

Original Article

Operational Resilience, Critical Success Factor for Technological Performance

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Abstract: Changing manufacturing environment, crisis, and unprecedented shocks are threatening the technological performance of manufacturing businesses globally. The effect of these disruptive events are felt much more in the food and beverages manufacturing industry, as their activities are critical to national economic growth. Poor technological performance has been presumed to be caused by the absence of operational resilience proxied by technological resilience, recoverability, workplace resilience, disruption absorption, and resilient culture. Therefore, this study filled the highlighted gap by increasing our understanding of how operational resilience factors affect technological performance in the Nigerian food and beverage manufacturing sector. Descriptive and inferential statistics were used to assess the hypotheses posed in this study utilising primary data from a sample of 491 top, medium, and lower-level employees of food and beverage enterprises in Nigeria. The structured and modified questionnaire utilised for the study was found to be reliable and valid, and the Cronbach's alpha scores varied from 0.85 to 0.92. According to study results, technical performance is positively and significantly impacted by operational resilience dimensions of technological resilience, disruption absorption, and resilient culture. The study concluded that operations managers should adopt carefully operational resilience dimensions of technological resilience, disruption absorption and resilient culture to improve the level of technological performance of their companies.

Keywords: Disruption absorption, Operational resilience, Recoverability, Technological Performance, Resilient Culture.

I. INTRODUCTION

Economic disruption occasion mainly by digital technology with rapid changing manufacturing technology threaten technological performance of businesses. Nowhere is this innovation more evident than the technology challenges manufacturers and distributors face every day. Indigenous technology adopted has been found to be accountable for reduced efficiency and productivity in the manufacturing sector (Essuman et al., 2023; Jaing et al., 2023; Omari et al., 2020). The manufacturing sector faces a number of challenges, including generally lower levels of industry adoption for technology to stay competitive and identify the steps required to deploy the newest automation technologies (Udofia et al., 2021). The technological performance of the food and beverages manufacturing sector is likewise challenged by the foregoing. The dynamic changes in the economic competition as well as advancing information and communications technology challenges the food and beverages manufacturing sector. The Russia–Ukraine struggle has also caused poor technological performance as increased production shutdowns are being recorded (Essuman et al., 2023). Similarly, information technology (IT) malfunctions, industrial accidents, and quality problems, are limiting the technological performance of this important sector.

In Nigeria, 66% of total consumer expenditure, and 22.5% of the manufacturing industry value are attributed to the food and beverages manufacturing sector (Oladejo et al., 2021; Oyedijo et al., 2021). The food and beverages manufacturing sector makes up 38% of the entire manufacturing sector of Nigeria, and contributes 4.6% of the GDP which is ₦17.7 billion (Amos et al., 2020; Oladejo et al., 2021; Oyedijo et al., 2021). Further, the sector's total manufacturing output stood at ₦46.6 billion as at 2019 (Flanders, 2020). As a result, the production of food, drinks, and tobacco dominates Nigeria's manufacturing sector, with sugar and bread goods producing the most in terms of output value (Flanders, 2020). Due to its unique role of expanding economies because of its general use to human life and health, the food and beverages manufacturing industry is deemed responsible for economic growth (Oladejo et al., 2021).

Similar to other African countries, the Nigerian manufacturing environment is highly unstructured. Despite being considered the biggest economy in Africa with a gross domestic product (GDP) of US\$484.9 billion (Oyedijo et al., 2021), resource optimization and inadequate technology adoption stiffens the production efficiency of the manufacturing sector. The



food and beverages sector is influenced by, and also influences the environment. The current globally increasing volatile and unpredicted shocks, protracted complex crisis, and other degrees of disruptive events experienced locally and on a global scale are stiffening production activities further. Ecological changes, natural disasters, and changing societal developments call for a new paradigm in addition to the basic goal of maximizing service levels and minimizing cost, hence the focus on operational resilience (Ivanov, 2017; Ivanov et al., 2019; Tremblay et al., 2023). Operational resilience, according to Aslam et al. (2020) and Chowdhury et al. (2019), is the capacity to build the necessary level of preparation, reaction, and recovery to manage disruption risks and return to the pre-disruption state or even a better one after the disruption.

Extant literature revealed growing concern in the understanding of operational resilience and technological performance. This study however, identified the gap in establishing this relationship within the Nigerian food and beverages manufacturing industry. Although there are studies on production improvement function and corporate operational efficiency (Umoh & Wokocha, 2013); adaptability, information technology, agility, mutual trust, and flexibility (Jermsittiparserta & Pithuk, 2019); and information systems capabilities on firm performance (Felipe et al., 2019), not much has been done on operational resilience and technological performance within the context of the food and beverages manufacturing companies in Nigeria. The ability of the food and beverage manufacturing companies to quickly pivot according to the needs of its customers is what defines it as there is a little margin for error in this sector. Nowhere is this innovation more evident than the technology challenges manufacturers and distributors face every day. This highlights the requirement for built-in redundancies that allow producers to halt the line and find solutions to production problems promptly in order to demonstrate the level of their technological performance. Technology performance guarantees the ability to create goods quickly, resulting in new benefits and value creation for customers (Nwankwere et al., 2017).

Technological performance in the food and beverages industry is challenged by the presence of decaying infrastructure, the need to improve uptime and at the same time reduce cost so as to remain competitive and profitable. In addition, demand for higher quality at lower cost has been shown to be driven through the adoption of modern technological facilities and software, in the production process (Felipe et al., 2019). By examining the impact of operational resilience factors on the technological performance of the Nigerian food and beverage manufacturing industry, this study aimed to close this gap in the literature.

II. LITERATURE REVIEW

Discourse on varied views of operational resilience and technological performance as found in literature are captured in this section, with the aim to expand knowledge and deepen understanding along conceptual, empirical and theoretical lines.

A) Operational Resilience

This study starts by elaborating on the definition of resilience in order to comprehend operational resilience better. Resilience was defined by Namdar et al. (2017) as a system's potential ability to adapt and function in the face of threat. Resilience is the capacity of a system to absorb a shock without affecting its structure, identity, or functions, according to Melián-Alzola et al. (2020a). These concepts imply that disruptive events will always occur in the corporate environment. The level of conceptualization differences in resilience can be attributed to the concept's multidimensionality (Altay et al., 2018; Essuman et al., 2020; Lohmer et al., 2020; Melián-Alzola et al., 2020a). To manage production and operations activities, the resilience concept is developing into a key instrument (Dubey et al. 2019, Essuman et al. 2020). Scholars should be guided by the conceptual component as well as the sort of system within which resilience is implemented in diverse fields of research (Jia et al., 2020; Melián-Alzola et al., 2020a; Irawan et al., 2021). McFarlane et al. (2018) defined operational resilience as an industrial operation's capacity to respond to and recover from unanticipated or unmanageable interruptions while studying the impact of operational resilience on production control.

Through a process of continual learning and modifications in response to a series of disturbances the company has experienced, resilience capabilities are formed (Alqudah et al., 2020; Belhadi et al., 2021; Ivanov, 2022). Reducing the amount of time between the beginning of a disruptive incident and the firm's recovery phase is the aim of operational resilience (Olaleye et al., 2021). An infrastructure system's ability to function during a disaster and the amount of time it takes for it to recover to its pre-accident performance levels are both used to quantify operational resilience (Irawan et al., 2021). Literature (Ivanov et al., 2019; Lohmer et al., 2020) has suggested a number of specific resilience strategies, such as the creation of IT infrastructure and information sharing, as well as backup capacity and inventory, response effort, response time, increased security, postponement, and supplier relationship building.

According to Annarelli et al. (2020), the static or dynamic approach to operational resilience was discussed. The static approach was characterised by continuous monitoring, anticipation ability, redundancy, simulation, initial vulnerability, focus on minor aspects, and learning from mistakes. The dynamic approach, meanwhile, was characterised by internal communication and improvisational capabilities. The proactive and reactive approach to operational resilience describe the

timing of initiating resilience in a firm which could be preventive, adaptive, or a combination (Chowdhury & Quaddus, 2017; Jia et al., 2020; Lohmer et al., 2020). Other studies have conceptualized operational resilience as either input-based resilience (IBR) involving flexibility, visibility, adaptability, and velocity; or output based resilience (OBR) comprising of disruption absorption, recoverability, and resilient culture (Aslam et al., 2020; Essuma et al., 2020; Wong et al., 2020). This study however, adopted the OBR perspective and presented operational resilience along dimensions of technological resilience, recoverability, workplace resilience, disruption absorption, and resilient culture which were found necessary for building resilience in the manufacturing sector and well supported by extant literature (Bui et al., 2020; Jiang et al., 2023; Esumman et al., 2020; Irawan et al., 2021; Romero et al., 2021).

III. TECHNOLOGICAL PERFORMANCE

Changes in the internal environment as well as the external environment of a business affects how well the technology such organization use for production performs (Dunlop-Hinkler et al., 2011). These changes affect how well organizations are able to carry out their production function when comparing the quality of machines used for production with the industry average. To gain higher technological performance most companies are transforming from manual processes to more complicated, automated and computerized technologies (Ikon & Nwankwo, 2016). The coming of information technology and quest for better quality, lower prices, as well as the constant research and development in the industrial sector has brought about rapid changes in the technology or techniques used in production. Especially with the onset of the coronavirus, production systems experienced changes that required new machines to achieve. Because of this, the efficiency of manufacturing companies' output is increasingly challenged by how quickly they can adapt to such technical advances.

Both the infrastructure and value-creation perspectives can be used to analyse technological performance, such as IT flexibility (Batra, 2020). The ability to mobilise and deploy IT-based resources in combination or concurrently with other resources and capabilities was defined by Felipe et al. (2019) using the resource-based view. Connecting this ability to mobilize and deploy as a performance indicator, could be appreciated from the flexibility derived, which is necessitated by frequent changes in the manufacturing industry. Consequently, equipment supply and integration, food processing, as well as filling and packaging require digital technology, right software to help optimize processes, and data to uncover potential enhancements. Zhua et al. (2020) submitted that digital business activities along with supply chain actors are strengthened through e-business. This study further suggests engagement on online procurement, and distributor engagement in online channel management, as means of improving technological performance.

The industrial sector faces problems from infrastructure and engineering system failures as well as the harmful effects of system disruption caused by natural catastrophes (Ganin et al., 2015). Additionally, due to this subsector of the manufacturing industry's dynamic nature, there is intense competition within it (Nwankwere et al., 2017). Efficiency and performance are enhanced through support for technology as well as by the development of technological competences (Amos et al., 2022). Production manager's aim for certain levels of technical performance, such as technological advancement, technological support, and shorter product life cycles, in order to improve production efficiency and operational procedures (Nwankwere et al., 2017). According to Esumman et al. (2020), unanticipated power outages, technological malfunctions, unsatisfactory suppliers, a lack of raw materials, or restrictions on the movement of people and goods because of a variety of disruptive events, including the emergence of a pandemic (like the coronavirus), cause process delays, increase idle time, and underutilize other resources. Breakdowns in operations may result in additional costs, which are signs of subpar technological performance.

Further, developments and advancements in technology, such as additive manufacturing (Morisse & Prigge, 2017) is critical in production as cost and energy consumption reduction is targeted. Operational optimization and use of technology has been found to be important tools for achieving production efficiency (Kinyanzui et al., 2018). Technological performance has also been associated with cost reduction (Felipe et al., 2019). Therefore, this work uses technology performance as a major indicator of production efficiency as supported by literature (Kinyanzui et al., 2018; Jermsittiparserta & Pithuk, 2019). From the foregoing, technological performance is therefore defined in this study, as the level of technological effort utilized in production that affects the production output level and product quality. Most manufacturing firms in the Nigerian food and beverages sector, still utilize old machines that are no more as efficient, which may be related to the low level of technological performance experienced in this sector.

IV. OPERATIONAL RESILIENCE DIMENSIONS AND TECHNOLOGICAL PERFORMANCE

According to empirical research by Ganin et al. (2015), infrastructure networks must be made resilient if manufacturing systems are to be shielded from the damaging effects of infrastructure and engineering system failures as well as system disruptions brought on by natural disasters. According to Nwankwere et al. (2017), manufacturing organisations work in a volatile, turbulent, and complicated business climate, which best demonstrates their technical capacity in developing and delivering creative products that consumer's value. Critical functionality or functionality of the techniques used in production

was found to increase in resilient systems (Ganin et al., 2015). The study further found that recoverability (time to recovery) had a significant effect on the technological performance of firms. The mechanism used for production to a long extent determines the level of production efficiency of that system, hence operational resilience helps ensure that the technology adopted for production are at its optimum (Dunlop-Hinkler et al., 2011).

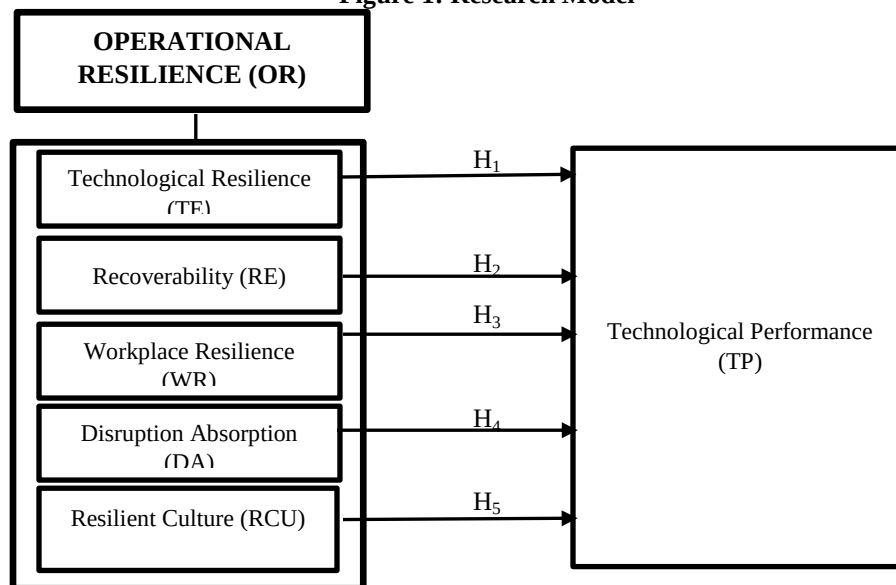
Esumman et al. (2020) found that unanticipated power outages, equipment failures, supplier problems, and a lack of raw materials revealed poorer levels of technological performance. The results of this study show that operational resilience has a considerable positive impact on efficiency, which helps minimise or lessen the effects of these technological failures on the production process. Similarly, Dubey et al. (2019) found strong linkage between operational resilience and technological performance. According to Felipe et al. (2019), operational resilience is necessary to produce fresh or innovative goods, particularly in times of crisis, as it offers a wider view of the operational aspects that influence organisational performance. According to Gu et al. (2021), supplier and customer resilience have a favourable, considerable impact on the performance attained via the use of information technology.

In their 2019 study, Jermisittiparserta and Pithuk discovered a beneficial impact of organisational flexibility of a supply chain for humanitarian aid on IT usage, which supports technical performance. Additionally, Zhua et al. (2020) research demonstrated that supplier involvement and platform architectural flexibility had a considerable favourable impact on the capabilities of online procurement. If manufacturing companies are able to effectively carry out online procurement and customer engagement, their technological performance and in turn production efficiency levels will improve. Dunlop-Hinkler et al. (2011) findings showed that speed to market, product quality, and production efficiency are significantly affected by flexibility and information sharing. Hence, technological performance of a firm links directly to the level of operational resilience adopted by such firms. Higher levels of technological performance are required as a result, and recent studies on data analytics capability and organisational flexibility (Dubey et al., 2019), resilience strategies and blockchain-coordinated supply chains (Lohmer, et al., 2020), and agile supply chain strategy and supply chain performance (Tarafdar and Qrunfleh, 2016) provide evidence in support of this claim.

Based on the foregoing, the following hypotheses were raised:

- H₀₁ Technology performance is unaffected significantly by technological resilience
- H₀₂ Technology performance is not significantly impacted by H02 Recoverability
- H₀₃ Technology performance is not significantly impacted by workplace resilience
- H₀₄ Technology performance is not significantly impacted by H04 Disruption absorption
- H₀₅ Resilient culture has no significant effect on technological performance

Figure 1: Research Model



Source: Authors' Conceptual Model, 2023

The figure 1 above shows the conceptual model linking the dimensions of operational resilience (technological resilience, recoverability, workplace resilience, disruption absorption, and resilient culture) which make up the independent variables, to technological performance (the dependent variable).

V. DYNAMIC CAPABILITY THEORY (DCT)

The resource-based view theory was expanded upon by the dynamic capability theory of Teece and Pisano, 1997 (Chowdhury & Quaddus, 2017; Samsudin & Ismail, 2019; Yu et al., 2019). According to the dynamic capabilities theory, organizations should be able to recognize, shape, and take advantage of opportunities. They should also be able to preserve their competitiveness by maximizing, combining, safeguarding, and reconfiguring their resource capability (Altay et al., 2018; Bustinza et al., 2019). The uncertain character of the environment strengthens the use of the dynamic capacity theory, which gives this viewpoint greater importance to businesses (Altay et al., 2018). According to the notion, a company seeking a sustainable competitive edge should create new capabilities and resources or repurpose existing capabilities and take advantage of new possibilities (Yu et al., 2019). According to Aslam et al. (2020), environmental uncertainty or disruptions play a moderating function in the resilience-performance connection and change it. The need for continuous learning, which supports operational resilience and technological performance, is also explained by dynamic capabilities theory (Samsudin & Ismail, 2019). As a result, the theory provides an explanation for the relationships between the variables used in this study and provides a framework for investigating how organisations, particularly manufacturing organisations, coordinate their resources and capabilities in response to risks and disruptions that have an impact on their technological performance (EL Baz & Ruel, 2021; Yu et al., 2019). Further, this theory has been found to be relevant even in developing countries (Aslam et al., 2020).

VI. METHODOLOGY

The main goal of this study was to determine the impact of operational resilience dimensions on the technological performance of Nigeria's food and beverage manufacturing sector. These dimensions included technological resilience, recoverability, workplace resilience, disruption absorption, and resilient culture. Due to the sector's substantial importance to the Nigerian economy, human existence, and survival, as well as the current frequent disruptions affecting performance and ultimately the country's economy, the use of the food and beverage industry as the study topic was justified (Akomolafe et al., 2023; Amos et al., 2020). The study took the positivism research philosophy as a quantitative study, and maintained the independence of the researcher through analytical procedures that eliminated bias while providing more accurate results. The survey research design was used for the study. Primary data was collected from the sampling unit for this study which consisted of the top, middle and lower-level staff of seven listed food and beverages manufacturing companies as at December 31, 2022. This study's primary objective was to ascertain how operational resilience factors affected the technological efficiency of Nigeria's food and beverage manufacturing industry. These characteristics included workplace resilience, technology resilience, recoverability, disruption absorption, and resilient culture. The use of the food and beverage business as the study topic was justified given the sector's significant contribution to the Nigerian economy, human existence, and survival, as well as the existing pattern of frequent disruptions impacting output and ultimately the nation's economy. The Cronbach alpha and composite reliability results for the variables met the accepted threshold of ≥ 0.7 . Using the factor loadings for each item and Average Variance Extracted, the convergent validity was measured and the acceptable threshold of ≥ 0.5 was considered. By evaluating the square root of the AVE for each construct's correlations with all other constructs in the model, Fornell and Larcker's (1981) discriminant validity was used.

The Partial Least Square - Structural Equation Modelling (PLS-SEM) using Smart PLS version 4.0.8.8 was used for the model analysis and hypothesis testing. PLS-SEM is a powerful statistical technique for new technology development since it can model composites and factors (Jia et al., 2020).

The model specification for the study includes:

$$Y = f(X)$$

$$TP = f(OR).....functional_relationship$$

Hence, the five dimensions of operational resilience (OR) (the independent variable) include:

- x_1 = Technological Resilience (TR)
- x_2 = Recoverability (RE)
- x_3 = Workplace Resilience (WR)
- x_4 = Disruption Absorption (DA)
- x_5 = Resilient Culture (RCU)

While

$$Y = \text{Technological Performance (TP)}$$

Hence

$$TP_i = \alpha_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \ell_i \dots \dots \dots \text{model_equation}$$

$$TP = \alpha_0 + \beta_1 TR + \beta_1 RE + \beta_1 WR + \beta_1 DA + \beta_1 RCU + \ell_i \dots \dots \dots \text{model_equation}$$

VII. ANALYSIS AND FINDINGS

To test the hypotheses raised in this study the Partial Least Square Structural Equation Model (PLS-SEM) implemented in SmartPLS 4 software was used, and the results for technological performance as the dependent variable, and operational resilience dimensions (technological resilience, recoverability, workplace resilience, disruption absorption, and resilient culture) as the independent variables are presented in Table 1, Table 2, Figures 1, and 2 to show the relationship.

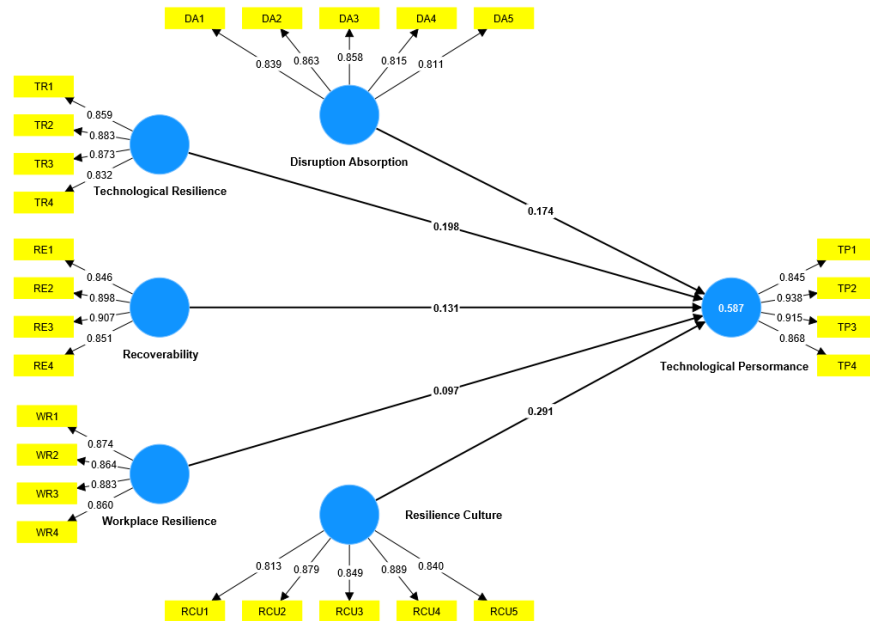


Figure 1: Path Analysis Showing the Measurement and Structural model

Source: Authors Data, via Smart PLS 4.0.8.8 (2023)

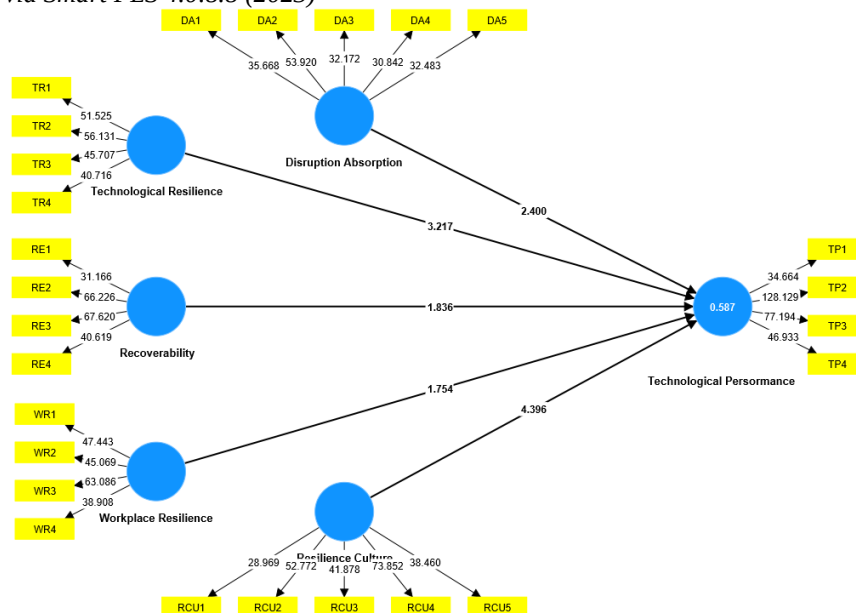


Figure 2: T- Statistics

Source: Authors Data, via Smart PLS 4.0.8.8 (2023)

Table 1: Summary of the PLS – SEM for the Effect of Operational Resilience Dimensions on Technological Performance in Food and Beverages Manufacturing Industry, Nigeria.

Path Description	Original Sample (o) Unstandardized Beta (β)	T	Sig.	F ²	R	R ²	Adj. R ²	Q ²
Technological Resilience -> Technological Performance	0.198	3.217	0.001	0.034	0.769	0.592	0.587	0.574
Recoverability -> Technological Performance	0.131	1.836	0.067	0.017				
Workplace Resilience -> Technological Performance	0.097	1.754	0.080	0.010				
Disruption Absorption -> Technological Performance	0.174	2.400	0.017	0.032				
Resilience Culture -> Technological Performance	0.291	4.396	0.000	0.075				

Source: Researcher's Result via SmartPLS Version 4.0.8.8 (2023)

The PLS-SEM Path analysis results for both the outer (measurement) model and the inner (structural) model for hypothesis two are shown in Figure 1. How well the items on each latent variable measures it is shown on the measurement model, and it can be observed that the items on each latent variable had values between 0.811 and 0.938, this fits well within the acceptable threshold of 0.7 for factor loadings (Hair et al., 2019), which showed that all the items loaded well. The relationship between the dependent variable (technical performance) and the independent variable's dimensions (operational resilience dimension) was also demonstrated by the inner model, and it is summarized in Table 1. As a result, Table 1 in Figure 1 shows the PLS-SEM result for the impact of operational resilience dimensions on technological performance of the Nigerian food and beverage manufacturing business. Table 4.2.2.2b provides further information on the model's fit, with a focus on the squared Euclidean distance (d_ULS), Standardized Root Mean Square Residual (SRMR), and Normed Fit Index (NFI) values.

From Table 1 Technological Resilience ($\beta = 0.198$, $t = 3.217$, $p < 0.05$), Disruption Absorption ($\beta = 0.174$, $t = 2.400$, $p < 0.05$), and Resilient Culture ($\beta = 0.291$, $t = 4.396$, $p < 0.05$) had significant positive effect on technology performance of food and beverages manufacturing industry, Nigeria. However, Recoverability ($\beta = 0.131$, $t = 1.836$, $p > 0.05$) and Workplace Resilience ($\beta = 0.097$, $t = 1.754$, $p > 0.05$) had insignificant effects on technological performance. From the results of the analysis, three of the dimensions of operational resilience (technological resilience, disruption absorption, and resilient culture) have significant and positive effect on technological performance of the food and beverages manufacturing industry, Nigeria. Further, the T- statistics results for technological resilience ($t = 3.217 > 1.96$), disruption absorption ($t = 2.400 > 1.96$), and resilient culture ($t = 4.396 > 1.96$) have T-test statistic values greater than 1.96. This implies that, technological resilience, disruption absorption, and resilient culture are the main drivers of technological performance in the food and beverages manufacturing industry, Nigeria. These results suggested that when food and beverages manufacturing companies improved technological resilience, disruption absorption, and resilient culture practices in their production system, there would be a corresponding improvement in their technological performance.

The magnitude of the association between the operational resilience characteristics and the endogenous variable (technological performance) is reflected in the model's R value, which further supports these findings. The value of $R = 0.769$ obtained from the model demonstrated a strong positive relationship exists between the dimensions of operational resilience and technological performance, as indicated by the threshold for R values of 0.75, 0.50, and 0.25 indicating strong, moderate, and weak relationships between the dependent and independent variables in a model (Hair et al., 2021). The Adjusted R^2 was used to establish the explanatory power of the study's model. The $Adj. R^2$ value (0.587) revealed that operational resilience dimensions explained about 58.7% of the variation in technological performance level of the food and beverages companies under study, while the remaining 41.3% of variations in technological performance was explained by other exogenous variables diverse from the operational resilience dimensions reflected in this study.

The effect size was determined using Cohen's f^2 metric to show the rank order of the predictor constructs' relevance in explaining a dependent construct in the structural model (Hair et al., 2019). Effect sizes with values that are >0.35 , >0.15 , and >0.02 could be considered as strong, moderate, and weak, respectively (Cohen, 1988). From the results on Table 4.2.2.2a three dimensions of operational resilience (technological resilience, disruption absorption, and resilient culture) had weak effect sizes ($f^2 = 0.034$, 0.032 , and 0.075). These results implied that there was a weak change in R-Square (R^2) values of technological

performance when any three dimensions of the exogenous variable (technological resilience, disruption absorption, and resilient culture) were removed from the model. However, recoverability ($f^2 = 0.012$) and workplace resilience ($f^2 = 0.010$) results showed negligible effect size on the R^2 when removed from the model. Summarily, going by the threshold of the effect sizes (f^2), operational resilience dimensions had weak effect sizes on the change in R^2 of technological performance in the food and beverages manufacturing industry, Nigeria.

The predictive relevance of the model was established using the Stone-Gleisser Q^2 value obtained via SmartPLS Predict. The threshold for Q^2 values are 0.02, 0.15, and 0.35 representing small, medium, and large predictive relevance respectively (Hair et al., 2019). Chin (1998) suggested that Q^2 above zero confirms that the structural model specified is relevant and significant. Table 1 revealed a Q^2 value of 0.574 from the model, indicating that operational resilience dimensions had large predictive relevance with regard to the endogenous variable, technological performance of the food and beverages manufacturing industry, Nigeria. This implied that, the structural model specified was relevant, significant at $p < 0.05$, and had sufficiently large predictive quality.

To assess the study model's fit, additional analysis of the Standardised Root Mean Square Residual (SRMR), the squared Euclidean distance (d_ULS), and the Normed Fit Index (NFI) data was conducted. Table 4.2.2.2b displays the estimated model's findings.

Table 2: Model Fit

	Saturated Model	Estimated Model
SRMR	0.047	0.047
d_ULS	0.771	0.771
d_G	0.475	0.475
Chi-square	1154.034	1154.034
NFI	0.868	0.868

Source: Researcher's Result via SmartPLS Version 4.0.8.8 (2023)

The model fit results were obtained from SmartPLS 4.0.8.8 using PLS Bootstrapping. The estimated and saturated models are used to report the model fit, with more emphasis on the estimated model results. From Table 2 the difference between the observed correlation and the model-implied correlation matrix (SRMR) = 0.047, d_ULS = 0.771, and NFI = 0.868. These results are within the acceptable threshold of < 0.08 for SRMR, d_ULS > 0.5 , and NFI within 0 to 1 with values closer to 0.9 are deemed acceptable (Birkie et al., 2017). Hence, the study model was of good quality and is void of model misspecification.

The multiple regression model generated from the data in Table 1 is thus expressed as:

$$TP_i = \alpha_0 + 0.198TR_i + 0.131RE_i + 0.097WR_i + 0.174DA_i + 0.291RCU_i + U_i \text{-----Eqn i (Predictive Model)}$$

$$TP_i = \alpha_0 + 0.198TR_i + 0.174DA_i + 0.291RCU_i + U_i \text{-----Eqn i (Prescriptive Model)}$$

Where:

TP = Technological Performance

TR = Technological Resilience

RE = Recoverability

WR = Workplace Resilience

DA = Disruption Absorption

RCU = Resilient Culture

From the predictive model technological resilience, disruption absorption, and resilient culture have significant effect on technological performance, while recoverability and workplace resilience do not. Hence, the prescriptive model does not reflect recoverability and workplace resilience, indicating that the food and beverage companies pay less emphasis to these variables. Further, the prescriptive model aligns with the results obtained from the path analysis confirming that when improvements of the three dimensions of operational resilience (technological resilience, disruption absorption, and resilient culture) are made by 0.198, 0.178 and 0.293 units respectively, given that all other factors are held constant, there will be a matching improvement in technological performance. Similarly, a decrease in technological resilience, disruption absorption, and resilient culture by one unit, would amount to a corresponding decrease in technological performance of the food and beverages manufacturing industry, Nigeria.

Further, the evaluation of the relative effect (β) of the significant exogenous variables showed that resilient culture had the highest positive significant effect ($\beta = 0.291$, $p < 0.05$) than technological resilience ($\beta = 0.198$, $p < 0.05$) and disruption absorption ($\beta = 0.174$, $p < 0.05$). The implication is that relative improvement of resilient culture, technological resilience, and

disruption absorption in the food and beverage industry would positively and significantly affect their technological performance. Likewise, Table 1 showed Adj.R2 =0.587 and Q2 =0.574 (significant at $p < 0.05$), this suggested that operational resilience dimensions (mainly technological resilience, disruption absorption, and resilient culture) positively and significantly affect technological performance in the food and beverages industry, Nigeria. Hence, the food and beverages industry should pay more attention to these dimensions of operational resilience to achieve improved technological performance. Consequently, the null hypotheses were rejected.

VIII. DISCUSSION OF FINDINGS

According to the results of the test of hypotheses, the technical performance level of the food and beverage industry in Nigeria is significantly influenced by operational resilience dimensions (technological resilience, disruption absorption, and resilient culture). These finding align with literature empirically, and theoretically.

Conceptually, technological performance was presented by Felipe et al. (2019) as the level of IT-based resources and capabilities that are mobilized and deployed to provide effort utilized in production that affects the production output level and product quality. This ability to mobilize and deploy production resources, achieves flexibility necessitated by frequent changes in the manufacturing industry. Hence, equipment supply and integration, food processing, as well as filling and packaging carried out with the right digital technology, right software, and data helps optimize production, and uncover potential enhancements thereby achieving higher levels of technological performance within the production system. As degrees of technological performance that production managers aim for greater production efficiency, Nwankwere et al. (2017) defined technological development, technological support, and shorter product life cycle. Disruption absorption, defined as a company's capacity to retain the structure and regular operation of operations in the face of disturbances, was also associated with improved technological performance (Brandon-Jones et al., 2014; Esumman et al., 2020).

The findings of this study were in tandem with extant literature such as Dubey et al. (2019) that found strong linkage between operational resilience dimensions and technological performance. Similarly, Felipe et al. (2019) found that novel or innovative products especially during a crisis situation are achieved through operational resilience, as operational resilience provides broader perspective of the operational factors that are behind organizational performance. These findings were corroborated by Gu et al. (2021) study that found positive significant effect of supplier and customer resilience on performance achieved through information technology usage. Further, literature also revealed that technological performance was achieved through blockchain-coordinated supply chains, data analytics capability and organizational flexibility (Dubey et al., 2019; Dunlop-Hinkler et al., 2011; Lohmer, et. al., 2020; Tarafdar & Qrunfleh, 2016).

Felipe et al. (2017) study examined organizational culture and organizational agility, and the study supported that resilient culture (clan culture and market culture) had positive significant effect on performance. The norms, values, and practises of an organization's resilient culture have either helped or hindered the performance of managerial and technological advances (Mandal, 2017). A resilient culture was also discovered to be essential for healthcare businesses to create organisational readiness and backup plans. Hence, Mandal (2017) study findings was corroborated by the results of this study, as resilient culture was found to have the highest positive significant effect ($\beta = 0.291$, $P < 0.05$) on technological performance in the food and beverages industry, Nigeria. Jermisittiparserta and Wajeetongratana (2019) findings corroborated Mandal (2017) as information technology integration and information technology flexibility components of resilient culture, were found to have positive significant effect on performance of small and medium enterprises.

Recoverability was found to have significant effect on the technological performance of firms (Ganin et al., 2015), this however, presented a divergent view from this study's results which revealed that recoverability ($\beta = 0.131$, $t = 1.836$, $p > 0.05$) had an insignificant effect on technological performance of food and beverages companies in Nigeria. Further research by Esumman et al. (2020) revealed that the efficiency of Small and Medium Enterprises (SMEs) in Sub-Saharan Africa is significantly impacted by recoverability and disruption absorption. In contrast, technological resilience, disruption absorption, and resilient cultures had positive significant effects on technological performance, while recoverability and workplace resilience had no significant effect on technological performance of the Nigerian food and beverage manufacturing industry. These findings indicate that operational resilience does not produce the same technological performance efficiency gains.

According to empirical studies, operational resilience dimensions are dynamic capabilities, and there is a positive correlation between dynamic capabilities and performance (Altay et al., 2018; Aslam et al., 2020; Belhadi et al., 2021; Brusseta & Tellerb, 2016; Bui et al., 2020). Dynamic capabilities, according to Samsudin and Ismail (2019), are the firm's capacities to mix, develop, and reconfigure external and internal expertise in order to react to an environment that is rapidly changing. As a result, a number of research (Aslam et al., 2020; Belhadi et al., 2021; Brusseta & Tellerb, 2016; Bui et al., 2020; Samsudin & Ismail, 2019) offer solid theoretical backing for the guiding theory (Dynamic Capability Theory) used in this work. The relevance of dynamic capability in developing countries (such as Nigeria) was well established in the work of Aslam et. al.,

(2020), while other studies (Bui et al., 2020; Macclever et al., 2017; Mandal, 2018) confirmed that dynamic capability helped explain how firms can systematically generate and modify ways of carrying out their operations, so as to gain higher levels of technological performance. The results of hypothesis two are theoretically connected to the dynamic capability theory. Hence, findings of this study proposed that the food and beverages manufacturing industry in Nigeria should give more attention to the development of technological resilience, disruption absorption, and resilient culture to achieve higher levels of technological performance.

IX. CONCLUSION

The top, middle and lower level management should focus on disruption absorption capability of taking time to consider reasonable response to changes in production technologies, the timely activation of contingency plan, technology innovation adoption, and advanced production capabilities development will drive the companies towards higher levels of technological performance. Emphasis on technological resilience and developing a resilient culture would foster the ability to meet special customers' specification, upgrade production processes, and adopt up-to-date technology. In Nigeria's food and beverage manufacturing sector, the study found that operational resilience dimensions (technological resilience, disruption absorption, and resilient culture) have a significant impact on technological performance, whereas operational resilience dimensions (recoverability and workplace resilience) have a minimal impact.

Being a multi-dimensional construct, the study recognizes that the components of operational resilience used in this study are not exhaustive. To ascertain how operational resilience affects technical performance, one could also consider other pertinent operational resilience aspects, such as the input-based resilience method. As the economic circumstances of models of resilience are important in the analysis, the fact that the research hypotheses were only tested in one nation restricts the generalizability of our findings (Jaing et al., 2023). Be that as it may, in the context of production and operations management, especially within the context of the chosen manufacturing industry, the adopted measures are the primary focus of an average manager and satisfy the primary objective of the study.

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