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Article

Toward a Sustainable Society: The Role of Environmental Knowledge, Knowledge Capability, Sustainable Innovation, and Innovation Orientation on Product Innovation

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Abstract

Contemporary stakeholders persist in pressuring firms toward environmental stewardship, dynamic organizations demonstrate high-level capability and strategically respond to market evolutions and aligned operations toward sustainability. The study aimed at investigating the connection between environmental knowledge and awareness and products/service innovation, the mediating roles of knowledge process capability-application dimension and sustainable innovation and the moderating effect of innovation orientation. Through questionnaire, empirical data was collected from 354 bank employees operating in Western Nigeria whose bank made the list of the most sustainable bank in Nigeria in 2024 sustainability ranking. SPSS and SmartPLS was used for data analysis and testing of hypotheses. The findings showed a significant positive association between environmental knowledge and awareness and products/service innovation, additionally, knowledge process capability-application and sustainable innovation significantly mediate the relationship between environmental knowledge and awareness and products/service innovation, while innovation orientation negatively moderate between environmental knowledge and awareness and knowledge process capability-application. However, innovation orientation did not moderate the relationship between sustainable innovation and product/service innovation. The study underscore the importance of knowledge management strategy, firm innovation orientation toward sustainability stewardship in service organizations and provide valuable theoretical insights for management scholars. An integrated dynamic capability and absorptive capacity theories underpinned the study.

Keywords: dynamic capability theory; absorptive capacity theory; sustainability; environmental stewardship; stakeholders; knowledge management

1. Introduction

The pursuit for sustainable competitive advantage placed organizations in a position as market reactors in the value chain [1–5] Research in the marketing literature assert that to gain stakeholders trust, firms must learn to simultaneously configure market offering to align with current market demand-the market driven cum customer dominant approach [6,7] The dynamic nature of market is a consequent of the shifting interplay of time, events and value preposition, [8]. Market dynamism has reflected on strategic management literatures beckoning on business approaches to shift from production and managerial view of the firm to stakeholder's management [9]. The emergence of stakeholder's management approach is due to the inadequacies of the production and managerial approach that failed to address the emerging demand of contemporary, more aware stakeholders clamoring for sustainable business practices. [10–12]. Stakeholder's business perspective advocates for a more inclusive business operation of the economic, social and environmental performance to realized sustainability initiatives [10,13].

The research stream of environmental protection and natural resource management has prompted a new way of thinking by advocating for sustainable management of the earth resources [14,15]. This view corresponds with the proponents of stakeholder's management theory, which central view hinged on, "those with a stake or are affected by the firm operation". Following this way of thinking, it stands to reason, that the environment is a stakeholder, and are affected by the actions of humans, for example, the loss of biodiversity, the ozone layer questions, climate change, draught, and depletion of critical natural resources. This indicates that the environment is a different kind of unclassified stakeholder affected by the activities of humans, as such new approaches to business are being advocated under a broader concept known as sustainability. As the pursuit toward a more sustainable society lingers, organizations are caught in a web of complexity on how to accommodate social and environmental issues—"Knowledge" into business processes that benefit sustainable innovative outcomes [16–19]. Additionally, a major challenge is understanding how *knowledge is process and apply*, how sustainable innovation practices and Innovation orientation (IO) translate Environmental knowledge and awareness (EKA) to sustainable product and service development that meet sustainability goals and have potentials for sustainable competitive advantage [20–24]. Previous literatures have often bypassed the role of these constructs, especially the mediation of Knowledge Process Capability-Application dimension (KPC-A) and Sustainable innovation (SI) practices and the moderating effect of Innovation orientation (IO) on Product/service innovation (PSI). This gap calls for further examination of how environmental knowledge and awareness, complimented by knowledge process capability, Sustainable innovation (SI) practices and a strong Innovation orientation (IO) can be mobilized to achieve the development of sustainable product and service that have implications for meeting stakeholders' demand through delivery of valuable, rare, inimitable, and organized market ready offerings, critical for the achievement of sustainable competitive advantage cum sustainable society.[25–27] hence, the study aims to address this gap by situating (KPC-A), SI as mediator and IO as moderator in the conceptual framework and investigate their role in delivering products and services that are sustainable.

Proactive organizations adopt processes that enable them respond to market and environmental dynamics—the dynamic capability perspective [28–30]. Extant research linked process capability to the deployment of knowledge management strategy which outcomes lead to enhance organizational performance and meeting the ever changing need of market [31–35] this is sensemaking, because knowledge management capability empowers organizations to create, access, apply and distribute the right knowledge to organizational actors [34,36,37]. The knowledge-based view of the firm strongly content the overarching importance of knowledge as the most valuable resources of the firm that benefit sustainable competitive advantage [38,39] in alignment, [40] proposed a knowledge management cycle model, demonstrating how knowledge is transformed from intangible resources to tangible market-ready products and services. Thus, the study draws on extant scholarship from strategic knowledge management and sustainability as a point of departure and proposed a knowledge-Based Sustainability (KBS) model, with the aim of testing the relationship between the constructs of Environmental knowledge and awareness (EKA), the mediating role of knowledge process capability-application (KPC-A) and Sustainable innovation (SI) and the moderating influence of a strong Innovation orientation (IO) on the development of sustainable innovative products and services.

Consequently, the study presents the following questions. How does Environmental knowledge and awareness (EKA) influence the development of Product/service innovation (PSI)? Does Environmental knowledge and awareness (EKA) benefit knowledge process application in the development of an innovative sustainable product and services? Does Environmental knowledge and awareness (EKA) lead to sustainable innovative practices capable of producing sustainable products and services? To what extent does knowledge process application and Sustainable innovation (SI) mediate the relationship between Environmental knowledge and awareness (EKA) on product and services innovation? To what extent does sustainable orientation moderate the relationship between

Environmental knowledge and awareness (EKA), knowledge process application and Sustainable innovation (SI) in developing sustainable product and services?

Knowledge management has become a compelling force in the hand of decision makers, and a hot research area for strategic management scholars and business people, hence, the surge in the number of literature on knowledge management, however, it is interesting to know that most of these scholarship investigated the direct relationship of an organization knowledge management capability on firm performance, [20,31,33,34,41,42] and most of these study are not in the context of sustainability. Therefore, the study fill this gap and contribute to existing empirical literatures on knowledge management and sustainability by bridging knowledge management and sustainability and their simultaneous effect on Product/service innovation (PSI). Secondly, most of these literature examined the direct relationship of these constructs on Product/service innovation (PSI) and overlook the mediating roles of knowledge process application and Sustainable innovation (SI) process on Product/service innovation (PSI), for instance, Sustainable innovation (SI) on the development of products and service innovation was initially examined by [43]. KM dimension of acquisition, dissemination and responsiveness on green innovation [44] KM on innovation [45]. Relationship of innovation and sustainable performance by [46]. Thus this paper address this gap. Third, current scholarship have overlooked the moderating role of sustainable orientation of firm on developing sustainable and innovative product and services, the paper also fill this research loophole, finally, most of the sustainability literatures focus on advance economy of western firms, very little studies on sustainability focused on developing countries, this study also fill this gap with empirical study of the financial sector of Nigeria and contribute to existing knowledge on sustainability footprint of the Nigerian banking sector. [47].

2. Theoretical Review, Hypotheses Development and Conceptual Framework

Extant theories provide the basis for sound scientific reasoning that eventually lend itself to making specific scientific statement that are further subjected to scientific testing. Claims are built upon relational concepts uncovered during rigorous review of related scholarly works. The study review a collection of relevant theories and based on the objectives of this research, the study locate the dynamic capability and absorptive capacity theories for justification of claims. The conceptual framework cum hypotheses are developed based on the central premises of these theories.

2.1. Theoretical Review

An Integrated framework of Dynamic Capabilities Theory (DCT) and Absorptive Capacity Theory (ACT) underpinned the research, these theories provide a comprehensive illumination of the interdisciplinary nature of the concepts of knowledge management, sustainability and Innovation of products and services. An integrated theoretical approach offer holistic evaluation of the variables under investigation and provide a treasure trove of unique insights to the study [48].

2.1.1. Dynamic Capability Theory

DCT is a derivative of a combination of three extant theories in strategic management discipline, e.g Porter competitive forces [49] the strategic conflict of game theory approach [50] and the resource efficiency paradigm [51]. DCT was put forward in an effort to shed more light on why firm build and sustain competitive advantage in regime of environmental and technological turbulence [28]. On the other hand, dynamic capabilities theory emphasize opportunity sensing, adaptation, integration, and the reconfiguration of internal and external capabilities in order to respond to environmental changes. It argue that firm superior performance is a function of continuous learning, resource deployment, and lean innovation capabilities. The term dynamic and capabilities according to [28] refers to rapid environmental changes induce by technology and market forces, while Capabilities is seen as resting on the firm processes, resources, competencies and position. Thus, dynamic capabilities is a firm ability to leverage its resources both internally and externally to rapidly respond

to emerging market demand through the introduction of new business model. The three important component of DCT are *Identification of opportunity*-this involve opportunity sensing through unmatched analytical capabilities, R&D activities and strong entrepreneurial foresight to identify emerging market trends, competitive stance and new technology to inform long-term business strategy capable of producing idiosyncratic result. [39,52,53]. *Opportunity capitalization*-this involves resource allocation and galvanization to capitalize on emerging market opportunities orchestrated by environmental dynamism and the reconfiguration and realignment of capabilities to maintain and sustain competitive stance.

2.1.2. Absorptive Capacity Theory (ACT)

ACT highlight the importance of an organizational knowledge processing capability to inform innovation especially in regime of environmental turbulence. Proposed by [54] they theorized that an organization innovation level is a function of its capability to absorb and process external knowledge. ACT benchmark external knowledge as an important component of organizational resources critical for strategic innovation. Scholars in strategic management and organizational learning have applied ACT to study innovation in organizations [55]. The main components of ACT include "*knowledge acquisition*" which emphasize identifying and acquiring external knowledge through R&D activities and synergistic strategies. "*Assimilation*" entails the organization's capabilities to interpret, internalize, and integrate imported knowledge into organizational routines to compliment existing knowledge, here, the internal processing capability of the organization is amplified. "*Transformation*" involves the combination of different forms of organizational knowledge to create new insights that align with prevailing market condition. "*Exploitation*" focus on the application of acquired and transformed knowledge to produce strategic gains, it lead to the development of new product and services critical for achieving competitive advantage. [54].

2.2. Environmental Knowledge and Awareness (EKA)

Environmental knowledge and awareness (EKA) is a by-product of knowledge management activities. For instance, knowledge dissemination indirectly impact green innovation through environmental awareness [44]. Household knowledge management pertaining to energy saving [56]. Environmental awareness through education [57]. The knowledge economy has open up opportunities for organizations to access plenty of information using different mechanism, such as digital tools and social media platforms to acquire environmental information [58]. Sustainability themes have become central to international conferences and there are existence of strong expression toward human and the environment, for example, environmental psychology which emerged in 1960s in US examined the complexity of interaction between human and the environment [59]. Environmental knowledge and the antecedent awareness are critical concepts in comprehending an individual's attitude and behavior toward the material world and how such individuals or groups approach sustainability issues, e.g. studies have linked environmental knowledge and awareness (EKA) to green behavior [59–61]. Green awareness of customers through environmental knowledge [62]. By extension, recent scholarship also investigated and found a strong correlation between environmental knowledge and green product [63]. The environmental management literature also highlighted the moderating roles of environmental knowledge on green innovation [64,65]. EKA is an important enabler in driving green behavior [66] influencing public and organizational policies and the subsequent sustainable development [67]. As the name imply, environmental knowledge and awareness (EKA) are individual's understanding about environmental issues, concepts and the antecedent consequences of human impact on the environment, awareness on the other hand is acknowledging environmental issues and the need for actions, often tied to a sense of responsibility [59,68]. Advancing this reasoning to organizational context or the managerial perspective, this implies an organization understanding about environmental problems and the need for collective action. Camacho, et al., assert in a recent publications that environmental knowledge is vital in shaping employees and organizational behavior [2,69]. According to [59] environmental knowledge

is grouped into two, “*factual knowledge*”- which is knowing the state of environment and “*procedural knowledge*” which is understanding how to remediate environmental problems. Additionally, there are arguments about the forms of specific environmental knowledge that predict ecological behavior [70]. The research stream on responsible environmental behavior have benchmark environmental knowledge as an influencing predictive factor for responsible environmental behavior. Individuals or groups possessing a superior level of environmental knowledge have a predictive tendency to act in ways that are less harmful to the environments. Moreover, environmental awareness is a precursor that compliment environmental knowledge with action [42,68,70,71]. However, knowledge alone does not culminate to action, therefore, it is critical according to [59] to address the knowledge-action gap by engaging this knowledge in accordance with social norms, this implies the integration of environmental knowledge and awareness into organization knowledge management strategy to scale up performance that align with sustainable development templates. This notion lead to the formulation of the following hypotheses.

H1 - Environmental knowledge and awareness (EKA) determine to a great extent knowledge process application (KPC-A) (The action stage 1).

H2 - Environmental knowledge and awareness (EKA) determine to a great extent Sustainable innovation (SI) practices (Action stage 2).

H3 - Environmental knowledge and awareness (EKA) directly impact Product/service innovation (PSI). (direct outcome stage).

2.3. Knowledge Process Capability-Application (KPC-A)

The research landscape of Knowledge management has consistently confirmed the linked between KM, firm innovativeness and performance [45,72–76]. To reap KM benefits organizations need to transitioned from the knowledge and awareness sphere to integrating knowledge from various sources into knowledge management strategy [59] and that is where knowledge management matters the most. Accordingly, the Knowledge based view of the firm (KBV) posit that an organizations knowledge process capability-application (KPC-A) is critical in leveraging the knowledge asset of the firm for the realization of strategic business benefits [38]. The literature have highlighted three major components of (KPC-A), *knowledge acquisition, sharing and knowledge application*, the KM application dimension mobilizes acquired and shared knowledge to create value, improved processes and triggers innovation [34,45,77]. The Knowledge process capability-application dimension which is the focus of the study, emphasized an organizational ability to manage and integrate knowledge resources from different sources to scale up performance [78]. For instance, knowledge integration and team performance was ealier investigated [79], its encapsulate individual competencies, organizational processes, culture and structure that compliment the effective use of knowledge assets, according to [37] Knowledge application has implication for addressing organizational challenges, exploit opportunities and produce actionable outcome. (KPC-A) amplify *knowledge integration*-which involves bringing together knowledge from diverse sources to confront organizational processes, while *knowledge utilization* focuses on knowledge usage to solve problems, improved processes and initiate innovation, furthermore, *knowledge renewal* focuses on updating, refining and integrating new knowledge to align with environmental changes [80], this will in turn enhance organizational processes, benefit the development of an innovative product and services and pro actively respond to market dynamism with potentials for superior performance. This is critical especially for knowledge intensive sector such as the financial industry. Knowledge application allow for quicker decision making, boost innovation along the value chain and enhance competitive profile of the organization [41]. The degree of organizational efficiency, innovation and strategic agility is a function of knowledge integration of both tacit-internally-oriented and explicit-externally-oriented knowledge [38,81]. In a knowledge driven economy, application of organizational knowledge is critical in driving innovation, it is transitionining from knowing to

doing, in other word, it is based on applied knowledge, and propel organization toward the achievement of sustainable competitive advantage. Therefore the following hypotheses are formulated based on the synthesis of previous literature.

H4 - Environmental knowledge and awareness (EKA) impact Product/service innovation (PSI) through the positive influence of Knowledge process capability-(Application dimension) (KPC-A).

H5 - Environmental knowledge and awareness (EKA) impact Sustainable innovation (SI) through the positive influence of Knowledge process capability-(Application dimension) (KPC-A).

2.4. Innovation

Innovation has become a common language among individuals and business people, this is attributed to its unique relevance to business success, for this reason, there's a lack of consensus definition leading to misunderstanding [82,83] Kenneth B. Kahn acknowledged this misconception ascribed to the meaning of innovation and theorized that for organizations to benefit from innovation, there is need to recognized that innovation take three stages and each of these stages function synchronously for the optimum realization of the benefits of innovation, he went on to identified these stages as, "*Innovation as a process, Innovation as a Mindset and Innovation as an outcome*" [82]. More specifically:

(..) Innovation as an outcome (Product/service innovation (PSI)) emphasizes what output is sought, including product innovation, process innovation, marketing innovation, business model innovation, supply chain innovation, and organizational innovation. Innovation as a process (Sustainable innovation (SI)), attends to the ways in which innovation should be organized so that outcomes can come to fruition; this includes an overall innovation process and a new product development process. Innovation as a mindset (Innovation orientation (IO)), addresses the internalization of innovation by individual members of the organization where innovation is instilled and ingrained along with the creation of a supportive organizational culture that allows innovation to flourish. Such an understanding and defining necessary elements, considerations, and vernacular surrounding the term so that better decisions can be made, thereby enabling innovation and having a greater propensity to succeed. (Kenneth B. Kahn 2018 in Understanding Innovation).

This insights serve as a guidance to the framing of the current study and its encapsulate the full essence and meaning of innovation which are represented accordingly, for instance, Sustainable innovation (SI) as a process. Innovation orientation (IO) as a mindset and Product/service innovation (PSI) as an outcome.

2.4.1. Sustainable Innovation (SI) (Innovation as Process)

The environmental science literature have persisted in raising the issues of the environmental problems of natural resource depletion [84–89]. Following this issues, economist and natural resource management researchers have associated the problems of natural resource depletion to overpopulation, economic growth and the industrial revolution [84,90,91]. To control the continuous depletion of these critical economic natural resources, scholars and stakeholders are advocating for the adoption of sustainable business practices that balance economic, social and environmental aspect of business performanc [92–95], subsequently, the concept of Sustainable innovation (SI) emerged within the themes of sustainability [96–98] Which implies, according to the literature "*the introduction and execution of new production processes that integrate the economic, social and environmental dimension into value preposition*" [43,93–95,97,99].

Considering the increasing demand for environmental stewardship and sustainable development, adopting a sustainable business model perspectives has implication in addressing sustainability challenges, innovate processes that produces differentiated market offerings and drive firms toward realization of competitive market position [98,100–103]. Consequently, Sustainable innovation (SI) according to extant literature involves a combination of several organizational

strategies from *eco-innovation* which aimed at developing processes and outcomes that mitigate environmental impact [104–107]. The adoption of sustainable business framework that integrate sustainability with profitability such as the circular economy business model of waste management and product regeneration [101,108]. Green innovation model of product, process and service innovation that reduces environmental impact and encourages sustainability [109,110]. Transitioning to stakeholders management theory to allow collaboration of stakeholder in the co creation of market offering [9], and system thinking perspective that allow for an holistic evaluation of the economic, social and environmental business performance [111]. Sustainable innovation (SI) as a process is pivotal for the successful realization of sustainable Product/service innovation (PSI), thus, cannot be overlooked [82]. Evidently, previous literature and theoretical lanscape of Sustainable innovation (SI) practices lead to the formulation of the following hypotheses.

H6 - Sustainable innovation (SI) practices positively mediate the relationship between Environmental knowledge and awareness (EKA) and products and service innovation.

H7 - Environmental knowledge and awareness (EKA) sequentially influences product/service innovation through the positive influence of knowledge process capability-(application) and Sustainable innovation (SI)

2.4.2. Innovation Orientation (IO) (Innovation as a Mindset or Culture)

Innovation orientation (IO) as a cultural construct appeared in the early work of [112] in his competing value model under the quadrant adhocracy culture, drawing from the work of Robert E Quinn, IO from a cultural perspective, emphasized sourcing for new information in the external environment, it is premise on fostering creativity and change management previous to organizational advancement [82,112,113]. As a multidisciplinary field, IO is an organization strategic belief and learning philosophy that drive wide range innovation in organizations, recognizing opportunities, mobilizing and allocating resources capable of producing new product, services and process improvement critical for the achievement of sustainable competitive outcome, it provide guidance and direct all organizational strategy, philosophy and operation [114–116]. A survey of the literature on innovation, reveal an interesting differentiating aspect between *Innovation and Innovation orientation*, while the formal emphasized product-process innovation [117,118] later is an organizational wide range philosophical application geared toward continous learning, opportunity sensing, intra-organizational collaboration spanning the entire organization to align innovation strategy with market dynamism with focus on producing idiosyncratic outcomes, this approach is supported by the knowledge-based view of the firm [38]. Adopting such an holistic business philosophy has the capability for synchronizing contemporary market forces prevalent in today's sustainability era. For instance, four aspect of IO has being identified from a synthesis of the research stream of Innovation orientation (IO) which are "*Market orientation*"-which is incorporating stakeholders insights e.g customer, competittors and sustainability advocates into the firm strategic planning and value preposition [119,120]. "*the Learning orientation*"- emphasize the deployment of knowledge management to acquire competencies crucial for lean innovation [114,121]. "*Technology orientation*"- are the investments made on R&D activities and the acquisition of critical technology that are previous to innovation capability [122] and lastly, the "*Entrepreneurial orientation dimension*"- are the proactiveness and risk management approaches deployed toward venturing into perceived innovoative opportunities [123–125]. Collectively, the business case for innovation-oriented firms have also being directly investigated. Innovation-oriented firms are directly associated with Idiosyncratic outcomes and enhance corporate performance critical for market differentiation [117,126]. IO are also reckoned directly with superior performance [127] and able to integrate social and environmental issues into the firm innovation strategy which are crucial in delivering sustainable innovative solutions [95]. Therefore, given the wide range moderating philosophical roles of the construct, the paper position IO as a key moderator in the conceptual framework with the ensuing hypotheses.

H8 - Innovation orientation (IO) moderate the relationship between Environmental knowledge and awareness (EKA) and product/service innovation (PSI).

H9 - Innovation orientation (IO) moderate the relationship between knowledge process application (KPC-A) and product/service innovation (PSI).

H10 - Innovation orientation (IO) moderate the relationship between Sustainable innovation (SI) and product/service innovation (PSI).

2.4.3. Product/Service Innovation (PSI) (Innovation as Outcome)

Products and service innovation that result from sustainable practices defer from those of other innovations. For instance, the emergence of energy saving devices and alternative energy like solar energy are classic examples of such innovations. Natural resource management and environmentally conscious processes are the central focus of organizations whose aim is to deliver sustainable product and services, whose outcomes meet the need of today's market and contemplate the need of future society [43,82,128,129]. To this end, organizations and individuals alike have adopted several environmentally conscious strategy to inform their actions. For example, the literature have identified cleaner production, environmental management practices and circularity cum waste management as enablers of sustainable product innovation [101,130,131].

Prevailing research in the context of sustainability define product innovation as the creation of new product and the improvement of goods and services that are capable of mitigating environmental problems, while service innovation are sustainable business models that are capable of delivering sustainable market values or new services [82,131] such business model include the triple bottom line that measure economic, social and environmental dimension of corporate performance, Sustainable organizational outcomes from this perspective implies balancing all aspect of people, planet and profit [132]. The circular economy business model of resource reuse and waste management support sustainability through innovative practices such as the product as-a-service (PaaS) business model and the closed loop supply chain [133–137].

Obviously, it has been recognized by prior research, that the systematic synchronization of both Sustainable innovation (SI), in other word, innovation as a process and Innovation orientation (IO) that is, innovation as a mindset or culture are the antecedents of Product/service innovation (PSI) [43,82,138]. Coherently, sustainable-oriented processes are capable of delivering innovative product and services whose outcomes are cost effective, resource efficient, reduce environmental impact and extend product and service life cycle [82,107]. Therefore, the hypotheses and conceptual framework (Figure 1) is developed based on the integration of (DCT) and (ACT) theories and prevailing literature.

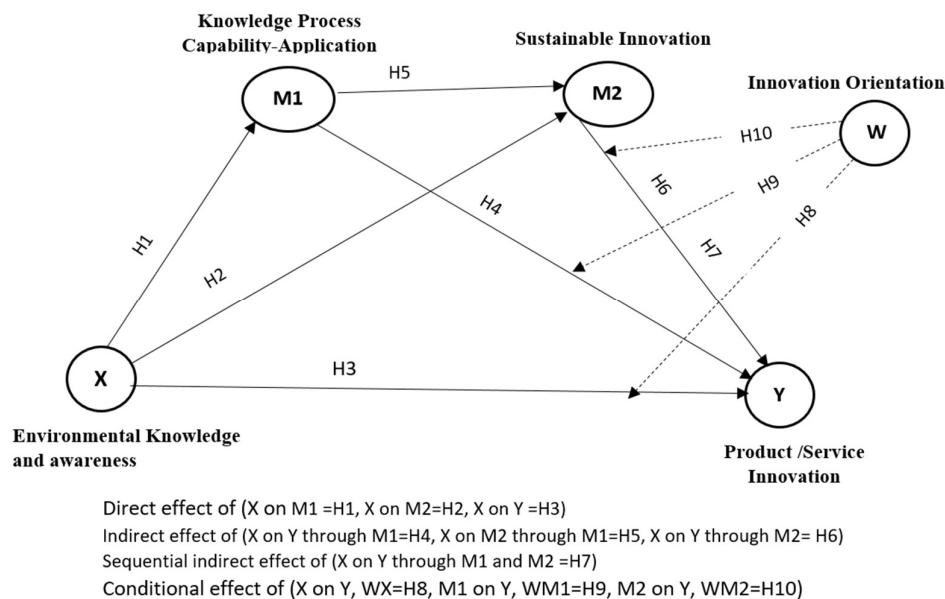


Figure 1. Authors research model.

3. Methodology

3.1. Research Approach

This study utilized the quantitative research design which is suitable for the collection of standardized data from a large number of participants and useful in investigating relationship among constructs [139]. This approach support generalization of research results and normalization to measure employees perceptions of sustainability practices of some sampled banks in operating in Western Nigeria and its impact on organizational outcomes. An adopted structured survey instruments of 5-point likert scale was utilized to assess the variables of environmental knowledge and awareness (EKA), knowledge process capability- the application dimension (KPC-A). Sustainable innovation (SI), innovation orientation (IO) and Product/service innovation (PSI). The numerical data provide validation of patterns and sustainability footprints of participating banks, previous studies have demonstrated the numerous advantages of numerical data which aid in uncovering trends [140,141]. The integrated theory used in conceptualising the research model, further established the research questions and hypotheses [28,54].

3.2. Population and Sampling Techniques

The focused population are bank executives working in Western Nigeria, whose banks made the list of the most sustainable banks in 2024 ranking in Nigeria, based on the listing, top 10 most sustainable banks were extracted, because these banks are frontiers in sustainability practices and are perceived to have successfully implemented sustainability programs relating to Environmental, Social and Governance (ESG) practices [47]. Additionally, the level of service innovations among the listed banks is competitively higher than rivals, these banks also dominate the list of most profitable banks in Nigeria in 2024 fiscal year [142] this performance indicator confirmed positive association between sustainability and financial performance [143]. Therefore, this outcomes benchmark these commercial banks as a focal point of study. while the second criterion is at individual level, banks employees with a tenure of two years at a particular financial institution are qualified to take part in the study, this threshold is based on previous findings, that longer work tenure contribute significantly to accumulated knowledge and enable familiarity with organizational culture and processes enabling employees to provide informed and reliable information [144] Furthermore, clearly

defining the population has implication for replicability, reliability and generalizability of findings [145,146]. Cohenrently, this criteria support the aim of the current paper and allow for examining the relationship between the variables under investigation. The study applied a combination of non probability convenience and snowball sampling techniques because they encourage increase participations [147] acknowledged, that convenience sampling allow the researcher to easily access participants, strengthen representation and generalization of research findings. Similarly, snowball techniques enhances participation through networking and referral strategy, where the initial contacts further redistribute the survey to potential participants who meet the survey criteria [148].

3.3. Data Collection and Procedure

A structured questionnaire adopted from previous studies were utilized in data collection, these items were distributed using a combination of face to face and electronic sharing methods to participants working in the selected banks, the measuring instrument was base on a 5-point likert scale of 1=Strongly agree to 5=Strongly disagree. The likert scale is a popular tool among researchers and instrumental in measuring participants perceptions about a particular subject [149] in this context, the survey measure environmental knowledge and awareness (EKA), sourced from [60] Knowledge process capability-(application) (KPC-A) adopted from [76] Sustainable innovation (SI) and Product/service innovation (PSI) were sourced from [43] while innovation orientation (IO) were adopted from [113].

The procedure of data collection involved two different stages, the first phase involved the distribution of survey to five participants from each of the 10 selected banks, resulting in an initial sample of 50 respondents, the 50 initial seed was then used to pilot test the questionnaire to examine the reliability and content validity of the instrument [139] while the second stage engaged snowball sampling techniques where the questionnaire was further redistributed by the first cohort of respondents to participants who meet the inclusion criteria [145]. Data collection period spanned approximately 59 days from 15th of January to 15th of March 2026. At the end of the survey, a total number of 354 respondents spanning different departments were realized (i.e 6 participants completed the survey per day), and because the total number of distributed survey is unknown due to snowball techniques application, the traditional calculation of response rate was not feasible, rather, a participation standard was applied in accordance with American Association for Public Opinion Research (AAPOR) [150]. In addition, Since the total number of population of bank employees in western Nigeria is not publicly available or unknown, Cochran's Sample formula was adopted to determine the adequacy of the realized sample size, because it is appropriate when the total number of the population is unknown [151,152]. The formula below is Cochran's sample formula for assessing the adequacy of a yielding sample size.

$$n^o = \frac{Z^2 \cdot P \cdot (1-P)}{e^2}$$

The Cochran's sample formula is base on the following assumptions

n= Sample size

Z = 1.96 (95% Confidence level)

P= 0.5 (calculated proportion of the population, 0.5 is use if estimated proportion of the population is unknown).

e = Margin of error.

Therefore, this formula can be rearrange to compute for the margin of error, since we have our sample size of 354 participants.

$$e = \frac{Z^2 \cdot P \cdot (1-P)}{n}$$

$$e = \frac{\sqrt{1.96^2 \cdot 0.5 \cdot (1-0.5)}}{354}$$

$$e = \sqrt{0.9604}$$

354

$$e = \sqrt{0.0027129}$$

$$e = \pm 5.2\%$$

Using 95% confidence level and a P value of 0.5, the sample size of 354 result to a margin error of $\pm 5.2\%$ suggesting that the survey is adequate and acceptable to make statistical precision.[151].

4. Data Analysis and Result

The collected data was screened and coded for analysis with statistical Packages for Social Sciences (SPSS) version 26 and SmartPLS software version 4.1.1.4. [153] General and demographic informations were portray with descriptive statistics, while the hypotheses were tested using regression analysis. Additionally, the mediation and moderation analysis were performed with process macro version 4.2 by Andrew F. Hayes which is appropriate for the analysis of mediation and moderation.

Table 1. present the demographic profile of participants according to specific categories, descriptive statistics such as frequencies and percentages was used to describe the characteristics of respondents which further help in the interpretation of result. The result of the analysis indicate that majority of the participants are male with 187 (52%) of the total respondent, while female respondents comprised 167 (47.2%). Concerning the age of participants it was grouped into age bracket to provide valuable insights of participants, the most predominant age bracket of respondents are between 21 to 30 years old amounting to 132 participants (37.3%), 31 to 40 age group amounted to 107 participants (30.2%) and the second largest age bracket of respondents are 41 years and above which accounted for 115 respondents (32.5%). Furthermore, information about the marital status of participants, the output result shows that 182 (51.4%) of participants are single, while respondents who are married accounted for 135 (38.1%), 23 (6.5%) are divorced, and 14 participants (about 4.0%) are separated. Educational level of participants, majority of the sample hold a bachelor degree 258 participants (72.9%), while those with master degree amounted to 82 respondents (23.2%), only 14 participants (4.0%) hold a Ph.D. degree. Regarding banking experience of participants, employees with 2 to 6 years' experience amounted to 231 participants (65.3%) being the majority, while the second highest are those with 7 to 11 years' experience (74 respondents 20.9%), individuals with 12 to 17 years of experience accounted for 45 (12.7%) participants, finally, those with 18 year experience and above are 4 participants (1.1%). Concerning job titles, the number of account clerk who took part in the study are 21 (5.9%), banking associates 15 participants (4.2%), book keepers 16 (4.5%), while branch managers comprises 49 respondents (13.8%), customer care agents constitute 83 (23.4%), executive directors represent only 7 participants (2.0%), while the number of general managers who took part in the study accounted for 29 (8.2%) respondents, investments analysts and loan officers comprised a total of 74 participants (21%), managing directors 9 respondents (2.5%), finally, teller officers constitute 51 participants (14.4%). These descriptive figures offer clarification of demographic distribution of participants, which essentially constitute bank employees working in Western Nigeria and since the study aimed at measuring employees' perceptions of sustainability programs of their respective banks.

Table 1. Demographic profile of participants.

	Variables	Frequency	%
Gender	Male	187	52.8
	Female	167	47.2
Age group (Years)	21-30	132	37.3
	31-40	107	30.2
	41 and above	115	32.5
Marital status	Single	182	51.4
	Married	135	38.1
	Divorced	23	6.5
	Separated	14	4.0
Education	Bachelor	258	72.9
	Master	82	23.2
	Ph.D	14	4.0
Years of Exp	2-6 Early career	231	65.3
	7-11 Mid-career	74	20.9
	12-17 Late career	45	12.7
	18 and above Highly exp	4	1.1
Job title	Account Clerk	21	5.9
	Banking Associate	15	4.2
	Bookkeeper	16	4.5
	Branch manager	49	13.8
	Customer Care agent	83	23.4
	Executive Director	7	2.0
	General Manager	29	8.2
	Investment analysts	37	10.5
	Loan officer	37	10.5
	Managing Director	9	2.5
	Teller	51	14.4
	Total	354	100.0

4.1. Descriptive Analysis of the Study Variables

Descriptive statistics is employed to describe the five variables under investigation, using the values of mean and standard deviation because these statistical components provide valuable information about the central tendency of the variables and their variability. For instance a higher mean score indicates a strong agreement of the measured construct among participants, while standard deviation suggests the extent of distribution of responses relative to the mean value.[154]. Thus, the values of the mean and standard deviation for environmental knowledge and awareness (M=5.94, SD= 2.38), present a relatively high mean, which demonstrates respondents' high level of environmental awareness and its antecedent issues, while the standard deviation is relatively balanced, indicating variability in participants' responses although with little disparity, reflecting a high level of awareness among participants with differing understanding of environmental knowledge. The mean score for knowledge process capability- the application dimension (M= 4.39, SD= 1.82) is comparatively lower than the mean values of other constructs, meaning that application of knowledge processes among participants is unpopular, similarly the lower standard deviation implies clustered responses around the mean score. Implying a persistent limited understanding of knowledge process capability-application (KPC-A). The analysis shows that sustainable innovation (SI) has the highest mean values (M= 11.02) benchmarking the construct as the most significant variables among respondents, while the high standard deviation (SD= 4.68) shows differences in the perceptions of participants, which implies that some organizations are probably more advanced in sustainable innovation (SI) than counterparts. Regarding innovation orientation, the mean value (M= 9.25), is comparatively higher than Environmental knowledge and awareness (EKA), however, it is lower than sustainable innovation (SI), the implication for this, is Innovation orientation (IO) has a strong association to innovation, as for the high score for standard deviation (SD= 4.07) this suggests variability and differing views in strategic alignment of innovation across participants and their respective organizations. Lastly, the mean score for product/service innovation (PSI) (M=5.97), is closely similar to the mean value of environmental knowledge and awareness (EKA), meaning there is a strategic fit on Product/service innovation (PSI), furthermore, the balanced standard deviation score (SD = 2.59) shows diverse responses, implying differences in the level of strategic innovation and adoption among participating firms. In essence, sustainable innovation (SI) appears to be the significant variable because of its highest mean values, highlighting its centrality in the present scholarship on corporate sustainability, Innovation orientation (IO) is the second most important construct also due to its large mean score, demonstrating its relevance to organizational innovation cum sustainable competitive outcomes. Moreover, knowledge process capability- (application) seems to be less mobilized, pointing to a critical gap to fully exploit knowledge effectively. Additionally, Environmental knowledge and awareness (EKA) and Product/service innovation (PSI) occupied a balance position, underscoring their importance. These submissions are in line with the notion of organizations integrating sustainability to drive innovations, however knowledge application is often neglected [95,155] Table 2 presents the mean scores and standard deviation of the variables.

Table 2. Mean and Standard deviation of variables.

Variables	Mean	SD
Environmental knowledge and awareness (EKA)	5.9435	2.38080
Knowledge process capability-Application (KPC-A)	4.3898	1.82383
Sustainable innovation (SI)	11.0169	4.67768
Innovation orientation (IO)	9.2514	4.07321
Product/service innovation (PSI)	5.9689	2.58929

4.2. Scale Reliability and Validity

Scale reliability analysis evaluate the internal consistency and dependability of measuring items in a scale to ensure the intended constructs are being measure, while validity test is perform to ensure the right construct is being measure [156] Frequently used tools for assessing the accuracy and quality of measuring instrument in social science empirically based research are Cronbach's alpha and Composite reliability [157] Cronbach's alpha examine items interrelationship and assume equal contributions of items to concepts, on the one hand, composite reliability offer in depth analysis as its account for factor loading and the overall contributions of each indicators to same latent construct and very relevant in structural equation modelling [158–160]. The acceptable threshold for composite reliability coefficient values is generally 0.70, while cronbach alpha values within the range of 0.67-0.87 is consider reasonable and acceptable [161,162] Additionally, the Average Variance Extracted (AVE) are utilized to examine the convergent validity of indicators to a construct, in other words, how assortments of items converge well to measure the same construct, the computed values conveys the interrelationship and the accuracy of indicators to same construct. AVE values exceeding 0.50 confirmed convergent validity of items in the measurement scale [163]. Table 3, the SmartPLS output shows the reliability and validity of the items used in the study, furthermore, result from the factor loading exceed the minimum acceptable threshold of 0.60, demonstrating items suitability for the study [159].

Table 3. Reliability and validity result.

Variables	Outer loading >0.06	Cronbach alpha > 0.6	CR >0.7	AVE >0.5
Environmental knowledge and awareness (EKA)				
EKA1	0.682			
EKA2	0.677			
EKA3	0.771			
EKA4	0.702	0.670	0.801	0.502
Innovation orientation (IO)				
IO1	0.651			
IO2	0.658			
IO3	0.798			
IO4	0.681			
IO5	0.728			
IO6	0.828	0.819	0.870	0.529
Product/service innovation(PSI)				
PIS1	0.692			
PIS2	0.715			
PIS3	0.743			
PIS4	0.793	0.718	0.826	0.543
Knowledge Process Capability-Application KPC-A				

KPC-A1	0.766			
KPC-A2	0.708			
KPC-A3	0.733	0.577	0.780	0.542
Sustainable Innovation (SI)				
SI1	0.703			
SI2	0.658			
SI3	0.738			
SI4	0.681			
SI5	0.718			
SI6	0.737			
SI7	0.741	0.837	0.878	0.506

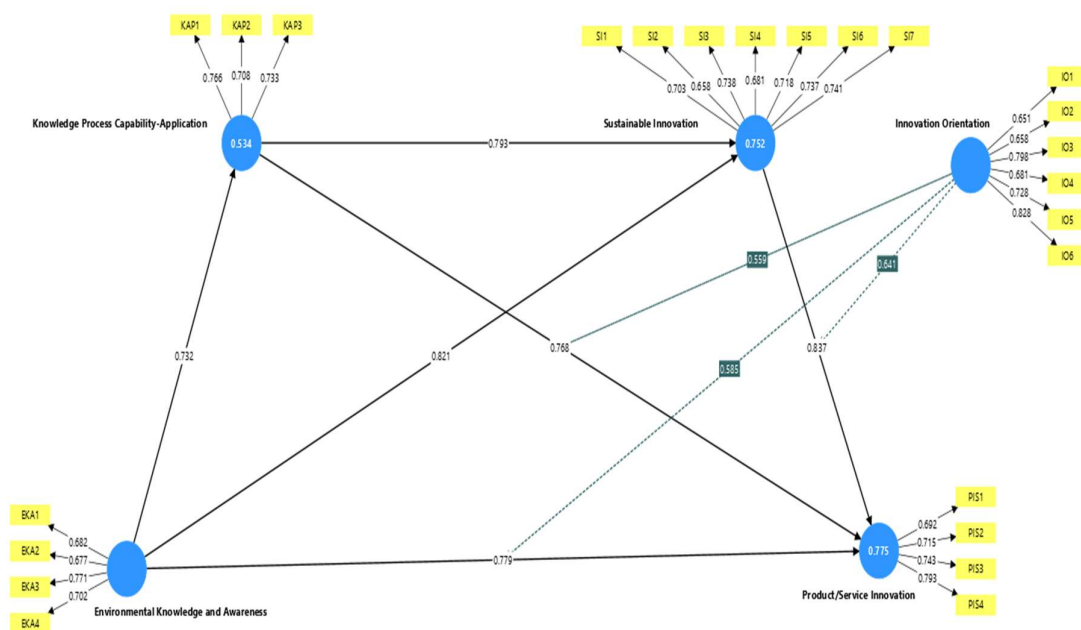


Figure 2. Structural model.

4.3. Discriminant Validity- Cross Loading

Discriminant validity analysis examine how collections of items measures a particular construct and not another concept in the model. According to [164] discriminant validity ensures that construct are different from other construct in the model and its associated items accurately measure intended construct [165] Reviewed collections of articles and uncovered several techniques for assessing discriminant validity, few of such techniques is the Heterotrait Monotrait Ratio (HTMT), the Fornell-Larcker criterion and Cross loading. The HTMT techniques measures average correlation of constructs in the model and the relative average correlation within same construct. Different authors published different threshold for HTMT [166] recommended HTMT values of < 0.90 for conceptually similar concepts. To access discriminant validity of constructs the authors inspect the HTMT table from smartPLS output and found some values slightly exceeded the recommended threshold > 0.90,

although, this point to a possible overlap, however, this scenario is not problematic when the investigated constructs have high theoretical similarities (e.g Sustainable innovation, product/service innovation, innovation orientation, environmental knowledge and knowledge process capability). Prior studies have encountered such case where HTMT exceeded the recommended values [167], for this reason, smartPLS cross loading was scrutinized to examined indicators loading on constructs, since it is one of the oldest approach used to discriminate between variables. Cross Loading shows the average correlation between each items, built on the assumption that, 'for discriminant validity to exist, indicators should load more strongly or highly on the theoretical latent construct its intend to measure than every other construct in the model [160,168]. Additionally, all variance inflation factors (VIF) values for all indicators ranges between 1.159 to 2.179 which is below the recommended benchmark of 5, suggesting there is no multicollinearity problem in the outer model, further more collinearity for predictors (environemetal knowledge and awareness, knowledge process capability-application, and sustainable innotion) was assesed, the VIF values ranges between 1.000 to 2.153. which also fall within the acceptable threshold of 5. The statistical output result from smartPLS in Table 4, shows that all items in the meaausment scale met this requirements, demonstrating items adequacy, distinctiveness of constructs and the absence of multicollinearity.

Table 4. SmartPLS Cross -Loading matrix table.

Items	EKA	IO	KPC-A-	PSI	SI	VIF
EKA1	0.682	0.522	0.461	0.510	0.558	1.242
EKA2	0.677	0.505	0.443	0.497	0.531	1.250
EKA3	0.771	0.651	0.598	0.655	0.607	1.345
EKA4	0.702	0.587	0.555	0.533	0.626	1.229
IO1	0.449	0.651	0.448	0.530	0.527	1.469
IO2	0.529	0.658	0.563	0.583	0.606	1.385
IO3	0.624	0.798	0.645	0.648	0.690	1.970
IO4	0.624	0.681	0.606	0.616	0.617	1.418
IO5	0.613	0.728	0.591	0.618	0.649	1.547
IO6	0.645	0.828	0.661	0.701	0.647	2.179
KPC-A1	0.521	0.618	0.766	0.595	0.595	1.228
KPC-A2	0.541	0.564	0.708	0.529	0.544	1.159
KPC-A3	0.554	0.607	0.733	0.570	0.609	1.161
PIS1	0.507	0.574	0.549	0.692	0.544	1.304
PIS2	0.514	0.638	0.545	0.715	0.581	1.311
PIS3	0.673	0.628	0.594	0.743	0.667	1.339
PIS4	0.590	0.664	0.573	0.793	0.662	1.519
SI1	0.553	0.550	0.480	0.543	0.703	1.579
SI2	0.454	0.493	0.456	0.486	0.658	1.456
SI3	0.576	0.666	0.628	0.569	0.738	1.740
SI4	0.604	0.608	0.569	0.652	0.681	1.430
SI5	0.619	0.668	0.609	0.628	0.718	1.630
SI6	0.626	0.639	0.606	0.658	0.737	1.631
SI7	0.626	0.624	0.569	0.602	0.741	1.649

4.4. Inter-Construct Correlation

Correlation measures the direction and the linear strength of relationship between variables under investigation. Researchers frequently used the Pearson product moment correlation coefficient to examine the direction and the strength of relationship between constructs, correlation coefficient (r) ranges between -1 and +1, -1 indicate a significantly negative relationship, while +1 is considered a significantly positive relationship [169]. Similarly, according to [170], correlation values of 0.1 signifies a weak relationship, 0.3 moderate association, while 0.5 and above demonstrate a strong correlation among variables. In this study, the Pearson product moment correlation analysis output result (Table 5) shows that all constructs in the model are highly connected (i.e all (r) values are above the 0.5 threshold)

Table 5. Inter-construct correlation matrix table.

Constructs	1	2	3	4	5
Environmental knowledge and awareness (EKA)	1				
Knowledge Process capability-(Application)	.732**	1			
Sustainable innovation (SI)	.817**	.793**	1		
Innovation orientation	.807**	.814**	.861**	1	
Product/Service innovation	.780**	.766**	.835**	.852**	1

N = 354, ** P < 0.05. *. Correlation is significant at the 0.01 level (2-tailed).

4.5. Hypotheses Testing

This section is dedicated to examining the structural relationship among investigated constructs; it details important statistical descriptions drawn from testing the study hypotheses. Table 6, present the direct and total direct effect and its antecedent findings, table 7, explore the mediation analysis, and finally table 8, shows the moderation analysis. These analyses are demarcated for the purpose of clarity.

4.5.1. Direct Effect

Direct effect examine the direct prediction of an independent variables X, on dependent variables Y, in other word, it is not mediated by a third or intermediate variable in the model [171].

Table 6. Direct and total direct effect.

Hyp.	Paths	R ²	β	SE	t-value	p-value	Decision
H1	EKA → KPC-A	0.54	0.73	0.028	20.14	0.000	Supported
H2	EKA → SI	0.67	0.82	0.060	26.55	0.000	Supported
H3	EKA → PSI	0.61	0.85	0.036	23.39	0.000	Supported

N= 354, EKA= Environmental knowledge and awareness, KPC-A= Knowledge Process Capability-(Application), SI= Sustainable innovation, PSI= Product/Service Innovation.

As shown in Table 6, all the examined variables are positively and significantly related, for instance, in (H1), Environmental knowledge and awareness (EKA) have a significant positive impact on knowledge process capability-(application), (KPC-A), i.e at every 1-unit increase in EKA will result in 54% increase in (KPC-A), implying that the more modern organizations become knowledgeable and aware about operating environment, the more likely they apply those knowledge in their value

chain especially in the context of sustainability, therefore, (H1) is sustained ($\beta = 0.73$, $P = 0.000$). Again, (H2) test the impact of EKA on SI, the result shows that Environmental knowledge and awareness (EKA) has a statistically positive impact on Sustainable innovation (SI) which explained 67% variance in SI, meaning that organizations exposed to current environmental issues are more likely to engage in sustainable practices, therefore, H2 supported ($\beta = 0.82$, $P = 0.000$). Furthermore, (H3) has a positive and statistically significant result ($\beta = 0.85$, $P = 0.00$) i.e EKA significantly impact product/service innovation (PSI) by accounting for 61% changes in PSI, this findings demonstrate that PSI is a functionality of organizational awareness of its various stakeholders and market needs.

4.5.2. Mediation Analysis

A Mediation analysis investigate the different path ways and mechanism (mediators) by which an independent variable (predictor) affect the dependent variable (outcome), it has a time dimensional processes, in other words, time 1 (t_1), when the independent variable start operating, through time 2 (t_2) the mediating variable, and time 3 (t_3), the dependent variable [156]. Logically, according to [172], the coefficient of any individual indirect effect, that is, the value of the travel effect of the independent variable from (t_1) through (t_2) to (t_3), should typically be smaller than any examined total direct effect (i.e the absence of t_2). The coefficient values (β) in the mediation output result in Table 7 met this condition

Table 7. Mediation analysis (Indirect effect) .

Hyp	Structural Paths	R ²	P	β	BSE	95% CI BLL-BUL	Result
H4	EKA → KPC-A → PSI	0.69	0.00	0.33	0.05	0.21-0.41	Supported
H5	EKA → KPC-A → SI	0.75	0.00	0.31	0.04	0.23-0.39	Supported
H6	EKA → SI → PSI	0.72	0.00	0.49	0.05	0.38-0.60	Supported
H7	EKA → KPC-A → SI → PSI	0.74	0.00	0.14	0.032	0.087-0.21	Supported

N= 354, boothstrapped = 5000, EKA = Environmental knowledge and awareness, KPC-A= Knowledge Process Capability-(Application), SI= Sustainable innovation, PSI= Product/Service Innovation.

To assess the significance of the mediation of constructs the boothstrapped lower and upper level confidence interval (CI) was used. According to [172], if the values of the boothstrapped CI is above zero, this support the claim that the indirect effect is statistically positive. As seen in Table 7, all the mediation analysis supported the various claims, for instance, the conclusion that EKA significantly impact PSI through the mediative effect of KPC-A (H4) has a statistically positive effect due to the absence of zero values in the 95%CI (BoothLL0.21 - BoothUL0.41) with coefficient value ($\beta = 0.31$, $P = 0.00$) this effect is visible under the R² value, e.g the combined forces of both EKA and KPC-A result in 69% variation in PSI, this imply that organizations with higher level of stakeholders knowledge and awareness, can processed and leverage those knowledge to produce idiosyncratic sustainability integrated product and services. Furthermore, the mediation mechanism between EKA and SI through KPC-A was also statistically significant (H5), e.g ($\beta = 0.31$, $P = 0.00$, 95%, CI (boothLL0.21-boothUL0.41), the R² also explained the variance in SI (R² = 75%).

Also, (H6) the positive influence of EKA on PSI through SI was statistically significant as the standardized 95%CI (boothLL0.38 - boothUL 0.60) values are above zero with coefficient value of ($\beta = 0.49$, $P < 0.01$), indicating that firms with sound environmental knowledge are capable of engaging in sustainable practices that eventuate to producing sustainable innovative product and services, this variability in PSI is manifested under the R² of 72% induced by the combined presence of EKA and SI.

The authors are also interested in testing the sequential mediation that integrate mediation1 and 2 as illustrated in Figure 1 (Authors research model), (H7) where KPC-A and SI sequentially mediate the relationship between EKA and PSI, the sequential mediation analysis result suggest that KPC-A and SI sequentially mediate the effect between EKA and PSI, thereby producing a statistically significant outcome as the standardized CI value exceed zero (boothLL0.087 – boothUL0.21) with coefficient value ($\beta = .14$), demonstrating a complete sequential mediation. Additionally, it is important to note that the combined interaction of EKA, KPC-A and SI account for the 74% changes in PSI the ($R^2=0.74$), simultaneously, organizations with a higher level of Environmental knowledge and awareness (EKA) with efficient knowledge process architecture are capable of infusing those knowledge to inform sustainability footprints that translate to producing sustainable differentiated market offering

4.5.3. Moderation

Moderation analysis seek to understand the condition under which the relationship between the independent and the dependent variable is impacted, instead of finding different pathways as in the case of mediation. A moderator predict or modify the size or effect of the independent variable on the dependent variable [156,172].

Table 8. Moderation analysis.

Hyp	Structural path	R ²	β	t	P values	95% CI BLL-BUL	Decision
H8	IO×EKA → PSI	0.75	-.017	-2.15	0.03	-.0327-.0015	Supported
H9	IO×KPC-A→ PSI	0.74	-.025	-2.54	0.01	-.0439-.0056	Supported
H10	IO ×SI → PSI	0.76	0.000	.098	0.922	-.008 .009	Not supported

N= 354, EKA= Environmental knowledge and awareness, KPC-A= Knowledge Process Capability- (Application), SI= Sustainable innovation, PSI= Product/Service Innovation, IO=Innovation orientation.

Table 8 present the moderation analysis identified in the study, utilizing PROCESS v4.2 by Andrew F. Hayes. The first moderation hypothesized the moderation effect of IO on the relationship between EKA and PSI (H8), the output result shows that 75% (the R²) explained the changes in PSI impacted by the combined effect of IO and EKA, demonstrating a strong impact on PSI, also, the 95% CI above the zero values (BoothLL-.0327 - boothUL-.0015), means that the combined interaction of IO and EKA on PSI is negatively and statistically significant ($\beta = -0.17$, $P < 0.05$), in other word, as IO increases, the positive effect of EKA on PSI diminishes. Furthermore, IO significantly moderate the relationship between (KPC-A) and PSI (H9) the analysis shows that 74% (R²) variance in PSI is accounted for by IO and (KPC-A), although negatively significant ($\beta = -.025$, $P < 0.01$) with the absence of zero values in the 95% CI (boothLL-.0439 - boothUL-.0056), this implies that, as IO move incrementally, the positive impact of (KPC-A) on PSI decline. (H10), proposes that IO moderate the effect of SI on PSI, the analysis revealed that the overall model is statistically significant, meaning that 76% variation in PSI is explained by IO and SI, however, the coefficient result shows that the interaction model (IO × SI) is not statistically significant ($\beta = 0.00$, $P = 0.922$) moreover, the 95% CI has a zero value (boothLL-.008 - boothUL .009) meaning that IO has no moderating effect on the relationship between SI and PSI.

These findings have foundational theoretical implications when considering the diverse configuration of organizational resources. For instance, the resource based view (RBV) of the firm assert that organizations depend largely on critical resources such as environmental knowledge to obtain competitive advantage, conversely according to dynamic capabilities theory (DCT) the

presence of strong Innovation orientation (IO) empowered firms to independently innovate without needing environmental knowledge [28], for this reason, the marginal benefits of environmental knowledge on innovation decline resulting to negative outcome.

5. Discussion and Conclusions

Sustainability embedded innovation is central to modern stakeholders, as such, firms scramble to integrate and align processes that produces sustainable innovative outcomes. The study investigate the contributions of Environmental knowledge and awareness (EKA) of some selected Nigeria commercial banks in rolling-out product and services that are stakeholders-conscious. Furthermore, it examined the mediating roles of knowledge process capability-application dimension (KPC-A) and Sustainable innovation (SI), while paying particular attention on the moderating effect of Innovation orientation (IO) of firms. Insights from the findings offer critical theoretical implications to dynamic capability and absorptive capacity theory.

The supported hypotheses suggest firms that are sensitive to environmental issues are able to refine and process ready-to-use-knowledge, thereby positioning environmental knowledge and awareness (EKA) as foundational catalyst for innovation. Additionally, sustainable innovative processes and products and service innovation is a direct functionality of environmental knowledge possession. The dynamic capability theory emphasized the need for firm environmental scanning, opportunity exploitation and transformation of resources in alignment with market shift, the strategic management literature recommend such tools like SWOT and other similar analytical tools for acquiring environmental knowledge [28,173] Similarly, absorptive capacity theory [54] benchmark Environmental knowledge and awareness (EKA) as important organizational resources that allow firms exploit and translate new knowledge into new product and service development, thereby underscoring the critical roles of knowledge in innovation cycle.

The positive impact of Environmental knowledge and awareness (EKA) on products and service innovation through the interaction of Knowledge process capability-(Application dimension) (KPC-A) signifies that organizations need to strategically synergize and applied various acquired knowledge to benefit innovation outcomes. Environmental knowledge and awareness as a first order in innovation cycles provide the foundational information, however, innovation only occur when dynamic and capable organizations consciously coordinate and transform possessed knowledge into tangible innovative products and services. Knowledge process capability-(application) constitute an important organizational capability that enable firms to share and applied external environmental knowledge to confront pressing organizational problems, this view aligned with the proposition of dynamic capability and absorptive capacity theory that firm's ability to exploit, reconfigure and capitalized on knowledge resources is the most differentiating dynamic and absorptive ability that enables firm deliver lean innovation [55,174], the mediation benchmark knowledge process capability- application as a central mechanism whereby Environmental knowledge and awareness (EKA) transitioned from knowledge-state to action-state through conversion cum application that eventuate into superior innovation, this notion fill the knowledge-action gap highlighted by [59].

As expected, knowledge process capability-(application) play a significant role between environmental knowledge and Sustainable innovation (SI) by empowering enterprises to convert environmental informations into eco-efficient processes that eventually lend itself to environmentally conscious solutions such as low carbon emission, waste management solutions and so on, this finding shed light on how organizations interpret, incorporate and apply Environmental knowledge and awareness (EKA) to render sustainability-concentrated innovations, according to [93] such innovation represent business-society dialogue. Dynamic capability theory proposes that firms recognize their capabilities and knowledge resources and align such to ecological requirements [52], knowledge process capability-(application) represent such dynamic capability where environmental knowledge is operationalized into sustainability-oriented processes, this support the argument that sustainability is capability-based processes and not passive response to stakeholders demand.

Similarly, absorptive capacity theory assert that, the ability to exploit and transform new external knowledge assets into innovative solutions is directly related to a firm innovative capabilities [54].

The positive impact of environmental knowledge and awareness on products and service innovation through the mediating influence of Sustainable innovation (SI), demonstrate that organizations with strong knowledge of operating environment possessed a higher tendency of introducing environmentally friendly strategy like waste management, paperless solutions critical for improvement of commercial ends. This finding positioned Sustainable innovation (SI) practices as a dynamic capability that allow enterprises to seamlessly adapt to environmental changes and compete favourably. While the absorptive capacity theory contend strongly that firm's ability to assimilate and apply extant environmental knowledge, might as well incorporate sustainable innovative practices into organizational operations which inturn result to innovative outcome.

Innovation orientation (IO) is of a particular interest to the authors, prior to this research, IO as a higher order construct [115] was perceived to be playing an important significant moderating role in shaping how firms sense and seize economic opportunities, however, the analysis suggest that Innovation orientation (IO) negatively moderate the relationship between Environmental knowledge and awareness (EKA) and Product/service innovation (PSI), the negative interaction indicates that, as IO amplified across organizational processes, the positive effect of Environmental knowledge and awareness (EKA) on Product/service innovation (PSI) decreases. Similarly, IO moderate negatively the relationship between knowledge process capability-(application) (KPC-A) and Product/service innovation (PSI), suggesting that at a higher level of IO, the positive impact of knowledge process capability on Product/service innovation also diminish. These findings demonstrates that firms with a stronger level of innovation philosophies continuously engage in research and development activities (R&D) to generate new market insights which in turn inform novelty processes, product and service development driven by market forces, thus positioning environmental knowledge and knowledge process capability-(application) as an already embedded organizational capabilities, this is consistent with the work of [115] conceptualizing Innovation orientation (IO) as a multidimensional concept. In accordance with dynamic capability theory, Innovation orientation (IO) perform a higher order dynamic capability intrinsically compelling firms to recognized and exploit opportunities, as enabler, IO provide conducive climate for environmental knowledge and knowledge process capability-application to impact product and services. Consequently, the overall impact of IO in the two moderating models (i.e IO and EKA and IO and (KPC-A) on Product/service innovation (PSI).

The unsupported moderation analysis of IO on the relationship between Sustainable innovation (SI) and Product/service innovation (PSI) may suggest that sustainability-oriented practices largely depend on external influences such as regulations and stakeholders' pressure, rather than strategic orientation, because sustainability innovation relies more on regulatory compliance and incremental innovation. This discovery also resonate with the notion of green dynamic capability theory and institutional theory, that not all innovation outcome reflect internal organizational capabilities, some environmentally and socially-oriented innovation are driven by institutional requirements and long-term sustainability goals [175,176].

5.1. Theoretical Implications

This paper provide important theoretical inputs to dynamic capability theory by identifying Environmental knowledge and awareness (EKA) as a critical organizational capability deployed for scanning the economic environments of firms, for identification of relevant stakeholders, emerging environmental shift and economic opportunities. Research in mainstream knowledge management recognized environmental knowledge and awareness (EKA) as knowledge acquisition sphere [34] Thus, the foundation of organizational change and the consequent knowledge process application and the integration of environment, and social aspect that eventually impact processes and product/service innovation (PSI) is rooted in Environmental knowledge and awareness (EKA) capability of business entities. Similarly, the study contributes to absorptive capacity theory by demonstrating how environmental knowledge is assimilated, coordinated and transform through

knowledge application and sustainable practices to create environmentally-oriented economic values, benchmarking knowledge process application and Sustainable innovation (SI) practices as crucial components of a firm absorptive capacity- “A firm ability to consolidate on extant knowledge assets to confront processes, product and services innovation”. [54]. Additionally, the paper contribute to ongoing debates on sustainability cum innovation literature by empirically testing the role of environmental knowledge and awareness on the development of sustainable-oriented product and services, and the mediation of knowledge process application and sustainable innovation practices. This capability mechanism explain the foundation of sustainable product and service development in service organizations.

5.2. Managerial Implications

The study present decision makers and organizational strategist in the financial and service-oriented sectors an important insights for collecting, combining and coordinating varied knowledge resources to confront processes, and create economic values that are stakeholder-conscious. The contemporary financial industry operates in regime of high market changes spurred by sustainability themes and technological introductions, to remain competitively relevant, management need to synchronized stakeholders interest with those of economic objectives. Consequently, management practitioners should recognized environmental knowledge and awareness (EKA) - “a collation of knowledge resources encompassing regulations, ecological impacts, customers reviews, business networks and competitors”, as the foundation for the identification of market gaps. Managerial dynamic capability appears when assortments of knowledge assets are orchestrated and synchronize in alignment with sustainability requirements’ that eventuate to producing a portfolio of idiosyncratic market values, that are difficult to imitate by rivals [25]. The paths mechanism of the model, if carefully follow has managerial contributions that could help scale up processes critical for meeting emerging environmental pressures that characterizes today’s business environment. Innovation orientation (IO) of firms is pivotal in shaping how managers engage in knowledge acquisition activities, collaborate and reconfigure knowledge resources to generate novel innovations.

6. Conclusions

Translating abstract theories into real-time practices is the key objective of the pragmatic school of thoughts, based on empirical evidence, the study draw on dynamic capability and absorptive capacity theories to explained how financial institutions operating in Western Nigeria, employ environmental knowledge and awareness (EKA) as dynamic organizational capability to shape and reconfigure market propositions, environmental knowledge is seen as a critical organizational resources used by firms to respond to varied interest of stakeholders, as such, economic values of competing firms are a functionality of inputs from different environmental sources. Additionally, doing business sustainably requires that captured knowledge are processed and appropriately applied for effective decision making in the value creation chain, thus, knowledge process capability- (application) and Sustainable innovation represent absorptive capacities of firms where the allocation of processed knowledge occurred to confront processes and determine sustainability ventures that renders products and services capable of filling prevailing market gaps, business objectives are anchored on stakeholders analysis to determine specific market values, while, innovation orientation (IO) serve as a philosophical trajectory that guide the overall direction and business objectives of firms.

Research Agenda

Although this study provide strong theoretical and empirical insights, it has several shortcomings that highlight the future research directions. Similar to extant literature, the use of quantitative research approach in the current study limit its depth and context and does not reflect how the investigated variables develop into strategic organizational capabilities overtime, therefore,

a longitudinal research approach should be deployed to unpack how these capabilities evolved and developed. Additionally, quantitative-questionnaire approach is subject to common method bias and social desirability effect, where respondents wrongly represent or overstate their company sustainability footprints thereby distorting reality, therefore, future research should focus on incorporating sustainability certifications and reporting for an extended period of time to measure sustainability-based innovation performance. Lastly, the unsupported moderation of Innovation orientation on the relationship between Sustainable innovation and product/service innovation opens a research window to explore alternative moderators such as stakeholders' pressure, regulation, organizational structure, or technological turbulence.

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Abbreviations

The following abbreviations are used in this manuscript:

EKA	Environmental Knowledge and Awareness
KPC-A	Knowledge Process Capability-Application
SI	Sustainable Innovation
IO	Innovation Orientation
PSI	Product/Service Innovation

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