

RESEARCH PAPER

# Managing Materials Vendor Risks for Improved Project Operational Performance: The Role of Risk-Oriented Culture

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## ABSTRACT

**Highlight:** Sound risk management implementation is well noted for helping organisations to overcome operational inefficiencies. However, the management of risk associated with construction materials vendors, and how they impact project operational performance appear to have not been extensively researched.

**Goal:** In this study, the effect of materials vendor risk management (vendor risk identification and vendor risk prevention) on project operational performance (project quality and scheduled completion time) was investigated. We also interrogate the mediating role of risk-oriented culture in the relationship between vendor risk management and operational performance.

**Design/Methodology/Approach:** The target population was all 1,044 registered public construction firms under the Urban Regeneration Programme in Nigeria. The cross-sectional survey design was adopted, and random sampling was used to select 173 project managers, engineers, surveyors, vendors/contractors, and store representatives. Primary data was collected through the structured questionnaire, they were analysed via the Structural Equation Modelling (SEM) technique.

**Results:** Three main conclusions are made about managing vendor risks: First, properly identified materials vendor risks (in terms of material handling issues, price escalation, non-compliance to specification, delivery delay, and sharp procurement practices) is positively related to operational performance. Second, implementing context-specific risk prevention measures (prior assessment score, vendor financial capacity, warranty policy, continuous monitoring, technical capacity) positively enhances operational outcomes. Third, paying attention to risk culture orientation of project stakeholders positively impact their risk prevention capability and operational performance of construction projects.

**Limitations:** Study was limited to few operational performance indicators in project management. Future study could include other performance indicators.

**Practical Implications:** The results can help project operations managers in industry address numerous risks associated with materials vendor.

**Originality/Values:** The numerous abandoned and failed construction projects in developing countries as a result of less attention to vendor risks management prompted this study.

**Keywords:** Vendor Risk Management; Construction Project Management; Construction Supply Chain; Sustainable Project Quality; Risk Culture.

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**Conflict of interest:** The authors have no conflict of interest to declare.

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## 1 INTRODUCTION

All over the world, the construction industry consists of many players including the main contractors, design team, sub-contractors, clients, materials vendors, and facilities managers amongst others (Xiaohua et al., 2017). Each of these actors are important to ensuring positive performance outcomes. Though each participant is a potential source of successful construction operation, they could, on the other hand, become a bane to construction operations if not properly coordinated by an integrated project management team. In particular, construction vendors (i.e. suppliers of critical contract materials) through their activities, could become very painful source of risk to project completion if not effectively managed (Hany et al., 2013).

Managing construction vendor risks has become an interesting topical issue in construction supply chain literature over the last 10 years (Bahamid et al., 2022; Hany et al., 2013; Zuofa & Ochieng, 2014). The reason is not farfetched; construction projects are known to be complex, multiple stakeholders, capital intensive, and temporary like delivery; and as such its processes including materials supplies are exposed to various (Amoah et al., 2011; Nsikan et al., 2022). Thus, the risks associated with construction vendors could delay construction delivery time, increase budget overruns, and may even ruin the reputation of the entire sector.

In Nigeria, the construction industry is witnessing continuous growth, making above average contribution (reported in year 2022 as N12.9trn or 9.5%) to National GDP (Trading Economics, 2022). However, it has battled credibility issues over the years, owing to the numerous failures of construction infrastructure and building collapse spread across towns and city centres (2012; Damoah & Kumi, 2018; Eja & Ramegowda 2020; Souza et al., 2022).

Doubtless, suggestions have been made towards strengthening the operational performance outcomes of this industry. For example, Zuofa & Ochieng, (2014) advocated for the involvement of well-trained project management professionals at all stages of the project life cycle. Similarly, Nweze, (2016) suggested stiffer sanctions for unethical project implementation practices. Akande, (2018) encouraged project management training for public sector professionals, proper monitoring, construction supervision and enforcement. While these suggestions look satisfactory, on a closer examination, they appear to dwell more on the project design and implementation issues while ignoring the role that proper management of supply chain vendor risks could play on project performance (Akande, 2018).

In many developing nations, managing construction project risks has been undertaken with less success (Adedugba et al., 2022; Oladapo, 2015)), and without considering the antecedence of organisational risk culture, attitude, norms and risk perception (Adebayo et al., 2020; Adedugba et al., 2022). This has hurt the operational performance of construction projects in the industry (Ghosh & Jintanapakanont, 2014; Kosutic, 2022). Likewise, low-quality construction works, budget overrun, project tardiness, and on-site conflicts have characterised the construction projects executed in many developing nations; and have been reported to be the direct consequence of poor risk identification, risks prevention, and low risk-orientation culture (Aibinu & Henry, 2016; Kosutic, 2022).

Given this situation, it is tempting to deduce that the numerous abandoned construction projects in many developing countries are as a result of less attention to vendor risk management (Adedugba et al., 2022; Ubani et al., 2015), as well as the poor approach to managing the risks, and the culture of risk orientation associated with material vendors (Agápito et al., 2019; Ferreira et al., 2019). In this context "risk-oriented culture" generally implies an organizational culture that values and encourages a proactive approach towards identifying, and preventing risks. For a construction supply chain firm, Shimizu, (2020) argues that such a culture would likely prioritize risk assessment score, risk awareness of vendor financial and technical capacity, and continuous monitoring of risk potentials of supply chain members. Risk-oriented culture has been recently understood as an important factor in supply chain management literature (Elia et al, 2019; Kurniawan et al., 2017; Ma et al., 2020), its prospects as a success element in managing vendor risk for enhanced construction projects performance is envisioned in this study. Therefore, this study investigates the relationship between vendor risk management and project operational performance and interrogates the mediating role of risk-oriented culture in the relationship.

## 2 THEORETICAL FOUNDATION AND HYPOTHESIS DEVELOPMENT

Generally, the concept of risks (understood as one’s vulnerability to situations in which the consequence or results is not certain, (Chapman & Stephen, 2022), and the strategies for managing risks has been studied and reported widely (Aduma & Kimutai, 2018; Barber, 2019). This section undertakes a review of the extant research to understand the nexus between vendor risks management and project operational performance.

Vendor risks management (VRM) is viewed as the process of implementing strategies that helps in purposefully identifying and preventing (rather than mitigating) negative supply-side occurrences, and ensuring the continuous performance of construction projects (Chapman, 2011; Ferreira et al., 2019). In Figure 1, the elements that define VRM and their relation with project operational performance are provided as the conceptual model of this study. The theoretical underpinning of the model is founded on two known theories- the Resource Based View (RBV) and the Agency Theory. The RBV theory suggests that a firm’s resources and capabilities are key drivers of competitive advantage (Brandon-Jones et al., 2014; Mishra et al., 2019). In our model, the ability to identify risk and prevent risk is viewed as a strategic resource that when properly developed could contribute to effective project management (Jegan et al., 2023; Sharma et al., 2023). Similarly, a risk-oriented culture, in this context, becomes a crucial organizational capability that enhances the utilization of these resources (risk identification and prevention), ultimately influencing operational performance.

On the other hand, in the supply chain project management context, agency theory emphasises the need to align the interests of different stakeholders (Matinheikki et al., 2022; Mitzkus, 2013). Risk identification and prevention can be seen as mechanisms to mitigate agency problems by reducing information asymmetry and aligning the interests of project participants (Zsidisin & Ellram, 2003). A risk-oriented culture further strengthens this alignment, fostering better cooperation and coordination (Mitzkus, 2013).

In that regard, we review past studies to provide the theoretical basis for hypotheses development in relation to the variables- vendor risk identification, vendor risks prevention, risk-oriented culture and project operational performance.

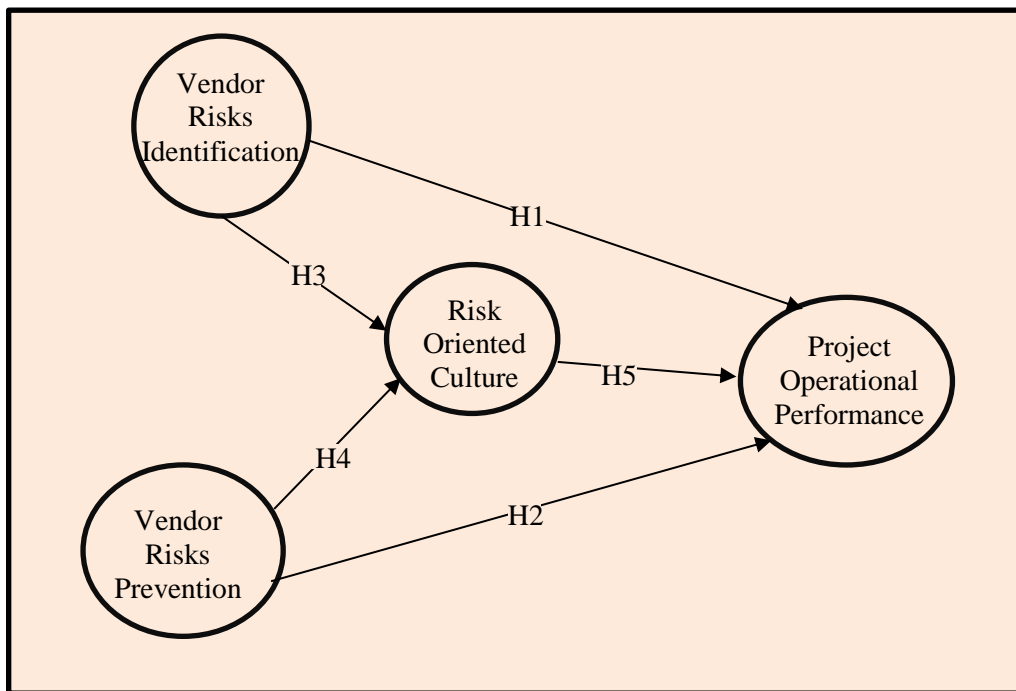


Figure 1 - Conceptual model

## 2.1 Vendor Risks Identification

Vendor risk identification is aimed at ascertaining the potential sources of risks associated with project materials vendor. It also makes effort to uncover the potential consequences associated with the identified vendor-related risks (Bahamid & Doh, 2017; Hany et al., 2013). To that extent, an understanding of the prevailing circumstances and events that trigger such risks is vital (Azis, 2020; Hany et al., 2013). According to Amos et al., (2016) project vendor risks identification can either be internal or external. Internal risks usually come from within the project organization or employees who implement and design the systems. It can also emanate from procedures and policies aimed at achieving the objectives of the project. Internal risk issues usually arise from poor selection, training and management of project personnel (Ahmed et al., 2019).

External risk sources, on the other hand arises mainly from project stakeholders outside the firm. In particular, studies such as Hany et al., (2013) have identified three main risks sources associated with materials sourcing including poor materials handling on transit and during storage, delivery time delays, and materials obsolescence. In the same vein, Souza et al., (2022) found that materials exposure to inappropriate level of light or heat energy, poor logistics handling, sharp and unethical practices, and price escalation arising from hoarding activities are responsible for high project materials risks. Agapito et al., (2019) carried out a comprehensive literature review on SCRM and developed a typology of risk sources for the project supply chain which include raw materials shortages, machine failure, delivery delays, order specification variances, and labor uncertainties. In similar study, Ferreira et al., (2019) reported significant association involving identified risk sources and operational performance. Therefore, the identification of risks in the management of project vendors is important because it has an impact on project performance.

Despite the importance of risk identification to project performance, extant studies on this subject are limited in terms of determining how supply chain vendor risk identification relate to construction project operational performance (Hany et al., 2013; Nnadi & Ugwu, 2013; Adedugba et al., 2022). To fill this gap, we expect materials vendor risk identification to significantly impact on project operational performance in the construction industry. Therefore, this study proposes the following:

H1: Construction vendor risk identification is significantly related to project operational performance

H2: Construction vendor risk prevention is significantly related to project operational performance

## 2.2 Vendor Risk Prevention

Risk prevention is a systematic measure of curtailing risks occurrence. Its works by making determined effort to inhibits the enablers of construction project risks (Alaghbari et al., 2017). Vendor risk prevention is a proactive respond to management of project risk in construction. At risk prevention stage, available options and actions are developed to decrease threats to the project objectives even before they occur (Chapman & Stephen, 2022).

The literature has documented various risks prevention mechanisms for construction project management. For instance, Ahmed et al., (2019) in a study of construction risk prevention trend in Hong Kong suggested the prevention of political risk involving local construction enterprises, and placing demand for warranty policy document prior to contracting. In a similar study, Ahmed et al., (2012) suggest the use of foreign consultant to monitor foreign exchange risk, gain knowledge of financial capacity of vendors, and assessing previous supplier assessment score, testimonials or user reviews. Tiwari, (2023) proposed four risk-prevention strategies as follows: determining technical capacity, requesting for warranty policy, screening, delivery flexibility, and continuous monitoring of vendor performance. Hany et al., (2013) argued preventing risks by deploying appropriate mechanism and approaches is capable of enhancing the performance of construction project in terms of continuity, cost efficiency, and client satisfaction. Other scholars (Chapman & Stephen, 2022; Nyaoga, 2016) maintained similar opinion that taking proactive risks prevention measures is necessary for improved project management performance.

Prior literature (Azis, 2020; Bahamid & Doh, 2017; Nyaoga, 2016) is deficient in their focus on generic project risks prevention measures while neglecting context-specific methods- construction vendor risks prevention. In addition, studies that specifically examines the relations between

vendor risks prevention and risk culture orientation are scarce (Bahamid & Doh, 2017; Matinheikki et al., 2022; Mitzkus, 2013; Nyaoga, 2016). We contribute new insights to fill these gaps by arguing that significant relationship exists between construction vendor risks prevention measures and project operational performance. It is therefore proposed that:

H3: Construction vendor risk identification is significantly related to risk-oriented culture of project management firms

H4: Construction vendor risk prevention is significantly related to risk-oriented culture of project management firms.

### 2.3 Risk-Oriented Culture

Building a strong risk culture or risk-oriented culture is important for managing construction project risk which is aimed at boosting operational performance. A risk-oriented culture is a shared set of behaviours, perception, knowledge, attitudes, beliefs, norms and values about how to deal with project risk (Han et al., 2017). According to Aibinu & Odeyinka, (2019), if a project team has a common purpose and approaches risk in a consistent way, which reflects that purpose, it is most likely to protect the project and make it more successful. According to Shimizu et al., (2020) supply chain firms with a strong risk-oriented culture are more likely to have their professionals aware of potential supply chain risks, understand their implications, and make decisions with risk mitigation in mind. Azis (2020) contended that attitudes to risk are based upon individual and corporate beliefs, which are inherent in the business and the organizational culture. Assaf & Al-Hejji, (2016) argued that attitude toward risk can affect behaviour associated with risk management. Barber, (2019) posited that the goal of the risk culture is to create a well-defined environment where both managers and professionals are not afraid of risks and related responses to risks taking. Thus, the need for awareness and inclusion of cultural influences in managing construction project vendor risk is vital. A strong risk-oriented culture provides guidance for organizational members on risk-taking, it builds risk-taking capability, encourages the transparent flow of risk information amongst members, and emphasize orgainsational learning (Aduma & Kimutai, 2018).

Although, studies have reported positive effects of risk-oriented culture on sustainable performance of project firms (Moczyłowska et al., 2023; Nyaoga, 2016), and the performance of joint venture security investment (Xiaoteng, 2022), our study specifically addresses risk-oriented culture in the context of construction project performance. Surprisingly, emphasis on the role of risk culture appears not to have received much empirical attention in project risk management literature (Adedugba et al., 2022; Nnadi, & Ugwu, 2013). In addition, studies on the mediating role of risk-oriented culture on the relationship between construction vendor risk management and project operational outcomes have not been well explored (Adebayo et al., 2020; Adedugba et al., 2022; Motilewa, et al., 2015). By serving as a mediating variable, a risk-oriented culture is expected to influence the relationship between the other variables (vendor risk identification, and vendor risk prevention), and the overall operational performance outcomes of the construction project firms. It acts as a mechanism through which the study variables impact organization's approach to identifying, and preventing vendor risks in construction projects. Therefore, we expect that risk-oriented culture would provide the indirect link as a mediator between materials vendor risk identification, risk prevention, and project operational performance. To that extent, the following hypotheses are proposed:

H5: Risk-oriented culture is significantly related to project operational performance

H6a: Risk-Oriented culture has a mediating effect on the relations between materials vendor risk identification and project operational performance

H6b: Risk-Oriented culture has a mediating effect on the relations between materials vendor risk prevention and project operational performance

## 3 METHODOLOGY

### 3.1 Research Design

Research design specifies the type of data to be collected in order to provide reliable answers to the overall research question (Okesina, 2020), as well as the sampling technique to be adopted (Hair et al., 2010). This study adopted the cross-sectional survey design to describe the relationship between vendor risks management variables and project operational performance amongst

construction companies. We employed the cross-sectional survey because it has been found to be economical, speedily, and enhance uniformity in data collection from selected samples over a short period of time (Okesina, 2020). In particular, the uniformity attributes/advantage of survey design was important in realising the overall aim of the study- establishing relationship between vendor risks and operational performance in the context of construction project management. Although similar studies exist that relied on survey approach to investigate risks mitigation, they were mainly descriptive in analysing and summarising results, and many seldom consider the mediating effect that risk culture orientation could have in the relationship (Brammer & Walker, 2011; Cheng et al., 2016; Nitya & Paul, 2020). The current study extends the frontier of project risk management knowledge by using the structural equation modelling to analyse the mediating role of risks culture orientation between vendor risks identification, risks prevention and operational performance.

### **3.2 Research Population and Sampling**

The target population of this research was all 1,044 registered construction companies currently involved in the public construction works under the Urban Regeneration Programme (UBN) in Nigeria. Nigeria is a country in sub-Saharan Africa. The UBN is an intervention of the Federal government targeted at regenerating one urban centre in each of the six geopolitical regions of the nation. This targeted population was considered appropriate for this study because of their homogenous characteristics (Creswell, 2014). For instance, all the target firms were currently operating in the Nigerian construction industry, involved in the public infrastructure projects, and carried out materials vendor selection and procurement activities in similar construction programmes initiated by government. The choice of location was due to the numerous construction projects that were on-going in the study area such as bridges, buildings, flyovers, shopping malls, and road infrastructures. This has provided better opportunity to study the targeted population seamlessly without also compromising the required thoroughness of a scientific study (Saunders et al., 2019). From the targeted population, a total of 173 respondents were randomly selected based on existing sub-population of occupational categorisation namely: Project managers, Project engineers, Quantity surveyors, Construction managers, Civil engineers, Stores supervisors and Contractors. These individuals constituted the unit of analysis for this study. In order to avoid prejudice in selecting these individuals, and to ensure sample representativeness, the random sampling approach was adopted to select equal number of construction professionals from each of the occupation categories for purpose of questionnaire administration as shown in Table 1.

### **3.3 Data Collection Instrument**

The data collection instrument for this study was the structured survey questionnaire. The decision to utilise this instrument was based on its ease of standardisation, economy and convenience in data collection (Creswell, 2014). Inputs from relevant literature aided the development of the survey questionnaire and its scale. The questionnaire items were scored on the basis of the 5-point Likert scale where 1 represents "strongly disagree, and 5 represents "strongly agree. The structured questionnaire had three sections: The demographic section with questions meant to collect information about the profile of respondents and organization's demographics, the vendor risk management practices section (vendor risks identification, risks prevention, and risk-oriented culture), and the operational performance section comprising project quality and scheduled completion time. A total of 25 questionnaire items were designed for this study. Items were carefully drafted to ensure they generated responses that would facilitate the achievement of the overall aim of the study. The administration of the questionnaire was done physically at construction sites where the various construction works were going on in the urban centers spread across the six geopolitical zones of Nigeria. The services of a Research Consultant were engaged to undertake the distribution and retrieval of administered copies of the questionnaire. The entire data collection process took three months between September and November 2022.

### **3.4 Measurement**

For this study, the predictor variable is vendor risks management, while the response variable is operational performance of construction firms. The variable- vendor risk management had two

dimensions including - vendor risk identification and vendor risk prevention. Vendor risk identification was measured by five indicators, namely: poor material handling, incessant price escalation, non-compliance to specification, delivery delay, and unethical procurement practices. Example of questionnaire items in this regard is "Our company takes care to identify unethical practices by material vendors, and Our company has in place strategies to identifies non-compliance with material to specification" Likewise, vendor risk prevention i.e taking proactive measures against occurrence of vendor risks, was measured by 5 indicators including: prior assessment score, vendor financial capacity, warranty policy, continuous monitoring, technical capacity. Example of questionnaire items for vendor risk prevention include "Our company take steps to determine previous vendor assessment score, and Our company request for warranty policy before selecting vendors" On the other hand, operational performance was measured using two indicators - scheduled timelines (i.e meeting project completion deadlines), and project quality (i.e less or no defect)- an indicator of project durability. The two higher-order constructs were included in the model to further provide insights on measures of operations performance in a project management context in line with prior empirical evidence (Alkaissy, 2022; Nguyen & Watanabe, 2017).

The following two items serve as examples used to gauge performance- "Time between order placement and material delivery has improved in recent years, and the rate of project failure has dropped significantly over the years" Risk-oriented culture- a third element was used as the mediating variable. It was measured by four construct items namely: Risk-neutrality culture, risk-averse culture, risk-tolerant culture, and risk-acceptance culture.

### 3.5 Validity and Reliability

In determining the quality of the items in the questionnaire, some validity and reliability measures were taken. In terms of questionnaire validity, three methods were adopted to ensure both content and construct validity. First, questionnaire items were adopted from empirical works that has established validity and reliability. However, the wording of some items in the adopted empirical papers were rephrased to further enhance clarity and to suit the context of the current study. To that extent, the following prior studies were used: Andreas & Carl-Marcus, (2012); Azis, (2020); Darko et al., (2019). Second, the questionnaire items were thoroughly examined by two operations and supply chain management experts, and one field construction project expert to confirm that the items are representative and comprehensive. Third, we conducted a pilot survey with the first draft of the questionnaire using a sample size of 43 project management practitioners. According to Creswell (2014), an adequate sample of size 30 is acceptable for pilot survey. The feedback from pilot respondents was used to further subject the instrument to reliability checks. This led to a few modifications in the preliminary items used in the questionnaire. The evaluation of construct reliability and the test of the hypothesized relationship as shown in the conceptual model were all done using the Structural-Equation Modelling (SEM). The Partial least square PLS-SEM is an analytical technique for constructing predictive models that effectively test relationships between latent variables (Alhabatah et al., 2023; Hair et al., 2017). The technique was adopted because of its suitability for small sample size analysis, and the use of a self-reporting questionnaire (Hatcher 2013; Hsin, et al., 2013). Moreover, its ability to conduct a path analysis for all structural relationships at once, leading to more accurate results also informed its choice (Astrachan et al. 2014).

We started with the measurement model test using the confirmatory Factor Analysis (CFA), (factor loadings, and average variance extracted (AVE). The results (Table 2) indicate that over 80% of the vendor risk management elements yielded high loading values that were greater than 0.70. This is an indication that the scale truly measured the constructs as expected (Saunders, Lewis, & Thornhill, 2019). In addition, a Cronbach's reliability test was conducted for the purpose of checking the internal reliability of the questionnaire items. As shown in the results (Table 2), scale items' reliability was found to be above  $\alpha=0.70$  threshold. In the opinion of Nunnally & Bernstein's (1994), a reliability threshold of 0.7 indicates that a research instrument is good and also confirms the internal reliability of the items used in the questionnaire.

## 4 RESULTS AND DISCUSSION

### 4.1 Respondent’s Demographics

Of the 173 copies of the questionnaire administered to targeted respondents, 103 valid responses were utilised for data analysis. The valid number of responses represent those who responded to the survey within the scheduled timeframe, and correctly answered the questions without any omissions. Thus, a 59.5% survey response rate was achieved. Pagell et al., (2014) recommends a minimum 45% response rate for project management research in the context of developing nations. Therefore, we concluded that our response rate, which also represents the effective sample size of this study was adequate, representative, and appropriate for generalisation of study findings.

Results in Table 1 presents the demographic characteristics of respondents. It indicates that 86.4% of the respondents were male while 13.6% were female; an indication of male dominance and the attendant obstacles women face in an attempt to break the glass ceiling in construction industry (Al-Dalaeen, & Tarawneh, 2022; Lekchiri, & Kamm, 2020). In addition, majority of the respondents (54.6%) were between ages 41-50. This was followed by 22.6% of respondents who were between ages 39-40 years, and 14.6% who were 51years and above. Similarly, 10.5% of the respondents had less than 5 years of industry experience, while majority of them (58.5%) have been involved in managing construction related risks between 11- 15years. Majority of respondents (68.7%) were bachelor degree holders only, and the entire respondents comprises of Civil Engineers (22.3%), Project Managers, (33.7%), Construction Managers (12.9%), Quantity Surveyors (16.0%), supervisors in construction materials warehouses and stores (10.4%) and those representing building developers (4.7%). In addition, 54.5% were in those working in procurement and logistics, while 5.8% and 7.3% of respondents respectively were involved in project information technology, and project design. The demographic characteristics of sampled respondents accurately described the nature and composition of professionals in the construction project industry as reported in similar studies such as Vipin & Rahima, (2019), Muhammad et al., (2022) where most respondents were largely construction engineers, project managers, and construction contractors.

**Table 1** - Demographic profile of the respondents (N= 103)

Characteristics	Element	Per cent %
Sex	Male	86.4
	Female	13.6
Age	Below 30 years	8.2
	Between 30 & 40 years	22.6
	Between 41 &50 years	54.6
	51 years and above	14.6
Industry Experience	Below 5	10.5
	Between 5-10	21.9
	Between 11-15	58.5
	Between 16-20	8.4
	Above 20	0.7
Highest Qualification	First Degree (Bachelor)	68.7
	Second- Master’s Degree	26.0
	Third- Doctorate Degree	5.3
Department	Stores and materials warehouse	32.4
	Procurement & logistics	54.5
	Information and communication Technology	5.8
	New Project Design	7.3
Job position	Project Managers	33.7
	Quantity Surveyors	16.0
	Construction Managers	12.9



Civil Engineers	22.3
Stores Supervisors	10.4
Contractors	4.7

## 4.2 Measurement Model Assessment and Descriptive Analysis

Table 2 shows the results for descriptive result (Mean and standard deviation (SD) and measurement model (items loadings ( $l_k$ ), Cronbach's Alpha ( $\alpha$ ), composite reliability (CR) and average variance extracted (AVE) to assess model validity and reliability (Gannon et al., 2017). All the factors loaded above the benchmark 0.70. This range from vendor risks identification (VRI) ( $l_k = 0.82$ ) to vendor risks prevention (VRP) ( $l_k = 0.85$ ). Moreover, all the measures of project operational performance scored above 0.70, which range from scheduled completion time (SCT) ( $l_k = 0.84$ ) to project quality (PQ) ( $l_k = 0.83$ ). The loading scores implies that each corresponding indicator is significant contributor to the applicable variable. Thus, the higher the factor loading score, the greater its indicator contribution to forming the study variables.

Furthermore, Table 2 indicates that values for Cronbach's Alpha, CR and AVE for each variable are well above the recommended cut-off values: 0.7, 0.7 and 0.50 respectively; thus, satisfying conditions for construct reliability and internal consistency (Hair et al., 2017a).

**Table 2 - Descriptive Score and Model Measurement**

Variable	Construct	Mean	SD	Loading	AVE (>0.50)
Vendor Risk Identification (VRI), (CR=0.79), ( $\alpha=0.87$ )	Risks of damaged materials during handling (transportation & storage)	4.05	0.83	0.70	0.65
	Unethical practices among material vendors	3.41	1.10	0.74	
	Materials procurement price escalation risks	3.46	1.07	0.81	
	Risk of non-compliance to specification	3.30	0.49	0.82	
	Material delivery delay risks	3.27	1.09	0.78	
Vendor Risk Prevention (VRP)(CR=0.72), ( $\alpha=0.75$ )	Vendor previous assessment score	2.70	1.06	0.72	0.63
Risk-Oriented Culture (CR=0.76), ( $\alpha=0.71$ )	Vendor financial capacity	2.33	1.15	0.73	0.64
	Warranty policy before selecting vendors	2.31	1.12	0.78	
	Vendor technical capacity and delivery flexibility	3.80	0.95	0.71	
	Continuously monitor of vendor risks	3.85	0.81	0.85	
	Risk neutrality culture	3.42	1.08	0.76	
	Risk aversive culture	3.12	0.84	0.75	
	Risk tolerant culture	3.20	0.85	0.80	
Risk acceptance culture	2.94	1.17	0.79		
Scheduled Completion Time (SCT)(CR=0.81), ( $\alpha=0.89$ )	Changes in material specifications affects scheduled completion time	3.35	1.09	0.72	0.59
	Material wastages affect completion time	3.15	0.95	0.69	
	Improved delivery time over the years	3.45	1.15	0.82	
	Improved time between order placement and delivery	4.05	1.04	0.76	
	Better supplier recovery time from material failure	3.60	0.88	0.84	

Project quality (PQ) (CR=0.76), (α=0.85)	Enriched quality of finished construction work	4.20	0.77	0.83	0.61
	Reduced rate of project failure or defect	3.45	1.15	0.71	
	Increased client/user satisfaction	3.60	0.88	0.68	
	Improved quality of materials shipped by contractors.	3.41	1.35	0.79	
	Enhanced buyer-vendor relationship	4.06	0.82	0.77	
	Rewarding management of materials quality efforts	3.64	0.84	0.81	

In addition, the mean values for most of the items that defines the relationship between construction vendor risks management and project operational performance were rated beyond the 3.0 benchmark. For instance, all the construct except three relating to vendor risk prevention had mean score less than 3.0 as follows: vendor previous assessment score (Mean= 2.70, SD= 1.06), vendor financial capacity (Mean=2.33, SD= 1.15), and warranty policy before selecting vendors (Mean= 2.31, SD=1.12). This results simply suggest that the construction firms under study are not paying the required attention to preventing materials vendor risk in terms of requesting vendors to present previous assessment score of past performance before award of contract, ascertaining the financial position/capability of vendors, and committing vendors to robust warranty policies to prevent operational and future default. This results simply corroborates the findings in the works of Adhitya et al., (2009), Ahmed et al., (2019) and Farooq et al., (2018) which all pointed out the consequences arising from the neglect of proper risk identification and mitigation in project management and all phases of project cycle. For instance, Ahmed et al., (2019) explicitly calls for attention of managers to the delays on project completion caused by materials vendors with inadequate financial and technical capacity to deliver the requisite materials within stipulated time and specified quality. In particular, proper assessment of suppliers prior to and contract award and using relevant parameters has been a recurring issue in the practice of project management in developing nations (Assaf & Al-hejji, 2016; Farooq et al., 2018; Han et al., 2017).

On the other hand, most respondents (Mean= 2.31, SD=1.12) agreed with the importance of identifying vendor risks in relation to damaged materials during handling i.e transportation & storage risks. They also subscribed to the idea of continuously monitoring vendor risks in the construction design process (Mean= 3.85, SD=0.81). Furthermore, respondents agreed that proper management of vendor risk through risk identification and prevention helps to improve operational performance in terms of the time between order placement and delivery (Mean= 4.05, SD=1.12), and enriched quality of finished construction works (Mean= 4.20, SD=0.77). Again, this finding is consistent with the works of Han et al., (2017), Idoro, (2019) which reported the numerous gains associated with proactive identification and prevention of risks for project managers.

### 4.3 Goodness of Fit Assessment

The goodness of fit (Gof) test evaluates the suitability of the proposed model for this study. It is a measure of the soundness of the relationship between the variables (Henseler & Sarstedt, 2013). Table 3 provides summarised results for measurement of model fitness. It can be observed that all criteria reached the recommended critical value limit for goodness of fit index (Henseler & Sarstedt, 2013; Wetzels et al., 2009). Hence, the proposed model is robust and worth analysing.

**Table 3** - Goodness of fit Analysis

No	Model Fit Indicator	Criteria	Value	Conclusion
1	Average path coefficient (APC)	$p < 0.05$	APC = 0.278 $p = 0.002$	Significant
2	Average R <sup>2</sup> (ARS)	$p < 0.05$	ARS = 0.268 $p = 0.001$	Significant
3	Average R <sup>2</sup> -adjusted (ARSA)	$p < 0.05$	ARSA = 0.258 $p = 0.005$	Significant
4	Tenenhaus Gof	Small if Gof $\geq 0.1$ Medium if Gof $\geq 0.25$ Big if Gof $\geq 0.36$	GoF = 0.375	Big

5	Sympon's paradox ratio (SPR)	Acceptable if SPR ≥ 0.7; Ideal if SPR = 1	SPR=0.872	Acceptable
6	R <sup>2</sup> contribution ratio (RSCR)	Acceptable if RSCR ≥ 0.9; Ideal if RSCR =1	RSCR= 0.985	Acceptable

**Notes:** ARS= Akaike's Regression Statistics; ARSA= Akaike's Regression Statistics Adjusted; Gof = Goodness of fit; APC= Average Path Coefficient; RSCR= R-Squared Contribution Ratio.

#### 4.4 Structural Model- Hypothesis Testing

Table 4 and Figure 2 demonstrate the results of hypothesis testing; showing the path coefficients ( $\beta$ ) and t-value. According to Hair et al., (2012) only predictor variables with  $\beta$  values above 0.1 can be accepted as influencing the response variable. In addition, a t-value greater than 1.645 is required for a positive relationship between the independent and dependent variables (Hair et al., 2017b). Therefore, the results yielded positive effects of VRI ( $\beta$ : 0.392 and t-value: 2.835) and VRP ( $\beta$ : 0.324 and t-value: 2.689) on POP. Hence, hypotheses (H1 & H2) are supported by the model. In addition, VRI ( $\beta$ : 0.307 and t-value: 2.412) and VRP ( $\beta$ : 0.314 and t-value: 2.785) made significant positive effect on ROC, confirming the proposed hypothesis H3 and H4. In addition, the direct effect of ROC on POP ( $\beta$ : 0.124 and t-value: 1.668), was also supported by the result. However, hypothesis 5 is moderately significant.

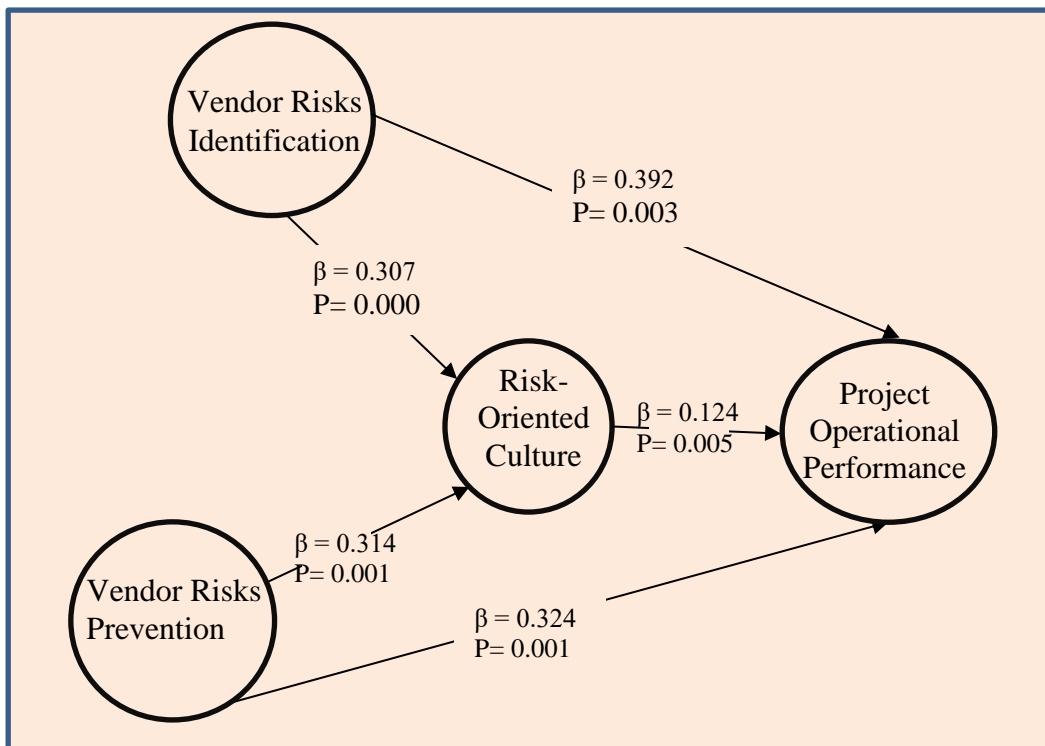


Figure 2 - Estimation Results

The structural findings show that the identification of vendor risk sources relating to material handling issues, price escalation, non-compliance to specification, delivery delays, and sharp/unethical procurement practices impacts strongly and positively on project operational performance in terms of scheduled completion time and project quality. Similarly, taking proactive measures to address materials vendor-related risks in ways such as demanding for prior assessment score, assessing financial capacity, requesting for warranty policy, continuous monitoring, technical capacity impacts positively on project performance (meeting completion time and delivering good quality project).

In other words, proper identification and prevention of construction vendor risks led to improvement in project performance measures including reduced wastages that affect completion time; reduced operation defect, reworks, and failure rate; improved recovery time from material failure; reduced order fulfilment mean time; and better quality of construction project finishing. These findings are consistent with those of Wieland & Wallenburg, (2012) and Windapo, (2006)

which confirm the relationship between risk management practices and operational performance.

Though the direct effect of ROC on performance seems moderate, its findings support the notion advocated throughout this study that individual orientation towards firms' risk culture influences their understanding and management of risks associated with material vendors (Ahmed et al., 2019; Motilewa 2015). In fact, the positive impact of VRI and VRP on culture of risk-orientation implies that managing vendor risks would be inefficient without taking due consideration of the risk orientation of managers and the prevailing risk culture (neutral, aversion, tolerant, & acceptance) of the organisation as a whole.

Table 5 reports the indirect effect of risk-oriented culture on vendor risk identification and performance ( $\beta$ : -0.061,  $P > 0.001$ ) on one hand; and risk prevention and performance ( $\beta$ : 0.235,  $P < 0.001$ ) on the other hand. Thus, it can be stated that the culture of risk orientation is a positive and significant mediator of risk prevention and project performance. However, the mediating effect of risk culture orientation on vendor risk identification and performance of construction project management was not significant; giving rise to a need for further research in different context and using larger sample.

**Table 4** - Structural Equation Model Results

Hypothesis	Path Coefficient( $\beta$ )	P-value	T-value	Conclusion
H1: VRI $\rightarrow$ POP	0.392	0.003	2.835	Significant/Supported
H2: VRP $\rightarrow$ POP	0.324	0.001	2.689	Significant/Supported
H3: VRI $\rightarrow$ ROC	0.307	0.000	2.412	Significant/Supported
H4: VRP $\rightarrow$ ROC	0.314	0.001	2.785	Significant/Supported
H5: ROC $\rightarrow$ POP	0.124	0.005	1.668	Significant/Supported

**Notes:** VRI: Vendor Risk Identification; VRP: Vendor Risk Prevention; POP: Project Operational Performance; ROC: Risks-Oriented Culture.

**Table 5** - Result of mediating (indirect) effect of Risk-Oriented Culture

Variable path	Coefficient	P	Conclusion
<b>H6a:</b> VRI $\rightarrow$ ROC $\rightarrow$ POP	-0.061	0.246	Insignificant/not supported
<b>H6b:</b> VRP $\rightarrow$ ROC $\rightarrow$ POP	0.235	0.002	Significant/supported

### Theoretical and Managerial Implications

There are theoretical and practical implications of the findings made in this study. The extant project risk management literature for instance, is enriched through the newly found mediator (risk-oriented culture) between materials vendor risk management and the operational performance. Thus, the research provides new information about the role that the orientation around risk culture plays for project management and construction materials supply chains- it is a determinant that has a positive impact on vendor risk management implementation. Thus, project management firms that develops a risk-oriented culture as an organisational capability are likely to effectively utilize the resources abounding in risk identification and risk prevention strategy in line with the RBV theory (Zu & Kaynak, 2012). This would in turn reduce information asymmetry, align stakeholders' interest and build stakeholder confidence as projects are being managed as postulated by the agency theory (Matinheikki et al., 2022; Mitzkus, 2013).

As a practical contribution, we suggest that project supply chain managers pay attention to risk prevention as a proactive measure of managing material vendors risk. Specifically, there is need to ensure that previous assessment report of the suppliers is presented before new procurement contract are signed. In addition, managers must request vendors to endorse robust warranty/guaranty policy before being selected as construction vendors. Similarly, managers must ensure that the financial capacity of the vendor is authenticated by reputable financial expert or bank before being selected as subcontractor to construction project works. Finally, this study advocates for proper understanding and assessment of the risk orientation culture of project professionals before assigning to them any risk management responsibilities.

### 5 CONCLUSION

In this paper, issues concerning the management of materials vendor risk in construction and

how they impact project operational performance were investigated. From the findings, three major conclusions are made as follows:

First, effective management of materials vendors' risks throughout the construction project ecosystem is essential for project managers and engineers (Agápito, 2019; Aduma & Kimutai, 2018).

Second, the need to develop strategies to identify vendor risks is increasingly crucial. Thus, managers that give attention to identifying vendor risks associated with a). material handling (both at transportation and at storage points) b). unethical procurement practices c). price escalation risks d). non-compliance to specification, and d) procurement delays are likely to achieve improved operational outcomes in terms of expedited delivery time, reduced rate of project failure, and client/user satisfaction (Ahmed et al., 2019; Motilewa 2015).

Third, for construction project managers, it is noteworthy that identifying and taking proactive preventive measures against materials vendor risks is one aspect, but it is an entirely different thing to ignore the potential of the risk-oriented culture of those saddled with the responsibility of managing vendor risks. Hence, to effectively manage vendor risks in construction projects, the proper understanding of risk culture is crucial.

### Limitations and Further Research

The article has some limitations that would provide the basis for future research. For instance, only two indicators of project operational performance were used, in the current study namely: completion time and project quality. Although the two project operational performance indicators were found to be directly suitable in the context of developing nation's project supply chain management, future study could explore other indicators in addition to the those adopted in this study. In addition, future study could incorporate other aspects of vendor supply chain risk management such as risk analysis, risk mitigation amongst others that were not used in this study. Such study could also test the moderating role of risk-oriented culture, and vendor monitoring capability on the relationship between supply chain risk management and project performance.

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