EFFECT OF PRODUCT INNOVATION ON THE PERFORMANCE OF ALUMINIUM MANUFACTURING FIRMS IN FCT, ABUJA

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Abstract
Given the competitive nature of the manufacturing industry and the critical role innovation plays in driving business success, it was essential to explore how these different types of innovation contribute to firm performance in this context. Hence, this study examined the effects of product innovation on the performance of aluminium manufacturing firms in FCT-Abuja, Nigeria. The study employed a cross-sectional research design, utilizing primary data collected through questionnaires distributed to managers and employees across 12 selected aluminium manufacturing firms in FCT-Abuja. A total of 198 valid responses were analysed using multiple regression analysis in SPSS v27. The results revealed that incremental and radical product innovations significantly enhance firm performance, with radical innovation having the most substantial impact. Modular product innovation also contributed positively but to a lesser extent. These findings highlight the importance of a balanced innovation strategy that incorporates multiple innovation types to optimize performance outcomes. The study concluded that a comprehensive innovation strategy integrating incremental, radical, and modular innovations is crucial for improving firm performance in the aluminium manufacturing sector. It was recommended that firms should invest in incremental innovations, foster a culture of radical innovation, leverage modular innovations for flexibility, and continuously monitor and adapt their innovation strategies to remain competitive in a dynamic industry.
Keywords: *Product, Innovation, Performance, Services, Aluminium, Firms*

INTRODUCTION

Globally, businesses have recognised the need for new ideas, products, services, or processes as a way to create value and drive economic growth, as it is a critical driver for competitiveness and success in today's rapidly changing global market. Today, the growing competitiveness in has made it almost impossible for firms not to consider the need for a wide range of activities that foster creativity, experimentation, and the development of new solutions to address existing problems or to exploit new opportunities, as it is a key element for sustaining long-term growth and ensuring that businesses remain relevant in an ever-evolving market landscape (Li et al., 2024; Ojenike, 2024).

Corporate institutions, in particular, leverage product innovation to sustain growth, increase market share, and enhance profitability. The ability to innovate in products is often a reflection of a company's capacity to integrate new technologies, respond to market trends, and invest in research and development (R&D) (Hadi, 2023). Product innovation, a subset of innovation, refers to the creation and introduction of new or significantly improved goods or services (Febrianti & Herbert, 2022). It involves changes in product design, materials, and features, aimed at enhancing customer satisfaction and achieving competitive advantage.

On a global scale, product innovation is crucial for companies seeking to differentiate themselves in the marketplace and to meet the ever-changing needs and preferences of consumers (Febrianti & Herbert, 2022). Garrido-Moreno et al. (2024) shared that product innovation explains as the process of developing new products or significantly improving existing ones, with the aim of delivering greater value to customers and achieving superior performance in the marketplace. It is essential for firms as it drives growth, competitiveness, and customer loyalty. Product innovation is useful and relevant for improving a firm's performance as it leads to the introduction of superior products, thus capturing new market segments and enhancing revenue streams.

There are several dimensions of product innovation, three of which are particularly critical (Febrianti & Herbert, 2022; Bogetoft et al., 2024). This is the incremental product innovation, which involves making small-scale improvements to existing products, and this form of product innovation is important for

maintaining a competitive edge and ensuring continuous improvement in product offerings (Permana et al., 2023). The radical innovation explains the development of entirely new products that create new markets or significantly disrupt existing ones. Radical innovation can be transformative, leading to substantial growth and positioning the firm as a market leader (Agazu & Kero, 2024).

Also, Febrianti and Herbert, (2022) identified the modular product innovation, which involves changes to the components of a product, which can be combined in different ways to create new configurations. Modular innovation allows for flexibility and customization, catering to diverse customer needs and enhancing product appeal (Wahyuni & Dewi, 2024). The ability of firms to adopt or combine these product innovation approaches is dependent on the level of performance that the firms seek to drive in the organisation.

Firm performance is a multidimensional construct that reflects the success of a company in achieving its goals and objectives within a specified period. It is often measured using financial indicators such as revenue growth, profitability, and return on investment (ROI). However, non-financial indicators such as customer satisfaction, market share, and innovation capability are also important measures of performance (Li et al., 2024; Ojenike, 2024).

The performance of aluminium manufacturing firms in the Federal Capital Territory (FCT) of Abuja, Nigeria, is influenced by a range of factors, including market demand, regulatory environment, and access to raw materials. These firms face significant challenges, such as high production costs, competition from imported goods, and infrastructure deficiencies. Additionally, the industry is impacted by fluctuations in the availability and cost of raw materials, which are often petroleum-based (Okeke et al., 2016).

The aluminium manufacturing sector in FCT-Abuja is facing a significant challenge in maintaining competitive performance amid rapidly evolving market demands and technological advancements. Despite the potential of product innovation to enhance competitiveness and operational efficiency, many aluminium firms in this region struggle to effectively integrate innovative practices into their production processes. This gap in innovation adoption not only limits their ability to meet customer expectations but also hinders their capacity to achieve sustainable growth in an increasingly competitive market. The lack of empirical studies that specifically address the impact of product innovation on the performance of aluminium manufacturing firms in FCT-Abuja further exacerbates this issue, leaving a critical gap in both academic literature and practical application.

Moreover, the aluminium manufacturing industry in FCT-Abuja operates in an environment characterized by fluctuating raw material costs, stringent environmental regulations, and shifting consumer preferences. These external pressures underscore the need for robust product innovation strategies that can drive performance improvements and ensure long-term viability. However, the existing body of research on product innovation and firm performance primarily focuses on broader manufacturing sectors, with limited attention given to the unique challenges and opportunities within the aluminium industry. As such, there is an urgent need to investigate how product innovation can be leveraged to enhance the performance of aluminium manufacturing firms in FCT-Abuja, providing valuable insights that can inform strategic decision-making and policy development.

There have been limited studies on the effect of product innovation on firm performance, particularly in the context of developing economies and aluminium manufacturing firms, which is a gap that this study wants to close. Therefore, understanding the dynamics of product innovation and its effect on firm performance is crucial for enhancing the competitiveness and sustainability of aluminium manufacturing firms in Abuja. The central objective of this study is to examine the effect of product innovation on performance of aluminium manufacturing firms in FCT-Abuja. The specific objectives are to:

i. examine the effect of incremental innovation on the performance of aluminium manufacturing firms in FCT-Abuja.

ii. investigate the effect of radical innovation on the performance of aluminium manufacturing firms in FCT-Abuja.
iii. assess the effect of modular innovation on the performance of aluminium manufacturing firms in FCT-Abuja.

LITERATURE REVIEW

Product Innovation

Product innovation is a multidimensional process that begins with a comprehensive understanding of the market and consumer preferences. Hadi (2023) defined product innovation as the creation and introduction of a new or significantly improved product offering, involving changes in its characteristics or intended uses. Also, Febrianti et al. (2022) stated that product innovation refers to the development of new products or modifications of existing products through technological advancements, design improvements, or novel features aimed at satisfying evolving consumer needs. Product innovation involves the conception, design, and implementation of new or improved products, often driven by market demand or technological advancements, to enhance customer value and market competitiveness (Li et al., 2024). It is the strategic process that encompasses the ideation, development, and launch of innovative products, addressing unmet consumer needs, technological breakthroughs, or market trends. The process of introducing novel products or enhancements into the market, encompassing changes in functionalities, features, design, or performance to offer increased value to consumers and gain a competitive edge explains the whole concept of product innovation (Hadi, 2023). Companies delve into market research, gathering valuable insights to identify gaps, needs, and opportunities. The foundation of successful product innovation lies in the ability to generate creative ideas. To foster innovation, companies often organize brainstorming sessions, engage cross-functional teams, and leverage methodologies such as design thinking. This creative process is essential for envisioning novel products that can capture the market's attention (Agazu & Kero, 2024). Once innovative ideas emerge, the journey continues with prototyping and concept development. Prototypes provide a tangible representation of concepts, allowing companies to visualize, test, and refine their ideas before progressing to full-scale development (Wahyuni & Dewi, 2024). The iterative nature of this phase is crucial in ensuring that the final product meets both functional and market requirements.

Incremental Innovation

Uribe-Ocampo and Kaminski (2024) defined incremental product innovation as a process characterized by gradual and continuous improvements made to existing products, services, or processes within an organization. This type of innovation typically involves small, methodical changes that aim to enhance performance, increase efficiency, or address specific customer needs. The focus of incremental innovation is on optimizing what already exists rather than creating something entirely new (Escrig-Tena et al., 2021). This approach allows companies to stay competitive by consistently refining their offerings in response to market demands or technological advancements. For example, a smartphone manufacturer may release new versions of a device with better cameras, improved battery life, or enhanced software features without drastically changing the core product design. Incremental innovation is often seen as a low-risk strategy because it builds on proven concepts and technologies, allowing businesses to maintain stability while gradually advancing (Uribe-Ocampo & Kaminski, 2024).

The benefits of incremental innovation are substantial, particularly in industries where maintaining a competitive edge is crucial (Giménez Espín et al., 2023). By making continuous improvements, companies can keep their products relevant and appealing to consumers, thereby extending the product lifecycle and maximizing return on investment. Moreover, incremental innovation allows businesses to adapt to changing market conditions without the need for massive overhauls or significant financial investments (Uribe-Ocampo & Kaminski, 2024). However, the downside of this approach is that it may not lead to significant market disruption or breakthrough innovations. Companies that focus solely on incremental improvements may miss out on opportunities for more transformative changes that could reshape their industry or create new markets.

Radical Innovation

Mahmud et al. (2024) shared that radical product innovation refers to the creation of new products, services, or processes that significantly differ from existing offerings and have the potential to disrupt entire industries or create entirely new markets. Unlike incremental innovation, which focuses on making small improvements, radical innovation involves introducing something that is fundamentally different and groundbreaking. This type of innovation often requires a significant investment of time, resources, and research and development, as it challenges conventional thinking and pushes the boundaries of what is possible (Chen et al., 2024). An example of radical innovation would be the development of the first personal computer, which revolutionized the way people interacted with technology and opened up new possibilities for business, communication, and entertainment.

The impact of radical innovation can be profound, as it can lead to the creation of new industries and transform the competitive landscape. Companies that successfully implement radical innovations can achieve significant competitive advantages, establish themselves as industry leaders, and capture substantial market share (Yusof et al., 2023). However, radical innovation also comes with higher risks, as the outcome is often uncertain and the market may not be ready to embrace such drastic changes (Chen et al., 2024). Additionally, radical innovations can render existing products or services obsolete, forcing companies to constantly innovate to stay ahead. Despite these challenges, the potential rewards of radical innovation make it a crucial strategy for businesses looking to achieve long-term growth and differentiation in a rapidly changing world.

Modular Innovation

Modular innovation involves making significant changes to the components or modules of a product while maintaining the existing architecture or system (Sun et al., 2019). This type of innovation allows companies to enhance the functionality or performance of a product without altering its core structure. Modular innovation is particularly relevant in industries where products are composed of multiple, interchangeable parts or modules that can be upgraded or replaced independently of one another (Zhang et al., 2024). For example, in the automotive industry, a manufacturer might introduce a new engine design that significantly improves fuel efficiency or performance, while the overall design of the vehicle remains the same. This approach allows companies to introduce meaningful improvements without the need for a complete redesign.

One of the key advantages of modular innovation is its flexibility (Ozman, 2011). By focusing on individual components, companies can quickly adapt to technological advancements or changing customer preferences without disrupting the entire product line. This approach also enables companies to offer a variety of options or configurations to meet different market needs, enhancing their ability to compete in diverse segments. However, modular innovation requires careful consideration of the compatibility and integration of new components with existing systems (Zhang et al., 2024). Companies must ensure that the changes made to one module do not negatively impact the overall performance or user experience (Sun et al., 2019). When executed effectively, modular innovation can provide a balanced approach to innovation, offering both significant improvements and stability within the product ecosystem.

Firms' Performance

In the view of Garrido-Moreno et al. (2024) the concept performance is a multifaceted concept that encompasses both financial and non-financial dimensions, providing a comprehensive view of an organization's overall success and efficiency. Financial performance focuses on quantitative measures such as profitability, revenue growth, return on investment (ROI), and financial stability (Bogetoft et al., 2024). It reflects a firm's ability to generate income, manage expenses, and sustain its economic viability. Metrics like net income, profit margins, and revenue streams are crucial indicators of financial health and are essential for assessing how well a firm meets its financial goals and delivers value to its stakeholders (Bogetoft et al., 2024). Strong financial performance supports a firm's ability to invest in growth opportunities, attract investors, and maintain competitive advantage.

In contrast, non-financial performance evaluates qualitative aspects such as operational efficiency, customer satisfaction, employee engagement, and innovation (Hadi, 2023). Metrics in this category might include process improvements, customer feedback scores, employee retention rates, and the success of new product developments. Non-financial performance provides insights into how effectively a firm manages its internal operations and meets external expectations (Ojenike, 2024). Both dimensions are interrelated; strong financial outcomes often result from high operational efficiency and customer satisfaction, while non-financial achievements can drive long-term financial success. Therefore, a balanced assessment of both financial and non-financial performance is essential for a holistic understanding of a firm's overall effectiveness and sustainability.

Empirical Review

Incremental Innovation and Performance

Uribe-Ocampo and Kaminski (2024) explored the impact of incremental versus discontinuous (radical) innovation on product development and firm success, focusing on the role of the "fuzzy front end" (FFE) stage. Qualitative approach was used and a semi structured interview was carried out using 15 participants. They found that incremental innovations leverage existing competencies to provide steady improvements, while discontinuous innovations involve significant changes and higher uncertainty during the FFE stage. The study emphasizes the need for a better understanding of how firms navigate these innovation types to enhance product success. However, it lacks a focus on the specific impacts of these innovation strategies on performance metrics in diverse industrial contexts. This framework provides valuable insights but does not address the differences in how incremental and radical innovations affect firm performance in specific sectors, such as aluminium manufacturing.

Escrig-Tena et al. (2021) examined the interplay between Quality Management (QM) and both incremental and radical product innovation capabilities, focusing on the moderating effects of control mechanisms. The study analyzed data from 111 organizations in the information technology service sector, utilizing a combination of formal and informal control mechanisms to understand their impact on innovation. The findings revealed that QM positively supports incremental innovation capabilities but does not significantly affect radical innovation. Formalization of the innovation process was found to enhance incremental innovation, while it had a detrimental effect on radical innovation. The author's focus was on IT firms, while the current study focused on manufacturing firms in Nigeria.

Giménez Espín et al. (2023) study focused on the impact of managing R&D in accordance with the UNE 166002:2021 standard on incremental product innovation and organizational performance. The study focused on Spanish manufacturing firms with over 50 employees, utilizing a structured questionnaire to gather data from 225 companies. The analysis, conducted using structural equation modeling, revealed that adherence to this standard significantly enhances both incremental and radical product innovations. Furthermore, these innovations were found to mediate the relationship between the application of the standard and improved business performance. The results underscore the effectiveness of the UNE 166002:2021 standard in fostering innovation and boosting organizational outcomes. The study was carried out in a developed economy, when compared to the current study that is been carried out in Nigeria.

Radical Product Innovation and Performance

Mahmud et al. (2024) investigated the impact of radical innovation and competitive advantage on the performance of micro, small, and medium enterprises (MSMEs) in the coffee shop sector, with a particular focus on management capability as a mediating variable. The study utilized a quantitative approach, collecting data through an online questionnaire from 124 respondents selected via probability sampling. The data were analysed using Structural Equation Modeling with Partial Least Squares (SEM-PLS). The results indicated that both radical innovation and competitive advantage significantly influence MSME performance, with management capability acting as a crucial mediator in this relationship. Despite these findings, the study is limited to coffee shop businesses, suggesting a need for further research to explore how these factors affect performance in other types of MSMEs.

Yusof et al. (2023) explored the effects of innovation capability on the relationships between radical and incremental innovations and business performance. The study used a sample of 218 employees in several construction firms. They utilized a mediation and moderation model to analyze how innovation capability influences these relationships in construction companies. The use of WarpPLS 7.0 software allowed for a thorough analysis, including checks for multicollinearity and common-method bias. The research found that innovation capability fully mediates the relationship between radical innovation and business performance. In contrast, companies with lower innovation capability showed a stronger impact of incremental innovation on business performance compared to those with higher innovation capability. This study provides valuable insights into the role of innovation capability in mediating the effects of different types of innovation on performance. However, the research is specific to the construction industry, which may limit its generalizability to other sectors.

Chen et al. (2024) investigated the impact of incremental and radical innovations on sustainable competitive advantage through a moderated mediation model. Using data from 201 Chinese firms, the authors employed multiple regression analysis and bootstrapping techniques to test their hypotheses. Their findings revealed that both incremental and radical innovations positively affect competitive advantage, with radical innovation having a more substantial impact. Innovation speed was found to mediate this relationship, and a supportive culture was identified as a significant moderator that enhances the effect of innovation on speed and, consequently, on competitive advantage. The findings suggest that while both types of innovation are beneficial, radical innovation is particularly effective in creating a competitive edge. However, the research's focus on Chinese firms may limit its applicability to other contexts or industries.

Modular Product Innovation and Performance

Sun et al. (2019) investigated how modular design (MD) and product innovation capabilities affect new product performance, with a focus on the role of product newness (PN). Their study employed structural equation modeling on data from 153 manufacturers in China's electronic and electrical appliance industries. They discovered that while a modular product design system and a product development roadmap (PDR) enhance modular design and innovation capabilities, MD tends to constrain product newness, whereas product innovation can improve it. The study highlights the strategic implications of balancing these factors but lacks exploration of how these findings might differ across various industries or geographical contexts. Also, despite this, there is a gap in understanding how these findings might apply to different sectors, such as aluminium manufacturing, and how they could affect performance in diverse market conditions.

Zhang et al., (2024) explored the product innovation process from a modular perspective, focusing on a large aircraft assembly line. Their study segmented the innovation process into key stages: product demand analysis, product module partitioning, opportunity recognition, and design. They developed an integrated innovation pathway incorporating various innovation theories and methodologies. Validation through a case study demonstrated that this modular approach significantly enhances product innovation development, though the study is limited in its applicability to industries beyond aerospace, such as aluminium manufacturing. This research provides valuable insights into structuring product innovation through modular pathways, offering a systematic approach to innovation. However, it does not address how these methods could be adapted or applied to different manufacturing contexts, particularly in industries with distinct operational characteristics.

Ozman (2011) examined the role of modularity in conjunction with industry life cycles and open innovation. The study asserts that during the early stages of an industry life cycle, open innovation strategies are used to explore external knowledge sources and leverage network effects to build a technology's installed base. As the industry progresses and a dominant design emerges, the impact of modularity on open innovation strategies becomes more pronounced. The paper highlights that the modularity of different components within a product system significantly influences the types of open innovation strategies adopted by firms. Despite these insights, the study primarily focuses on the broader

industry context rather than specific manufacturing sectors, leaving a gap in understanding how modularity and open innovation interact within niche industries such as aluminium manufacturing. However, the applicability of these findings to specialized sectors with unique technological and market conditions remains underexplored.

Resource-Based View (RBV) Theory

The Resource-Based View (RBV) theory posits that a firm's resources and capabilities are fundamental to achieving and sustaining competitive advantage. According to RBV, a firm's unique resources—such as physical assets, human capital, and organizational capabilities—are critical in determining its ability to innovate and perform successfully in the marketplace (Barney, 1991). These resources must be valuable, rare, inimitable, and non-substitutable to provide a sustained competitive edge. RBV emphasizes that leveraging these unique resources effectively can lead to superior performance, as they enable firms to execute strategies that are difficult for competitors to replicate. For aluminium manufacturing firms, resources such as advanced technology, skilled personnel, and efficient production processes are crucial in facilitating innovation and enhancing overall performance (Wernerfelt, 1984).

Applying RBV to the study of the effect of product innovation on the performance of aluminium manufacturing firms in FCT-Abuja is particularly appropriate. This theory helps explain how the firms' internal resources and capabilities contribute to successful product innovation, which in turn impacts performance outcomes. By focusing on how aluminium firms leverage their unique resources—such as advanced manufacturing technologies and skilled workforce—RBV provides insights into the mechanisms through which innovation drives performance improvements. For example, a firm with advanced aluminium processing technology and expertise can develop new products more effectively, leading to enhanced market performance and competitive advantage (Teece et al., 1997). Thus, RBV offers a robust framework for understanding the relationship between resource utilization, innovation, and performance within the context of the aluminium manufacturing industry in FCT-Abuja.

METHODOLOGY

This study employed a cross-sectional research design to investigate the effect of product innovation on the performance of aluminium manufacturing firms in FCT-Abuja. A cross-sectional design is appropriate because it allows the collection of data at a single point in time, providing a snapshot of the current practices, innovations, and performance metrics within the selected firms. This design is justified as it facilitates the examination of the relationship between product innovation and performance without requiring long-term data collection, making it both time-efficient and cost-effective. The unit of analysis for this study is the managers/employees of the selected aluminium manufacturing firms in FCT-Abuja. This choice is justified as these individuals are directly involved in the implementation and management of product innovations and are therefore best positioned to provide insights into how such innovations affect firm performance. Twelve aluminium manufacturing firms were selected for this study and the firms are Selcon aluminium, Carat Aluminium and Building Products, Tower Aluminium Limited, Cilla Aluminium Company Limited, Abed Aluminum Company, Aluken Aluminium Company, Alumaco Plc, Anchor Aluminium, Andy Young Aluminium Company, Aso Aluminium Project Limited, Atlas Aluminium Company Limited and Decson Aluminium Limited. The selection criteria included the firm's size, market share, and level of engagement in product innovation activities. These criteria are justified because larger firms with significant market share are more likely to have established innovation practices and their performance metrics can provide meaningful insights into the impact of product innovation. Additionally, firms actively engaged in product innovation are more relevant to the study's focus, ensuring that the data collected is pertinent to the research questions. The study population comprises 490 managers and employees across the 12 selected aluminium manufacturing firms. The population size was determined based on information obtained from the Human Resources (HR) units of the respective firms, which provided a reliable estimate of the total number of individuals involved in roles pertinent to product innovation and performance evaluation within these firms. The sample size was determined using Taro Yamane's formula:

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

Where:
n = sample size
N = population size (490)
e = margin of error (0.05 for 95% confidence level)
Where n = Sample size
N = Population of the study
e = Tolerable error (5%)

$$n = \frac{490}{1 + 490\ (0.05)^2}$$

$$n = \frac{490}{1 + 490\ (0.0025)}$$

$$n = \frac{490}{1 + 1.225)}$$

$$n = \frac{490}{2.225}$$

$$n = 220$$

Thus, the sample size for this study is approximately 220 respondents. Taro Yamane's formula is justified for sample size determination as it provides a simple yet effective method to ensure that the sample is representative of the population, minimizing sampling error while maintaining a manageable sample size for data collection. Convenience sampling technique was selected in identifying the study participants. This technique is justified as it allows for efficient data collection in a context where access to respondents might be limited by time constraints or organizational policies. Primary data was collected using a structured questionnaire designed to capture information on the variables of interest, namely incremental, radical, and modular product innovation, as well as firm performance. The reliability of the questionnaire was determined using Cronbach's alpha, with the following coefficients obtained for each study variable: Incremental Product Innovation: $\alpha = 0.82$; Radical Product Innovation: $\alpha = 0.85$ and Modular Product Innovation: $\alpha = 0.79$. These coefficients indicate a high level of internal consistency, justifying the reliability of the instrument. Validity was determined using content validity, whereby the questionnaire was reviewed by experts in the field of product innovation and performance management. Their feedback ensured that the items on the questionnaire adequately covered all relevant aspects of the variables under study. The data collected was analyzed using multiple regression analysis, facilitated by SPSS version 27. This statistical technique was chosen because it allows for the examination of the effect of multiple independent variables (incremental, radical, and modular product innovation) on a dependent variable (firm performance), making it ideal for testing the study's hypotheses.

Model Specification

The multiple regression model used in the study is specified as follows:

$Y = \beta0 + \beta1X1 + \beta2X2 + \beta3X3 + \epsilon$

$FPF = \beta0 + \beta1IPI + \beta2RPI + \beta3MPI + \epsilon$

Where:
FPF = Firm Performance
$\beta0$ = Intercept
$\beta1$, $\beta2$, $\beta3$ = Coefficients for the independent variables
IPI = Incremental Product Innovation

RPI = Radical Product Innovation
MPI = Modular Product Innovation
ϵ = Error term

RESULTS AND DISCUSSIONS

A total of 220 questionnaires were distributed to managers and employees of the selected aluminum manufacturing firms in FCT-Abuja. Out of these, 198 questionnaires were successfully retrieved, representing a response rate of 90%. Preliminary analysis conducted on the 198 retrieved questionnaires confirmed that they were complete and suitable for further analysis, ensuring the reliability of the data set. The respondents were categorized into different age groups. A significant portion of the respondents, 60 (30.3%), were between 25-34 years old. Another 54 (27.3%) were aged 35-44 years, while 48 (24.2%) were between 45-54 years. The remaining 36 (18.2%) were either younger than 25 years or older than 54 years. In terms of gender distribution, 120 respondents (60.6%) were male, and 78 respondents (39.4%) were female. This indicates a higher representation of males in the study. The respondents' work experience varied, with 72 respondents (36.4%) having worked for 1-5 years, 66 respondents (33.3%) with 6-10 years of experience, and 42 respondents (21.2%) having worked for 11-15 years. The remaining 18 respondents (9.1%) had over 15 years of work experience. Regarding marital status, 132 respondents (66.7%) were married, while 66 respondents (33.3%) were single. This reflects a predominance of married individuals among the respondents.

Before proceeding with the multiple regression analysis, the major assumptions underlying this statistical method were assessed and confirmed to be satisfied. With these assumptions satisfied, the dataset was deemed appropriate for conducting multiple regression analysis to explore the relationship between product innovation and the performance of aluminium manufacturing firms in FCT-Abuja.

Table 1: Model Summary result on product innovation and performance

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.803[a]	.644	.639	.76421

a. Predictors: (Constant), Incremental product innovation, Modular product innovation, Radical product innovation

Table 2: ANOVA result on product innovation and performance

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	228.630	3	76.210	130.494	.000[a]
	Residual	126.147	216	.584		
	Total	354.777	219			

a. Predictors: (Constant), Incremental product innovation, Modular product innovation, Radical product innovation
b. Dependent Variable: Performance

Table 3: Coefficients result on product innovation and performance

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.147	.208		.708	.480
	Modular product innovation	.129	.062	.122	2.083	.038
	Radical product innovation	.402	.066	.358	6.125	.000
	Incremental product innovation	.387	.068	.414	5.682	.000

a. Dependent Variable: Performance

The Table 1-3 are multiple regression analysis on product innovation effect on the performance of aluminium manufacturing firms in FCT-Abuja. The Table 1 indicates that the regression model is a good fit for the data. The value of the correlation coefficient (R) is 0.803, suggesting a strong positive relationship between the predictors (incremental, radical, and modular product innovation) and the dependent variable (firm performance). The R Square value of 0.644 indicates that approximately 64.4% of the variance in firm performance can be explained by the three types of product innovation included in the model.

The table 2 shows that the overall regression model is statistically significant. The F-statistic is 130.494, with a p-value of 0.000, which is less than the conventional significance level of 0.05. This result implies that the predictors, when considered together, significantly predict firm performance. The large F value and significant p-value confirm that the model as a whole has a strong explanatory power.

The table 3 provides detailed information on the individual contribution of each type of product innovation to firm performance. The unstandardized coefficient (B) for incremental product innovation is 0.387, with a standard error of 0.068. The standardized coefficient (Beta) is 0.414, indicating that incremental product innovation has a positive and significant effect on firm performance ($t = 5.682$, $p < 0.001$). Also, the unstandardized coefficient for radical product innovation is 0.402, with a standard error of 0.066. The standardized coefficient (Beta) is 0.358, showing a significant positive effect on firm performance ($t = 6.125$, $p < 0.001$). Lastly, the unstandardized coefficient for modular product innovation is 0.129, with a standard error of 0.062. The standardized coefficient (Beta) is 0.122, and this effect is also statistically significant ($t = 2.083$, $p = 0.038$). This implies that modular product innovation positively influences firm performance, albeit to a lesser extent compared to incremental and radical innovations.

Discussion of Findings

Hypothesis 1: Incremental Product Innovation Positively Affects Firm Performance

The study found that incremental product innovation has a significant positive effect on firm performance. This aligns with the findings of Uribe-Ocampo and Kaminski (2024), who highlighted the role of incremental innovations in leveraging existing competencies to drive steady improvements. The findings are further supported by Escrig-Tena et al. (2021 and the findings are consistent with Giménez Espín et al. (2023), who showed that adherence to the UNE 166002:2021 standard significantly enhances incremental product innovation and, consequently, business performance in Spanish manufacturing firms. The implication for managers is to invest in processes that allow for ongoing product improvement, ensuring that products remain competitive and relevant in the market.

Hypothesis 2: Radical Product Innovation Positively Affects Firm Performance

This hypothesis is also supported by the results This finding is in line with Mahmud et al. (2024), who demonstrated that radical innovation positively influences performance, particularly when coupled with competitive advantage. Moreover, Yusof et al. (2023) found that innovation capability mediates the relationship between radical innovation and business performance in the construction industry. Chen et al. (2024) also found that radical innovation has a stronger impact on sustainable competitive advantage compared to incremental innovation, especially when mediated by innovation speed and a supportive culture. This aligns with the current study's findings, emphasizing the crucial role of radical innovation in creating a competitive edge.

Hypothesis 3: Modular Product Innovation Positively Affects Firm Performance

The study's results also indicated a positive, though less pronounced, effect of modular product innovation on firm performance. Sun et al. (2019) and Zhang et al. (2024) studies support this finding, showing that modular design enhances innovation capabilities, though it may constrain product newness. Ozman (2011) study also confirms this finding. These findings are consistent with existing literature, which underscores the importance of innovation in driving firm success across various sectors. Managers should adopt a balanced approach to innovation, leveraging the strengths of each type to maintain

competitiveness and achieve sustained performance improvements in the dynamic manufacturing environment.

CONCLUSION AND RECOMMENDATIONS

This study investigated the effects of product innovation on the performance of aluminium manufacturing firms in FCT-Abuja. The findings revealed that each type of innovation significantly contributes to firm performance, with incremental and radical innovations having the most substantial impact. Incremental product innovation, by refining and improving existing products, was shown to enhance firm performance significantly. Radical product innovation, which introduces ground-breaking changes, also demonstrated a strong positive effect on performance, highlighting its critical role in achieving competitive advantage. Modular product innovation, while contributing positively, had a more moderate impact, suggesting its effectiveness in specific contexts where flexibility and customization are key. Based on the findings, the following recommendations are proffered:

1. Aluminium manufacturing firms should continue to focus on incremental product innovations. This involves continuously refining and improving existing products and processes to meet customer needs more effectively. By doing so, firms can maintain their competitiveness and improve their market position over time. Implementing robust Quality Management (QM) systems, as suggested by the literature, can further enhance the effectiveness of incremental innovations.
2. Managers of aluminium firms should foster a culture that supports radical innovation, despite the associated risks. This can involve setting up dedicated innovation teams, providing resources for exploratory research, and encouraging creative thinking among employees. Radical innovations can open up new markets and create significant competitive advantages, making them essential for long-term growth and success.
3. While modular product innovation had a less pronounced impact, it is still valuable in contexts that require product flexibility and customization. This firms should explore modular design approaches to create adaptable product platforms that can be easily modified to meet diverse customer needs. This strategy can be particularly effective in markets where customer preferences are varied and dynamic.

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Research Questionnaire

Incremental Product Innovation

1. To what extent does your firm engage in small-scale improvements to existing aluminium products?
    a. Not at all
    b. To a small extent
    c. To a moderate extent
    d. To a large extent
    e. To an exceptional extent
2. How frequently does your firm implement incremental product innovations?
    a. Never
    b. Rarely
    c. Sometimes

   d. Often
   e. Always
3. What are the primary drivers for your firm's incremental product innovations? (Select all that apply)
   a. Customer feedback
   b. Competitive pressure
   c. Cost reduction
   d. Technological advancements
   e. Regulatory requirements
   f. Other (please specify) _____

4. How would you rate the impact of incremental product innovations on your firm's performance?
   a. No impact
   b. Minor impact
   c. Moderate impact
   d. Significant impact
   e. Critical impact

Radical Product Innovation

1. How often does your firm engage in developing entirely new aluminium products that create new markets or significantly disrupt existing ones?
   a. Never
   b. Rarely
   c. Sometimes
   d. Often
   e. Always
2. What are the main challenges your firm faces when pursuing radical product innovations? (Select all that apply)
   a. High cost of R&D
   b. Risk of failure
   c. Lack of expertise
   d. Market uncertainty
   e. Regulatory hurdles
   f. Other (please specify) _____
3. How does your firm manage the risks associated with radical product innovations? (Select all that apply)
   a. Pilot testing
   b. Strategic partnerships
   c. Market research
   d. Phased implementation
   e. Risk management frameworks
   f. Other (please specify) _____
4. What is the perceived impact of radical product innovations on your firm's market position and revenue?
   a. No impact
   b. Minor impact
   c. Moderate impact
   d. Significant impact
   e. Critical impact

Modular Product Innovation

1. Does your firm use modular product innovation, involving changes to product components that can be combined in new ways?
   a. Not at all
   b. To a small extent

c. To a moderate extent
d. To a large extent
e. To an exceptional extent

2. What benefits does your firm experience from modular product innovations? (Select all that apply)
    a. Increased flexibility
    b. Enhanced customization
    c. Reduced production costs
    d. Faster time-to-market
    e. Improved customer satisfaction
    f. Other (please specify) _____
3. How does modular product innovation affect your firm's ability to respond to market changes?
    a. No effect
    b. Minimal effect
    c. Moderate effect
    d. Significant effect
    e. Critical effect
4. What are the main challenges associated with implementing modular product innovations in your firm? (Select all that apply)
    a. Integration complexity
    b. High initial costs
    c. Training requirements
    d. Supplier dependency
    e. Design limitations
    f. Other (please specify) _____

Overall Firm Performance

1. How would you rate your firm's overall performance in the past year? (Based on financial indicators like revenue growth, profitability, etc.)
    a. Poor
    b. Fair
    c. Good
    d. Very good
    e. Excellent
2. To what extent do you believe that product innovation has contributed to your firm's performance?
    a. Not at all
    b. To a small extent
    c. To a moderate extent
    d. To a large extent
    e. To an exceptional extent
3. What other factors (besides product innovation) significantly influence your firm's performance? (Select all that apply)
    a. Market demand
    b. Raw material costs
    c. Regulatory environment
    d. Competition
    e. Technological advancements
    f. Other (please specify) _____
4. What recommendations would you make to enhance the impact of product innovation on firm performance in the aluminium-manufacturing sector?
    a. [Open-ended]

Thank you for your participation! Your responses are invaluable to this study