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Research Article

PRODUCTION CHAIN AND COVID-19 DISRUPTION: SUSTAINABILITY VIA FLEXIBILITY FRAMEWORK A CASE OF THE BEVERAGE INDUSTRY

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Abstract: The pandemic has uncovered the weakness and volatility of production chains. The study examined the implication of corona-virus on the production chain functionality in a beverage production firm in terms of sustainability and flexibility. The study also evaluated a contextual analysis of an organization, the impact of the corona-virus outbreak, and the challenges the organization encountered. A purposive method was utilized as an information-gathering source from 200 participants. The outcome shows that the pandemic prompted critical disturbances such as the deficiency of resources/extra parts, accessibility of transportation, accessibility of work, and safety guidelines. The study also postulates that there is a need to re-design the production chain to be more flexible and resilient by providing recuperation plans (anticipation, choice of supply, modeling, observing) that consider measures in various echelons. Given this, a prescribed optimal procedure was suggested for the contextual analysis by considering inward, outward, and technological bottlenecks during the pandemic. A portion of the designated procedure and the optimization of the production chain can be considered and utilized in the other sectors.

Keywords: Sustainability, optimization, production chain, functionality, pandemic, flexibility.

MSC: 90B30, 91B38, 90B25, 90B70.

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1. INTRODUCTION

The COVID-19 pandemic has highlighted the vulnerabilities in global production chains, exposing businesses to unprecedented disruptions. The conventional linear supply chain models, characterized by rigid structures and centralized manufacturing, proved inadequate in the face of the pandemic's challenges. This study aims to delve into the background of production chains, the impact of COVID-19 disruptions, and the imperative for sustainability through a flexibility framework. Historically, production chains were designed for efficiency, cost reduction, and mass production. These linear models often involved long and complex supply chains, with limited flexibility. The pursuit of economies of scale led to centralized production hubs, making the system susceptible to disruptions in any part of the chain [1]. The rigid nature of these models left little room for adaptation during crises. The onset of the COVID-19 pandemic exposed the fragility of global supply chains. Lock downs, travel restrictions, and workforce shortages disrupted manufacturing, transportation, and distribution. The scarcity of critical components revealed the risks associated with relying on a few suppliers. The repercussions were felt across industries, from electronics to pharmaceuticals, underscoring the need for resilient and adaptable production systems. In the aftermath of the pandemic, businesses are reevaluating their production strategies. Sustainability has become a key focus, encompassing not only environmental considerations but also resilience in the face of unforeseen challenges. A sustainable production chain is one that can withstand disruptions, minimize environmental impact, and adapt to evolving market demands [2, 3]. The flexibility to respond swiftly to changing conditions is central to achieving these goals. Given this, a flexibility framework involves re-imagining production chains with adaptability as a core principle [4, 5].

This includes diversifying suppliers, embracing digital technologies for real-time monitoring, and implementing agile manufacturing practices [6]. Decentralized and rationalized production can reduce dependence on a single location, mitigating risks associated with geopolitical events or global crises. Additionally, incorporating circular economy principles can enhance resource efficiency and minimize waste. Beyond the immediate economic repercussions, the pandemic highlighted the environmental and social consequences of supply chain vulnerabilities [7, 8]. Increased waste, driven by excess inventory and disrupted logistics, exacerbated environmental degradation. The pressure to meet demand amidst disruptions also led to compromised labour conditions, revealing ethical concerns in the pursuit of operational continuity. In this crucible of challenges, a compelling case emerged for rethinking production models not only in terms of efficiency but also with a keen focus on sustainability. As production chains faced an existential reckoning, a call for flexibility resonated across industries [9, 10]. The ability to adapt swiftly to changing circumstances emerged as a crucial factor for survival. This flexibility is not merely a reactive response to unforeseen challenges but a proactive strategy that integrates sustainability principles. The traditional linear model, where inputs lead to outputs in a sequential fashion, proved insufficient in the face of disruptions [11, 12]. A new framework, emphasizing agility, adaptability, and sustainability, is essential to navigate the complexities of an interconnected global marketplace. This study proposes a holistic approach – a flexibility framework – as the pathway to sustainable production chains in the post-pandemic era. By embracing diversification of suppliers, leveraging digitization and technology integration,

implementing agile manufacturing practices [13, 14], and instilling sustainable principles, businesses can not only weather disruptions but also contribute to a more resilient and responsible global ecosystem. The subsequent sections of this study delved into each aspect of the flexibility framework, examining how these strategies collectively form a blueprint for a more sustainable and adaptable future in the realm of production chains.The examination was performed in light of a contextual analysis from a beverage firm in Lagos State, Nigeria. The beverage industry is characterized by intricate production chains spanning from raw material sourcing to distribution, faced acute challenges during the COVID-19 pandemic. The disruptions exposed vulnerabilities that necessitate a profound reevaluation of traditional production models. This provides a nuanced understanding of the motivations behind studying the impact of COVID-19 on the beverage industry and the imperative for a sustainability-driven flexibility framework [15]. The beverage industry is a complex amalgamation of suppliers, manufacturers, and distributors, experienced severe disruptions as the pandemic unfolded.

The reliance on a global network of suppliers for ingredients, packaging, and transportation made the production chain susceptible to interruptions. Lock-downs, restrictions on movement, and workforce shortages hampered the timely procurement of raw materials, production schedules, and the distribution of finished products. The resulting turbulence exposed inherent vulnerabilities, prompting a critical examination of the industry's ability to withstand unforeseen shocks. The pandemic-induced disruptions in the beverage industry were not solely economic but had far-reaching environmental implications. The beverage sector, traditionally associated with high resource consumption, encountered challenges in managing excess inventory, leading to increased waste and environmental degradation. Simultaneously, economic pressures intensified, necessitating a delicate balance between operational continuity and responsible resource utilization [16]. The motivation to address these dual challenges stems from the recognition that a more sustainable production framework is not only ethically sound but also strategically imperative for the long-term viability of the beverage industry. The beverage industry's unique characteristics, including perishable products, stringent quality standards, and intricate logistics, amplify the challenges posed by disruptions. Unlike durable goods, beverages often have shorter shelf lives, making inventory management more complex [17].

The motivation to delve into a case study of the beverage industry stems from the need to unravel these specific challenges and tailor a flexibility framework that not only ensures sustainability but is also attuned to the nuanced requirements of this sector. By understanding the specific challenges faced by the beverage sector during the pandemic, this study aims to contribute valuable insights and practical recommendations to guide the industry towards a more sustainable and adaptable future. Therefore, the study objective is the investigation of corona-virus implication on production chain functionality in a Nigerian beverage production firm and foster a model for optimizing functional operations to survive unpredictability, vulnerability, intricacy, and vagueness within the environment in terms of sustainability and flexibility.A sustainability via flexibility framework could contribute to the development of more resilient and adaptable production chains that can withstand disruptions like the COVID-19 pandemic. By incorporating sustainability practices into the production process, companies can reduce their environmental impact while maximizing profitability and competitiveness.

2. LITERATURE REVIEW

2.1. COVID-19 and Production Chain

The pandemic has exposed the fragility and instability of many production chains and operational activities [18]. Several organizations have gone bankrupt because of the bottleneck, and others are on the edge of collapse [19]. This has shown that many organizations have undermined the requirement and need for sustainable and flexible operations. Many production firms in Lagos State, Nigeria were also affected by the pandemic. This adversely impacted the organizations monetarily with an evidence in the reduction of profits. The circumstance is not different from the global production chains. The colossal effect of the pandemic is huge on the production network [20, 21]. Any form of constraints such as plant closure and production delay will affect the production chain and related businesses in the other districts. Consequently production firms according to [22] have illuminated every echelon within the production chain in the context of conveyances delay due to production imperatives, product line delays and other limitations. These could also be traced to disruptions in market demands for products in cognize to production. Thus, beverage production firms are encountering more disruptions than other sectors due to COVID-19 and the life span of beverages. The explanation according to [23] [2] can be linked to the absence of linearly linked echelons. These leads to a drop in profit and production quantity to such an extent that the beverage organization will minimize its functional operations. In Nigeria and other African nations, the obvious solution is closure for a brief time, which in most cases, resulted in losses and bankruptcy. Whereas others survived through merger and acquisition. To forestall the economic outcome or minimize the effect, it is essential for beverage production firms to come to terms with the reality of the pandemic [24]. An efficient and informed production firm would have adaptive models to deal with the circumstance. However, a significant bottleneck that also impacted the beverage companies to remain unproductive is COVID-19 absence of past information due to the rarity and recentness. Consequently, studies have not estimated the implications.

2.2. The Optimization of Sustainable Models during the pandemic

COVID-19 is an intricate issue within any production echelon that concerns the fundamental components of sustenance, which can be depicted as the balance of quantity and production. Regardless of the cyclic connection between sustainability and corona-virus, dealing with the production chain utilizing optimization procedure has been given minimal consideration. During the pandemic, vulnerability and disruptive bottlenecks have negatively impacted beverage production [25, 26]. Therefore, production firms must rethink models to procure new capacities and implement flexible procedures to co-tail difficulties such as financial and ecological angles to achieve operational functionality [27]. Also, the new discoveries referenced the risk of Covid connected to the production functions (e.g., production, modelling, production network tasks, and so on.). Therefore, the model of product and resource movement would be more effective through the collaboration of different echelons to produce long-term output over transient output. The pre- and post-coronavirus period brought new opportunities for more sustainable business adaptability [28], as well as the need to upgrade the production network and frameworks [29]. The result of disruptive periods have linearly affected functional operations, such as material deficiency, conveyance delays, the absence of extra parts, decreased work time,

and so on. These disturbances are embedded within a production network. This implies a decrease in output, income, and cycle productivity [7], even affecting the external inventory network [30]. The study by [31] recognized several decision-supportive networks that enhance production process. Besides, [32] formulated a paradigm that decided the effect of the pandemic in terms of production chain and versatility. Obviously, the corona-virus situation provides a chance for the improvement of an adaptable and flexible production procedure to protect the economic, ecological, and social aspects of the business [33]. The economic aspect of sustainability is directly connected to the social and ecological angle. By and large, social and ecological sustainability considerations have an aftereffect on the economic aspect. Consequently, a prescribed procedure is associated as eco-social and ecological models. Specialists, state-run administrations, and policymakers are undeniably worried about the adverse consequences on organizational paradigm and approach. Thus, production firms are endeavoring to address the difficulties and issues related to sustainability [34].

Consequently, there have been various drives towards change in an organization, for example, wellbeing and security, proficient correspondence techniques in medical care, remote working circumstances, and capacity improvement [35]. These are portions of social sustainability embraced by production firms to mitigate the effect of corona-virus and further conserve sustainability.Subsequently, the presence of COVID-19 has introduced social separation at office locations and workplaces to forestall the spread. This became a challenge because of the additional time required for the production firm to achieve productivity objectively. Herein post corona-virus guidelines is introduced into framework. However, ecological and economic perspectives are major mainstays of sustainability that manages resources that are minimal to optimize functional resources and reduce waste to preserve the habitat and minimize cost [36, 37]. Erstwhile, the study delves into the challenges faced by the beverage industry, there remains a gap in the literature regarding sector-specific analyses. More granular investigations into the unique characteristics of different beverage sub-sectors (e.g., soft drinks, alcoholic beverages) could offer nuanced insights into how disruptions and flexibility strategies vary across the industry. Furthermore, many studies touches upon global disruptions, but there is a lack of in-depth exploration of regional disparities. Variations in regulatory responses, supply chain structures, and market dynamics during the pandemic might have diverse impacts on beverage production chains. A more comprehensive understanding of regional nuances is crucial for effective global strategies. The study primarily focuses on immediate responses to COVID-19 disruptions. However, a research gap exists in the assessment of the long-term impacts of these disruptions on the beverage industry. Exploring lasting changes in production chain configurations, and sustainability practices would contribute to a more holistic understanding of the industry's post-pandemic landscape. The study contributes by proposing a holistic flexibility framework grounded in resilience theory. This framework integrates sustainable practices, providing a comprehensive guide for the beverage industry to fortify its production chain against disruptions while advancing sustainability goals. One of the key contributions lies in the emphasis on sustainability as a core component of the proposed framework. Pertinent to this, the study objective is the pandemic effect on production chain procedure in beverage firms in the context of sustainability through a flexible framework. An evaluation of the level of influenced production result was performed by driving an illustrative study. The study also visualizes an optimal enhancement by arranging a procedure to fabricate

operational functions that is adaptable to unanticipated disturbance and bottlenecks. The review will assist with encapsulating inspiration into a contextual investigation that will give a superior comprehension on the effect of COVID-19 on production chain. Consequently, the study examined the implication of corona-virus on production chain procedure of a beverage production firm by optimizing a functional framework that will be flexible in the midst of unpredictability, vulnerability, intricacies, and vagueness. Furthermore, the framework is intended to guarantee adaptability and flexibility. To comprehend the aim of the study two hypotheses were formulated:

H_1: The pandemic caused disturbance in terms of deficiency of resources/extra parts, accessibility of transportation, and request change in the production firm which adversely affected functional operations.

H_2: A connection exists between tele-working and dependability of the production network.

2.3. Theoretical Framework

The theoretical framework proposed for understanding the dynamics of the beverage industry's production chain amidst COVID-19 disruptions and its subsequent sustainability through a flexibility framework draws on key concepts from resilience theory. Resilience theory, within the context of the beverage industry's production chain, refers to the system's capacity to absorb shocks, adapt to changing conditions, and recover quickly from disruptions. Drawing from Holling's adaptive cycle, the industry can be seen as a dynamic system experiencing phases of growth, disturbance, and reorganization [38]. Resilience theory emphasizes the need for adaptability and transformation, aligning closely with the challenges posed by the COVID-19 disruptions. Theoretical foundations from resilience literature guide the identification of adaptive strategies and dynamic capabilities necessary for the beverage industry to navigate uncertainties effectively. Key elements of resilience theory includes:

Adaptive Capacity

Resilience theory posits that adaptive capacity is essential for systems to withstand and rebound from disturbances. In the context of the beverage industry, the ability to adapt is central to overcoming the disruptions induced by the COVID-19 pandemic. This involves the industry's readiness to implement flexible strategies in response to changes in demand, supply chain interruptions, and market dynamics.

Transformational Processes

The framework incorporates the notion that resilience often involves transformational processes. For the beverage industry, this implies a willingness to reevaluate traditional production models and embrace a flexible framework. Transformation may include shifts in supply chain configurations, the adoption of advanced technologies, and the integration of sustainable practices to fortify the industry against future disruptions.

Learning and Innovation

Resilience theory underscores the importance of learning and innovation in the face of challenges. The beverage industry, drawing from resilience principles, can leverage disruptions as learning opportunities. Through post-event reflections and the incorporation of new knowledge, the industry can innovate its practices, enhancing its ability to navigate future disruptions with greater efficacy.

3. METHODOLOGY

A contextual investigative model was utilized to examine the implication of corona-virus on the functional operations in the context of beverage production. Specifically, a beverage production firm was selected cautiously to assemble dependable information. The study formulated hypotheses by examining extant literature on the impact of corona-virus bottleneck on a production chain. Furthermore, the study was anchored by utilizing a contextual (case) study model [10, 39]. A beverage production firm was selected as a contextual investigation model because it is a market lead in Nigeria. Thus, the availability of staff and management from the contextual investigation firm was a vital construct. Also, the study inspiration was to indicate the implication of the pandemic from an extensive point of view within each echelon of the production chain functionality. The formulation of the questionnaire was based on the hypotheses and constructs verified in the production firm considered. The survey was arranged considering the implication of corona-virus on the operational functions of the production chain. Furthermore, the study survey was intended and designed specifically for the staff and supervisors. In this exploration, the variables for choosing the suitable respondents (test) for information collection was based on normalized/standard non-probability examining the specific construct of the study. During the information gathering process, the principal approach utilized was the technique of purposive sampling. Subsequently, the population utilized was based on the participants/staff in the contextual (case) investigation model company that is connected to production. The study explored the contextual (case) analysis organization to find new viewpoints with the hypothesis to compare the steps the selected organization has taken and is doing to guarantee operations during the pandemic. Furthermore, in the contextual investigation organization a schematic paradigm was developed to optimize productivity in the operational function and potential methodology. A descriptive analysis was utilized through SPSS and with an objective of comprehending the system and defined pattern.

However, information examination permits the study to analyse the implication of corona-virus on the functionality of the beverage production firm. The essential dependant constructs were chosen as the functional risk which incorporates the business functional activities, for example, production, item improvement, inventory network, acquirement, operations, and data/business investigation. In any case, the problem construct that impacted the organization's functionality and outcome during the pandemic is complex due to it's continuous nature and vulnerabilities. Purposive technique was also considered proper in light of the fact that it aims at selecting specific information that gives an itemized comprehension of the study [40]. Given this, a homogeneous examining model was utilized on two separate levels during the sampling procedure. At first, the study utilized positions, information availability, and functionalities. The classes were based on staff and supervisors. Extensively, a homogeneous model was utilized to generalize experience with the contextual investigation organization and explain the similar day-to-day operations during the pandemic. Besides, representative sampling model was also utilized to measurably examine the review methodically. A representative paradigm was utilized in circumstances where the populaces is high and difficult to examine. Participants were chosen based on specifics and divisions. Besides, the study conveyed one survey for employees and directors. Therefore, It is feasible to obtain data and perceptions on a designated populace by utilizing a representative model [41]. Representatives were

separated into three classes as per their degree of responsibility, contingent upon the commitment, and alternate points of view. However, with regards to studying an objective populace with enormous samples is not necessarily better, on the grounds that the sheer size does not guarantee an objective outcome [40]. In this manner, a representative model was picked within restricted participants, that objectively reflects explicit qualities exhibited in the populace. Moreover, the representative model provides an optimal, easier, and open approach of information accuracy. The study sample was 200 participants. Subjectively every participant functions in any of the principal divisions (e.g., production (63%), distribution center (24.1%), and administrative division (12.7%).

3.1. Formulation of Survey (Questionnaire) Construct

The survey was designed and intended for the staff and senior managers which included 16 normal and 5 extra inquiries for senior administrators. The inquiry includes three formulations e.g. (Minimal, multi-decision questions, and tickboxes). The survey for the staff and senior administrators varies. The poll for staff had two segments and an itemized third section for senior managers. Subsequently, two segments have no remarkable change regarding response from staff or senior managers, and the third segment was tailored towards methodologies and technological change in the contextual (case) analysis organization. The final segment provided a comprehension of administrative operations and other measure activities in the context of the organization's vulnerability model using a Likert scale of 1-5.

3.2. Descriptive Analysis

The information/data gathered was examined to affirm and validate the research hypotheses. This was based on selected constructs that was chosen from reviewed studies. Descriptive estimation was utilized to portray the essential highlights and every arrangement of the model is introduced based on the survey- inquiries through pertinent outcomes. Consequently, the survey incorporates categorical information where the participants' responses were assessed. Validity assessment was also utilized through corrected rectified total variable that estimated the value of each construct. An outcome higher than 0.30 [42] was utilized as the validity of every construct. A reliability test was also carried out via Cronbach alpha notwithstanding the estimate was more than 0.70 which is the minimum point.

4. RESULTS

Further investigation was done to evaluate the hypotheses which were predetermined. The investigation is dependent on the p-outcome of 5%, and the *t*-outcome (value) of 1.96, or the p-worth of 0.05. The fundamentals of the hypothesis were empirically based on the *t*-outcome (value) beyond 1.96 and the *p*-outcome (value) is below 0.05. This is in line with [43].

Table 1 also demonstrates the result from the immediate impact reflected in H_1 and H_2. The discoveries of the study have shown that a feasible production network in its context shows that the pandemic has a considerable impact on the accessibility of transportation and extra parts. Also, the connection between teleworking and dependability has exhibited a significant relationship and effect. A production network that can sustain operations after an unsettling influence like the Corona-virus pandemic is

a mark of a feasible production network. In view of the discoveries of this study, the outcome obtained is considerate and it is in accordance with past examinations. In the context of [44], sustainability and viability is the ability to withstand social ecological change. It provides extra attributes to the performance of the production networks.

Table 1: Statistical outcome

Hypothesis	**Path Coefficient (outcome)**	**T-outcome (value)**	**P-Outcome (value)**
The pandemic caused disturbance in terms of deficiency of resources/extra parts, accessibility of transportation, and request change in the production firm which adversely affected functional operations.	0.611	17.134	0.000
A connection exists between tele working and dependability of the production network.	0.577	19.213	0.000

The production network's versatility during interference's shows its capacity to forestall request gap and sustain product supply. This study is in accordance with the discoveries of [45], who stated that any production network during the pandemic will need components of agility, flexibility, and anticipation to guarantee production and inventory continuum. According to [46] the utilization of flexible production network methodologies can assist in minimizing disruptions. This will assist the business to be sustainable. Paper [47] posited that the production network suitability is essential for supporting competitiveness. However, organizations that changed the functionality of their providers and clients had optimal performance in the event of COVID-19. The study results in view of the outlined survey was utilized to examine the hypotheses formulated based on the production chain, and operational disruption. One of the significant discoveries was the verification and examination of the production chain under review and its network framework optimization during the pandemic.

5. DISCUSSION AND MANAGERIAL IMPLICATIONS

The geometric increase of coronavirus can be viewed as a high likelihood, and a maximum disruption risk [48]. In the course of the study, the pandemic was not the only bottleneck within the production chain there were other issues within the echelons of production. Therefore, the pandemic is a channel of disruption, either directly or by implication. The production chain disturbance has been driven by material deficiencies, particularly the lack of parts such as semiconductors during the pandemic. Nonetheless, the examined organization had the option of sustaining its standard during the process of production at a minimized loss, and optimized market prevalence, and stake. The accompanying segment interpreted the key discoveries of the study hypotheses.

Interpretation of important Discoveries

The following results was obtained in-line with the hypotheses:

H_1: The pandemic caused disturbance in terms of deficiency of resources/extra parts, accessibility of transportation, accessibility of work, and request changes in the production firm which adversely affected functional operations;

- Accessibility of transportation: The border closure triggered a progression of events that essentially impacted the logistics sector, i.e. the transportation echelon. Therefore, the transportation modes and dispatch services have become less obligated to conventional practices. This has prioritized alternative models and the practices. The inaccessibility of freight transportation on request has prompted a critical increase in lead times for the examined organization. Consequently, the production chain functionality has been impacted by the unpredictive nature of the corona-virus pandemic due to the transportation (90.40% of participants) and obvious difficulties, e.g., border closure, limitations on import and product, lack of transporters and resources request vacillations in many sectors.
- Accessibility of work: The government and associations have applied a few measures, for example, safety guidelines to forestall an increase of covid. 90.40% which comprises a large part of the beverage production unit staff were infected with corona-virus, while the senior managers could work in separated regions like workplaces or at home. The guideline of social distancing and the geometric increase in leave caused a decrease in shifts.
- Request vacillations: A sum of 81.40% of the staff affirmed that request fluctuation has increased in the examined organization. A large portion of businesses reduced in light of changes in overall yield, which was impacted by the shortage in resources, government laws, curfews, production stoppage, and workplaces closure.

H_2: A connection exists between tele working and dependability of the production network;

- The production chain encountered different difficulties and bottlenecks like a hazardous workplace, absence of technological framework, internet security issues, and limited correspondence channels. In spite of the fact that a greater part of the senior management operations was accomplished in a remote work framework. However, the organization's operational function was vigorously dependent on onsite operations. According to the survey, 71.05% of the production staff consented that they experienced issues working from home. Thus, operational optimality was impacted by distance, remote working, and disturbance in their functionality. Subsequently, senior management did not have similar constraints like the junior production and logistics employees.

Recognized bottlenecks and Issues in the Firm

The outcome of the survey provided a comprehension of the fundamental issues within the organization's production chain during the pandemic. The contextual (case) organization has encountered critical difficulties from April 2020 to May 2021, because of the corona-virus outbreak. The main issue during the corona-virus outbreak was that the business unit did not foresee the pandemic. It was viewed as a nearby or local issue that briefly impacted the local district. However, the spread of covid geometrically increased. The empirical discoveries show that the contextual investigation organization has itemized vulnerabilities with recognizable proof & minimization both proactively and responsively. Therefore, it is exceptionally urgent for the organization to distinguish and detect the risk to forestall any potential disturbances. However, the organization's operational functions are customized towards the just-in-time inventory model that implies low stock and minimized lead times due to the dynamics and risk of the industry.

Anticipation-Flexibility-Change Model to adapt during the Pandemic and future occurrence

The organization must have flexible capacities that are formulated by iterating and re-configuring the inward and outward procedures to deal with changing circumstances. In light of disruptions and difficulties during the pandemic, a schematic paradigm was developed to assist the contextual (case) organization & potential organizations. The system entails new drives to empower the change towards sustainability. The schematic paradigm is addressed in Figure 1. It was created in light of a sustainable model to deal with the implication of corona-virus on operational functions, in anticipation of the various difficulties, 'utilizing optimal procedures to conquer difficulties, and 'changing' its operational cycles to foster sustainability.

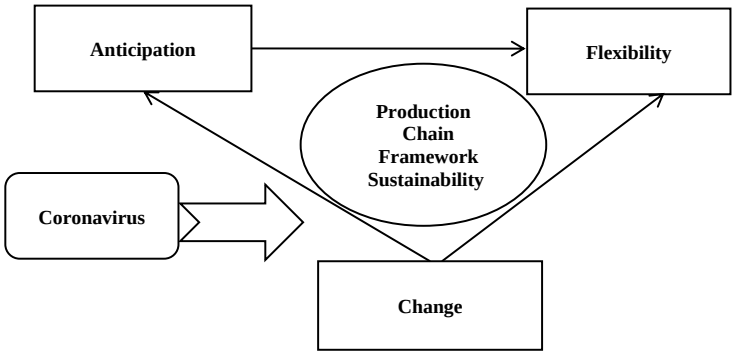

Figure 1: Anticipation-Flexibility-Change Model

Anticipation: It is the primary period of the production chain echelon which assists the firm with continuous production by detecting any expected interruption/difficulties prior to guaranteeing the progression of the production chain. Correspondence and communication is a fundamental element of this stage with subcategories like information. Consequently, it is classified under and named the anticipation stage. One of the vital discoveries of this study was the manner by which sustainable practices are perceived and carried out along with operational functions within the production network. Additionally, in the event that there are any disturbances or risks in the process, it is important to have maximal correspondence in order to achieve optimality.

Flexibility: The next phase of the system provides an understanding that enables an organization to adopt new drives to sustain the system by reducing the non-value echelons. A significant character such as flexibility assumes a fundamental part in production and inventory sustenance techniques that accommodate market adaptability and consumer dynamics. The progression to sustainability cycle occurs via flexibility. The utilization of the paradigm will birth business models that maximize profitability and shift towards a technological approach.

Change: The last phase of the model is changing the regular cycle of operations. This stage is significant for organizations to adopt and change sustainable cycles and values. Additionally, it contains miniature foundations, for example, 'joint efforts also 'technology' as sub-echelons. The technological utilization model and the joint effort with suppliers are two fundamental segments to begin the change of the organization towards

sustainability. Given this, each sub-echelon is tailored towards change. Therefore, the expression "anticipation" entails other sub-sections such as data and correspondence. Basically, the flow of the business should be based on structured information correspondence to anticipate any form of disruption previously and after. It will empower the organization's functionality ultimately. The next stage is "flexibility" which entails other sub-echelons such as inventory network, and actual assets under a precise design. The data given assists the organization with the management of disruptions by making moves ahead of time and adjustment. Therefore, it is proper to anticipate and plan what is coming & adjust. The final phase is "Change", which intends to empower the organization to change and enhance the day-to-day operations to stabilize and consistently improve efficiency. There are three sub-echelons (inward and outward correspondences, partner contribution, sustainability inclusive of technology). A solid technological framework can empower the contextual model organization to optimize productivity during the pandemic or future disturbance when individuals are permitted to teleworking within the production chain. It is therefore pertinent to noted that the beverage production firm which is the contextual investigation organisation should do the following;

Business continuity design in case of any potential disruption: As a rule, most organizations recognize the importance and the benefit of having a fallback plan, however, not all have a flexible or sustainable plan in terms of business continuum. Therefore, the firm can implement a flexible business design that allows the organization to respond rapidly to any potential disturbance. At the point when an interruption happens, the organization must adjust based on the business continuity design in the context of the organizational production chain model and flexibility.

Examine how suppliers and clients work and the predictability during crisis: During the anticipation stage, it was prescribed to dissect and examine suppliers and clients during the pandemic to identify the issues of taking appropriate actions at the beginning phase. After the corona-virus pandemic when the contextual investigation organization has recuperated completely from the interruptions, it would be essential to break down its suppliers and clients to distinguish which one overcame the pandemic without bottlenecks and which one had major problems that impacted the operational function. According to the assessment in the study, key activities are the continuum of work with clients or search new ones. The operational model based on the study to achieve optimality in the production chain must be based on three stages such as anticipate, flexibility and change. The prescribed procedure addresses an extensive outline of countermeasure activities that can be carried out to limit the impact of any potential disturbance. The practice is based on moderating and minimizing any form of disruption by taking an objective overview of different units of the beverage production firm.

To implement this framework, managers should consider the following:

Diversify Suppliers: To mitigate the risks of depending on single sources for raw materials or products, managers should diversify their suppliers. This will ensure a steady supply of materials and products, even during crisis. Additionally, managers should consider developing relationships with local suppliers to reduce transportation costs and increase resilience. Increase Visibility and Transparency: Managers should increase visibility and transparency in the supply chain through digital technologies and data sharing. This can help track products and ensure compliance with regulations, which is

especially important during a crisis. Additionally, managers should consider using block-chain technology to increase transparency and traceability in the supply chain. Develop Agile Production Processes: Agile production processes that can quickly adapt to changes in demand or supply are essential during crisis. This may involve implementing just-in-time (JIT) manufacturing, which can reduce inventory costs and increase responsiveness. Build Resilience into the Production System: Building resilience into the production system by increasing capacity and flexibility can help mitigate the impact of disruptions. Managers should invest in technology and equipment that can increase production capacity and flexibility. Additionally, managers should consider implementing cross-training programs to ensure that employees are able to perform multiple tasks. Incorporate Sustainability Practices: Incorporating sustainability practices into the production process can help reduce the environmental impact while improving long-term profitability and competitiveness. Managers should consider implementing sustainable practices such as reducing waste, using renewable energy sources, and minimizing carbon emissions. Additionally, managers should consider using life-cycle assessment (LCA) to evaluate the environmental impact of their products. Overall, the COVID-19 pandemic has highlighted the importance of sustainable and flexible production systems. Managers should consider implementing a sustainability via flexibility framework to address the challenges faced by production chains during a crisis. By doing so, they can increase their resilience, reduce their environmental impact, and improve their long-term profitability and competitiveness.

6. CONCLUSION

The study examined the implication of corona-virus on the operational function of production chain in a beverage production firm in Lagos State, Nigeria. The study was primarily based on assessing and examining the disruptions and implications during the pandemic and the potential risk of occurrence. In this specific situation, the study tested the model hypotheses and the framework disruption. The study suggests a multiple approach of optimizing the production framework by the integration of a flexible and resilience framework within the production echelon in the considered organization. This is in line with the study by [49]. The pandemic interrupted production cycles such as the lack of resources and extra parts, accessibility of transportation, accessibility of labor force, request vacillations and safety guidelines respectively. Throughout the study, significant insights were given on the implications of corona-virus in the beverage production firm:

- The emergency caused the study to re-evaluate the organization's necessities, which responded rapidly to Corona-virus measures (more than 75% of respondents agreed).
- The need to re-plan the production chain to be more flexible and resilient by providing a mechanism of recuperation (anticipating, provider determination, optimization, checking) that expects various measures.
- The results show that corona-virus catalyzed digitization. It additionally uncovers the advantage of sustainability, when encapsulated within the organization combined with optimal practices. The review further provided a comprehension of the firm's sustenance. The critical difficult distinguished in this study can be arranged into three fundamental classifications:

- **Internal bottlenecks**: production chain functionalities, procedures, social outlook, employee's abilities, monetary designs, and so forth.
- **External bottlenecks**: New guidelines, external arrangements, joint effort with suppliers, and so on.
- **Technological bottlenecks**: Information sharing, digitization framework, suppliers contribution, inner and external cooperation, and so forth.

The coordination and integration of technology with the operational function of the production networks can be implemented easily within the context of an internal operations but difficult to incorporate externally. In light of the results, the system should be formulated based on a flexibility and sustainable approach. This minimizes the effect of corona-virus on production chain functionality, where the organization would 'anticipate' the various difficulties, and prescribe a "flexible" procedure to overcome difficulties and 'change' its functionality/or cycles to foster sustainability. The outcome of this study further reveals that the beverage production firm should digitalize the present production model to meet requests. Consequently, the lessons from the pandemic shows that the utilization of an optimal practice is the best way to proceed. This is connected to a prescribed procedure based on flexibility and resilience. This study adds to existing studies by providing an empirical outlook in view of contextual sustainability. The study blends various paradigm like technology, production chain flexibility, disruption resistance and sustainability. This paradigm prompts the optimization of an hypothetical starting point for examining different echelon within the production chain. In will likewise add to modern practices by situating/outlining specific functional risks in a production network. The effect of the pandemic uncovered the significance and the comprehension of a new business model that is technological inclined. On the opposite side, the review provides new difficulties to remodel existing production chains in the beverage industry to be more sustainable. Also, these characteristics should be provided for the future functional change against the backdrop of activities within the production chain. Beverage firms and providers need to reconsider the production chain risk, from sourcing of resources to the production of completed items, in order to guard against a backdrop in market stake, and production chain interruptions. The theoretical framework employed in concluding the study on the production chain and COVID-19 disruption in the Beverage industry, with a focus on sustainability through a flexibility framework, is underpinned by resilience theory. Resilience, as conceptualized in this framework, denotes the beverage industry's capacity to absorb shocks, adapt to unforeseen disruptions, and foster sustainability in the face of systemic challenges. Implications for the beverage industry:

Strategic Adaptation:

The resilience-based framework concludes by emphasizing the strategic adaptation of the beverage industry. This involves not only short-term adjustments to mitigate immediate disruptions but also the cultivation of a mindset that views disruptions as inherent in the system. The industry should proactively develop strategies that allow it to continuously adapt to changing conditions, ensuring sustained operations and resilience.

Flexible Supply Chains:

The framework advocates for the establishment of flexible supply chains that can dynamically respond to uncertainties. By diversifying suppliers, adopting agile manufacturing practices, and integrating digital technologies, the beverage industry can

enhance its ability to adjust production volumes, optimize resources, and navigate disruptions seamlessly.

Sustainable Resilience:

Sustainability, as an integral component of the resilience framework, is positioned as a key outcome. The beverage industry is encouraged to not only prioritize short-term suitability but also commit to sustainable practices. This involves environmental responsibility, ethical sourcing, and social accountability. Sustainable resilience ensures the long-term viability of the industry by aligning economic, environmental, and social goals. In conclusion, the theoretical framework rooted in resilience theory provides a lens through which the beverage industry can comprehensively address the disruptions caused by COVID-19 and strive for sustainability through a flexible framework. The fundamental limitation of the study is the variation in production echelons and other variables not considered in the study. The contextual analysis was confined to one organization where gathered information were acquired from the organization's staff only. The discoveries was investigated & deciphered from an objective viewpoint. Information analysis and outcome selection were in the context of organizational significance which might not be tailored to other sectors. The constructs examined in view of the ongoing scenario can change over time, and the potential disturbance could significantly affect the hierarchical operations of the contextual organization. Given this, the sample populace utilized was considered as a representative populace because of the huge populace. Another limitation or shortfall of the study are as follows:

- Bias response given by the respondents due to friendly predisposition, privacy cover-up or other reasons.
- Contrasts in understanding. The context of inquiry might be misconstrued by respondents which might bring about misleading outcome.

Future investigations could focus on other regions. Another thought is the formulation of risk appraisal and moderation of the production network of the case organizations during the pandemic. This could help in comprehending and responding to inquiries, "what are the critical variables of risk relief systems in the business, and how did the organizations' fair in the improvement of techniques during the crisis?" In this way, industry-explicit risk examination concerning financial, ecological, social, and specialized variables should be done where these elements could differ from one activity to another. Future exploration can also consider mixed-method to examine the risk in order to obtain a robust and objective outcome.

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