Std. Deviation*	*T-Values*	*95% Confidence*		*Skewness*	*Kurtosis*
					Lower	*Upper*		
Over stock of unnecessary materials	BISC1	4.35	1.04	19.24	4.166	4.211	-0.481	-0.479
Difficulties in logistics planning	BISC2	4.28	1.66	23.79	3.667	3.963	-0.391	-0.409
Excessive Inventory accumulation at some stage	BISC3	4.03	1.73	17.67	4.02	3.877	-0.593	-0.419
Uncertainties of delivery possibilities	BISC4	3.89	1.38	18.73	3.667	3.843	-0.623	-1.407
Ineffective transportation/Logistics	BISC5	3.44	1.57	20.17	3.9221	3.986	-0.433	-0.607
Unmet customer expectations	BISC6	3.57	1.93	25.48	3.5771	3.937	-0.543	-1.707
Increased costly wastes	BISC7	3.48	1.57	18.49	4.0761	4.269	-0.964	-0.507

Overstock of unnecessary materials (M=4.35, t = 19.24) and excessive inventory accumulation at some stage (M=4.03, t = 17.67) were identified as the topmost bullwhip impacts on the supply chain. These two factors have consistently resulted in unnecessary material waste, which ultimately leads to a reduction in profit. It was also noted that problems with logistics planning (M=4.28, t = 23.79), not knowing if delivery was possible (M=3.89, t = 18.73), and inefficient transportation/logistics (M=3.44, t = 20.17) led to problems like longer delivery times and higher costs [30]. Furthermore, unmet customer expectations (M = 3.57, t = 25.48) and increased costly waste (M = 3.48, t = 18.49) were acknowledged to impact the supply chain. Generally, business executives are always required to understand the bullwhip effect, its causes, and how it impacts their overall costs and the supply chain at all. Therefore, it is recommended to establish a tight, predictable, and profitable supply chain management system to reduce errors. However, a thorough forecasting of demand is necessary to make informed decisions and maintain a consistent and efficient supply chain.

4.5 Construction Project Performance

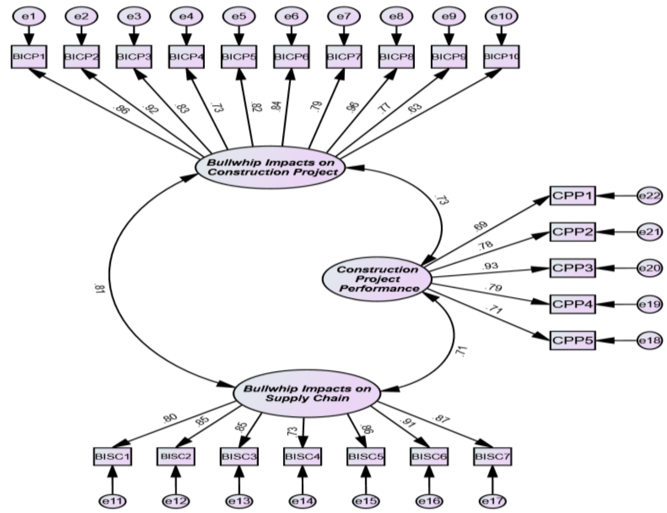
The current universally competitive construction environment, characterised by a constantly changing atmosphere, has made almost all construction businesses understand and monitor its performance (Taouab & Issor, 2019). The atmosphere has caused multiple companies to struggle to attain improved performance. Conversely, only those who strive to strategise, eliminate unnecessary processes, and modernise the remaining value processes can ensure sustainable performance. Previous literature has documented performance as a challenging concept to define, describe analytically, and measure. However, due to its long-standing contradictory nature, scholars have adopted terms such as effectiveness, efficiency, improvement, growth, and success interchangeably (Reijonen & Komppula, 2007). Conversely, despite the multidimensional performance concept, Tatjana (2012) contended that, over various definitions she had reviewed on performance from different literature, all had shown a common characteristic related to efficiency and effectiveness. Performance was characterised by Gruning (2002) as the capability of an organisation to realise its objectives. Krause (2005) also defined performance as the degree of achieving objectives regarding an organisation's vital features for the appropriate stakeholders.

Conventionally, the effective performance of construction firms or projects was appraised based on adherence to construction time, cost, quality, safety, environmental sustainability, and client satisfaction (Samson & Lema, 2002). However, new ideas in the workplace have recently led to a very different view of what constitutes good performance, along with a number of different ways to measure it (Murphy *et al.,* 1996). The emerging vision claimed that client satisfaction should be considered among the notable features when scrutinising construction performance. Consequently, this led to the development of compound variables to measure performance (Hove & Adewale, 2015). These variables recognised the satisfaction of other practitioners or stakeholders, such as owners, employees, suppliers, and/or distributors (Faridi & El-Sayegh, 2006).

4.6 The Collective Relationship between Bullwhip Impacts on Construction Project and Supply Chain to Improve Construction Project's Performance

Figure 1

Correlation of Bullwhip Impacts on Construction Project and Supply Chain



The above figure (1) shows the study's structural model (SM), which shows how the construct variables are related. It shows how the bullwhip effect affects construction projects and how supply chains can help improve project performance. The findings of the model indicated a high correlation of above 0.7 between the construct and the factor loading. Also, the findings have formed a statistical model fit that is used to evaluate the correlation between the model data. There is a minimum discrepancy ($\chi 2/df$) of 3.36 between the recognised model fit values and the recommended model fit indices. These include chi-square ($\chi 2$ = 1256.8) and degree of freedom (df = 373.9). Also, the Tucker Lewis Index (TLI) = 0.862, the Comparative Fit Index (CFI) = 0.917, the Adjusted Goodness of Fit Index (AGFI) = 0.973, and the Root Mean Square Error of Approximation (RMSEA) = 0.78. Generally, the findings have suggested positive significance associations between the construct and manifested factors supported by the data (Nachtigall, 2003). So, the study's model (Figure 1) shows a strong link (81%) between the effects of the bullwhip on the supply chain and the effects of the bullwhip on the construction project, between the effects of the bullwhip on the construction project and the performance of the project, and between the effects of the bullwhip on the supply chain and the performance of the project.

5.0 Conclusion and Recommendation

This study aimed to explore the bullwhip impacts on construction projects and supply chain performance. The study has identified nine bullwhip causes and eleven impacts that significantly influence the execution of construction projects and the performance of supply chain management. Therefore, the study's findings indicate that effective and efficient supply chain management is crucial for improving construction project performance, as it not only enables smooth information flow but also fosters collaboration among project stakeholders. Furthermore, SCM facilitates improved productivity and profitability, reduces lead time, and assists in transportation and logistics planning. Moreover, it reduces delivery uncertainties, maintains stock and inventory, controls the accumulation of unnecessary material, and accelerates a better project service level. Therefore, this study's significant contribution is that the bullwhip plays a crucial role in a construction project and cannot be overlooked. However, effective supply chain management always influences better performance in any construction project. Therefore, it is recommended that, given the integration of numerous value processes and participants in construction projects, it is essential to conduct a study to determine the required resources and the limited role of each stakeholder in a supply chain in order to prevent bullwhip effects and their consequences.

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