JTUS, Vol. 03, No. 1 January 2025
E-ISSN: 2984-7435, P-ISSN: 2984-7427
DOI: https://doi.org/10.58631/jtus.v3i1.147

Journal Transnational Universal Studies

The Effect of Product Development on Operational Performance: A Case Research of Ultimate Motors

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Abstract
In the competitive automotive industry, effective product development is the key to improving operational performance and maintaining market competitiveness. This research aims to analyze the impact of product development initiatives on operational performance at Ultimate Motors Plc. This research used mixed-methods with data collection through an online survey of 98 employees working in product development, manufacturing, and operations. The data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The results showed that product development initiatives explained 78.3% of the variance in manufacturing costs and production efficiency. Optimization of the assembly line had the most significant impact at 47.7%, followed by product design at 21.6%. However, the lack of employee training hinders the effective use of advanced design tools. While R&D and product innovation have a positive effect, their significance in influencing operational results is still limited. The implications of this research emphasize the importance of assembly line management in improving efficiency, reducing costs, and accelerating production time. It also provides valuable insights for the manufacturing sector in general, even though the research focuses on one company. Further research is recommended to explore additional factors that influence operational performance.

Keywords: Product Development, Operational Performance, Ultimate Motors, Assembly Line Management.

INTRODUCTION

In the high-octane world of business, a company's success is fueled by two intricately linked engines: product development and operational performance. Product development, the cornerstone of Operations Management, orchestrates the entire product lifecycle, from the initial spark of an idea to its final execution and market launch. This intricate journey encompasses several meticulous stages: design, where concepts are translated into blueprints; planning, where strategies for production and marketing are formulated; execution, where the product is brought to life; control, where quality and performance are monitored; and continuous improvement, where feedback is used to refine the product and processes (Cedergren, 2019).

Product development is an interdisciplinary field, drawing from a diverse toolbox of engineering, business, and social science principles. Engineers play a crucial role in designing the product's functionality and ensuring its technical feasibility. Business expertise is essential for market research, cost analysis, and developing a go-to-market strategy. Social science principles, particularly user research and understanding customer needs, are vital for creating products that resonate with the target market. To improve the odds of new product success, several strategies are crucial. A customer-centric approach that prioritizes understanding customer needs and preferences is essential. Effective coordination between development and marketing functions ensures a seamless transition from product conceptualization to market launch (Asikin et al., 2024). Additionally, creating unique and superior product features that differentiate the offering from competitors is vital for capturing market share.

Operational performance, the other vital engine of a company's success, serves as a measure of its operations' efficiency and effectiveness. It encompasses a multifaceted set of metrics, such as productivity, quality, cost, delivery speed, and flexibility, all of which significantly impact a company's competitiveness and profitability (Cooper, 2019).

Maintaining operational excellence, however, presents its own set of challenges. Rapid technological advancements can necessitate continuous improvements to production processes in order to maintain efficiency (Netland, 2016). Fluctuations in raw material prices and disruptions in the global supply chain can negatively impact production costs and delivery schedules (Kamalahmadi et al., 2022). Additionally, ensuring a skilled and motivated workforce capable of high-quality production requires ongoing training and development initiatives (Birdi et al., 2008). Strategic product development can play a key role in tackling these operational obstacles. Similarly, proactive material selection and supplier relationships forged during product development can help mitigate the impact of supply chain volatility (Swafford et al., 2022). And designing products with manufacturability and workforce training in mind can ensure a smoother transition to high-quality, efficient production (Boothroyd et al., 2020); (Akash et al., 2024).

Several key pillars are also critical for achieving operational excellence, including lean manufacturing, a skilled workforce, and efficient supply chain management. But by tightly integrating product development with these operational levers, organizations can create a powerful synergy that drives continuous improvement and strengthens their competitive edge (Jayaram et al., 2014). The automotive industry in Addis Ababa, Ethiopia, has emerged as a significant hub for assembly and production, driven by factors like the city's strategic location, improving infrastructure, and a readily available young and cost-effective labor force. Yet, companies in this context face unique challenges, including unreliable infrastructure, limited access to specialized automotive manufacturing skills, and fluctuating energy supplies, all of which can hinder their ability to optimize product development and operational performance (Kenea, 2022). This research research delves into the critical relationship between product development and operational performance, with a specific focus on Ultimate Motors, a company operating within the Ethiopian automotive industry. By examining Ultimate Motors' product development capabilities and its operational performance metrics, the research aims to identify key factors that contribute to or impede the alignment between these two essential business functions.

The alignment of product development and operational performance is a critical determinant of organizational success in the automotive industry. While research has highlighted the potential benefits of this integration, a significant knowledge gap persists concerning the specific factors influencing this relationship, particularly in the context of developing economies like Ethiopia. While existing literature highlights the potential benefits of aligning these two functions for overall organizational performance, a significant knowledge gap remains regarding the specific factors that enable or hinder this alignment, especially in the context of developing economies. This gap in understanding is particularly pronounced when it comes to the complex interplay between product development, and operational outcomes, such as production efficiency, production time and manufacturing costs. Recent studies have shed some light on this relationship. (Kenea, 2022) examination of the effect of product development strategies on organizational performance in the Ethiopian automotive industry suggested that effective product innovation, portfolio management, and design can significantly enhance technological advancement, market differentiation, and overall operational efficiency. However, (Kenea, 2022) tudy did not delve into how specific aspects of product design may impact operational performance metrics like production time.

Similarly, (Dagnaw et al., 2025) research on product development and operational efficiency in developing economies found that tight integration between R&D, customer satisfaction, and production reliability is critical for automotive manufacturers to maintain a competitive edge. Nwokah emphasized the importance of product time as a key operational performance indicator. Despite these insights, the research did not investigate whether a firm's efforts to innovate can lead to tangible improvements in production efficiency. Studies by (Krishnan & Ulrich, 2021) have suggested that a wider product portfolio can lead to economies of scale and scope, but may also introduce complexity and coordination challenges that can adversely affect operational outcomes. The applicability of these findings to automotive manufacturers in developing economies, and the extent to which assembly line management impacts production efficiency or manufacturing costs, remains an open question.

Alignment between product development and operational performance is crucial for automotive manufacturers in developing countries, but there is still a significant knowledge gap regarding the specific factors driving this relationship. Previous studies have relied solely on regression analysis, and have not had the comprehensive examination provided by the powerful structural equation modeling (SEM) technique. In particular, there is a limited understanding of how product design features, innovation efforts, and assembly line practices impact key operational metrics such as production efficiency, production costs, and production time in the context of emerging markets.

Based on the above background, the objective of this research is to examine the relationship between product development and operational performance in the Ethiopian automotive industry, specifically focusing on Ultimate Motors. The benefits of this research will contribute to existing knowledge and guide automotive manufacturers in Ethiopia and other emerging markets in aligning product development with operational objectives to increase competitiveness. In addition, this research offers valuable insights for policymakers and industry stakeholders to design supportive policies and infrastructure improvements, fostering an environment conducive to automotive manufacturing and innovation.

METHOD

Research Design

This research uses a descriptive and explanatory research design. Quantitative analysis was performed with IBM SPSS for frequency, descriptive, and validity tests, while the relationship between product development factors and operational performance was analyzed using SEM-PLS with SMATPLS 3. The qualitative approach involved in-depth interviews with key personnel to understand organizational capabilities, strategic decisions, and contextual factors in the Ethiopian automotive industry.

Research Approach

This research employs a mixed methods approach. The quantitative component involves statistical analysis of Ultimate Motors' survey, including descriptive tests and Structural Equation Modeling. The qualitative component comprises in-depth interviews with key personnel to gain deeper insights into organizational and industry factors shaping the product development-operational performance relationship. Integrating the quantitative and qualitative methods aims to provide a holistic understanding of the complex dynamics at Ultimate Motors.

Target Population

The target population for this research includes over 130 skilled professionals employed by Ultimate Motors PLC. The target population comprises employees from various departments, including Technique, Design, Manufacturing, Marketing, and Other

Sampling and Sampling Procedure

Sample Size Determination

In order to determine the sample size for this research, the confidence level (Z) was set at 95%; the margin of acceptable error (E) was 5%. Therefore, the sample size (n) for this proportion is determined by using https://goodcalculators.com/ (online sample size software).

The sample size (n) is calculated using Cochran's sample size formula:

$$n = \frac{[z^2 * p * (1 - P)/e^2]}{[1 + \left(z^2 * p * \frac{1 - p}{e^2 N}\right))]}$$

Where:
z = 1.96 with 95% confidence level (α)
p = proportion (decimal),
N = population size,
e = margin of error.
z = 1.96, p = 0.5, N = 130, e = 0.05

$$n = \frac{\left[1.96^2 * 0.5 * \frac{1-0.5}{0.05^2}\right]}{[1 + \left(1.96^2 * 0.5 * \frac{1-0.5}{0.5^2 * 130}\right))]} = \frac{384.16}{3.9551} = 97.131 \approx 98$$

The sample size of 98 subjects or employees will be used for this research.

Sampling Technique

The sampling method used in this research combines stratified sampling and simple random sampling. First, the population was divided into distinct strata based on departmental affiliation. The sample size for each stratum was proportional to the size of that department within the overall population. Then, within each stratum, a simple random sampling technique was employed. This involves randomly selecting participants from the sampling frame, where every individual has an equal and independent probability of being chosen. Random number generation or other randomization methods were used to facilitate the random selection process.

Data Source and Collection Methods

Data Type and Data Source

Both primary and secondary data collection methods were employed in order to acquire data for this research. Primary data were gathered through interview and questionnaire which was distributed for employees working at Ultimate Motors Plc. and secondary data were gathered from sources such as books, articles, journals and from online platforms to get a thorough understanding about the research. In addition to this we took some important data from the database system of the organization.

Method of Data Collection

The research employed a multi-method data collection approach, utilizing both questionnaires and in-person interviews. An online questionnaire distributed via email, Telegram, and Google Forms covered topics like product design, innovation, and perceptions of the company. Additionally, some questionnaires were printed and directly provided to key employees to assist in completion. To reduce potential bias and ensure better understanding among participants, the questionnaires were also translated into the local language (Amharic).

Measurement Instruments

A survey instrument was developed to collect data on the latent variables. The survey items were adapted from well-established scales in the operations management and new product development literature (Jayaram, 2019). Respondents were asked to indicate their level of agreement or perception on a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree) for each measurement item (Likert, 1932).

Partial Least Squares Structural Equation Modeling (PLS-SEM)

To analyze the relationships between the latent variables, the research employed a partial least squares structural equation modeling (PLS-SEM) approach using the SmartPLS 3 software (Ringle C, 2019). PLS-SEM is a variance-based structural equation modeling technique that is well-suited for complex models with multiple latent variables, especially when the research objective is prediction and theory development (Hair, 2019). PLS-SEM is considered a second-generation multivariate analysis technique, as it allows for the simultaneous examination of multiple dependent and independent variables.

This method was chosen over traditional regression and MANOVA (multivariate analysis of variance) tests for several reasons:

a. Complexity of the Model: The theoretical framework for this research involves multiple latent variables and their interrelationships. PLS-SEM is particularly appropriate for analyzing complex models, as it can handle a large number of variables and their interactions more effectively than regression or MANOVA (Hair, 2019).
b. Predictive Orientation: The primary objective of this research is to predict and explain the relationships between product development factors (PD, PI, and RD) and operational performance. PLS-SEM is well-suited for predictive research, as it focuses on maximizing the explained variance in the dependent variable(s) (Henseler, 2019).
c. Handling of Latent Variables: PLS-SEM can explicitly model latent variables, which are abstract constructs that cannot be directly observed or measured. This is particularly relevant in this research, whther amere the key variables (PD, PI, RD, and operational performance) are latent in nature. Regression and MANOVA, on the other hand, are better suited for analyzing observed variables (Chin, 2020).
d. Flexible Assumptions: PLS-SEM has less stringent assumptions compared to covariance-based structural equation modeling (CB-SEM) approaches. It does not require the data to be normally distributed and can handle small sample sizes more effectively (Reinartz, 2019).

The PLS-SEM method involves two main components:

a. Measurement Model: The measurement model specifies the relationships between the latent variables and their respective observable indicators or measurement items. Evaluating the measurement model is crucial to ensure the reliability and validity of the latent variable constructs.
b. Structural Model: The structural model defines the hypothesized relationships between the key latent variables, such as Product Design (PD), Product Innovation (PI), and Research & Development (RD). The researchers assessed the path coefficients, their significance and

relevance, as well as the model's overall predictive power and explanatory power. The general structural model can be expressed as:

$$\textbf{Operational Performance (y)} = \beta 0 + \beta 1x1 + \beta 2\ x2 + \beta 3x3 + \beta 4\ x4 + \varepsilon$$

Where:

y = operational performance

$\beta 1$ - $\beta 4$ are the slope coefficients for the four product development factors (x1 - x4)

ε is the measurement error

Validity and Reliability

The validity and reliability of the data were carefully examined. Ensuring the validity and reliability of the measurement instruments is crucial for making meaningful interpretations of the data (Creswell, 2017).

Table 1. Reliability test

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.945	.945	32

Source: From The Own Survey 2024

Method of Data Analysis

The data collected for this research was analyzed using various statistical tools. The Statistical Package for Social Sciences (SPSS) software version 27 was employed to present and interpret the findings. Descriptive statistical analysis was conducted to provide a concise summary of the data. This involved computing measures such as means and standard deviations for each variable, and presenting the results using tables, frequency distributions, and percentages. Furthermore, inferential statistical methods were utilized to draw insights from the data. These techniques allowed for the examination of relationships between variables (Sekaran, 2021). Correlation analysis was conducted to examine the relationships between the variables. Additionally, partial least squares structural equation modeling (PLS-SEM) using SmartPLS 3 was employed to assess the hierarchical structure of the research model, with the main variables specified as higher-order constructs and the sub-variables as lower-order indicators. The significance level for all analyses was set at $p < 0.05$ (Hair, 2019).

RESULT AND DISCUSSION

Demographic profile of the respondents

The demographic profile of respondents is presented in Table 2.

Table 2. Demographic profile of respondents (n = 98)

Profile of respondents	Response	Frequency	*(%)*
Gender	Male	51	52
	Female	47	48
Age	20-30 years	30	30.6
	31-40 years	45	45.9
	Above 40 years	23	23.5

Profile of respondents	Response	Frequency	*(%)*
Educational Status	Diploma	17	17.3
	Degree	63	64.3
	Masters	15	15.3
	Others	3	3.1
Marital status	Single	43	43.9
	Married	55	56.1
Service year	1-5 years	17	17.3
	6-10 years	59	60.2
	Above 10 years	22	22.4
Department	Technique	16	16.3
	Design	34	34.7
	Manufacturing	34	34.7
	Marketing	9	9.2
	Other	5	5.1

Source: own survey, 2024 based on SPSS version 27 software

Descriptive Statistics

In this research, descriptive statics were used as a way to examine the frequency, mean and standard deviation of the sample respondents of Ultimate Motors Plc. employees that are relevant in the raw data.

Table 3. Descriptive Statistics (n=98)

Descriptive Statistics			
	N	**Mean**	**Std. Deviation**
Product Design	98	3.76735	.609677
Product Innovation	98	3.62245	1.139319
Research and Development	98	3.55918	1.078739
Assembly Line	98	3.62857	.439306
Valid N (listwise)	98		

Source: own survey, 2024 based on SPSS version 27 software

Table 3 summarizes descriptive statistics for all variables assessed on a 5-point Likert scale (1 is strongly disagree and 5 is strongly agree). According to Zaidaton and Bagheri (2009), a mean score below 3.39 was considered low, a mean score between 3.40 and 3.79 was considered medium, and a mean score above 3.8 was considered high, illustrating the basis for comparing scores on a five-point Likert scale instrument. Firstly, the mean score for product design was 3.77 with a standard deviation of 0.61. This indicates that employees have a positive understanding of how product design strategies and activities impact performance metrics. Looking at the impact of product design, 2% strongly disagreed, 5% disagreed, 10% were neutral, 58% agreed, and 25% strongly agreed. This means that more than 80% of employees see product design as having a positive impact. The relatively small standard deviation of 0.61 suggests broad agreement on this point and minimal polarization of views.

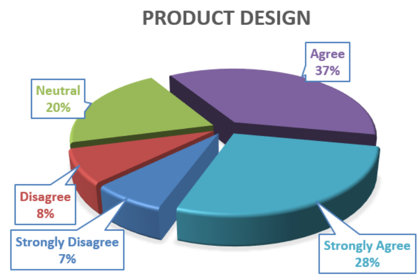

Figure 2. Impact of product design on operational performance (n=98)

Source: own survey, 2024

Secondly, the mean score for product innovation was 3.62 with a standard deviation of 1.14, falling in the medium range. This suggests employees have a moderately positive view of the company's product innovation efforts and their influence on production efficiency and production time. While the mean score is in the medium range, the larger standard deviation of 1.14 indicates more variation in employee perceptions on this topic. Nonetheless, 8% strongly disagreed, 10% disagreed, 12% were neutral, 52% agreed, and 18% strongly agreed on the positive impact of product innovation.

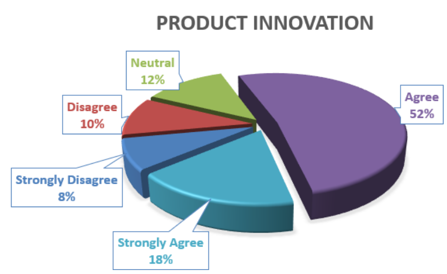

Figure 2. Impact product innovation on operational performance (n=98)

Source: own survey, 2024

Thirdly, the mean score for research and development was 3.56 with a standard deviation of 1.08, also in the medium range. This indicates employees have a moderately positive perception of the company's R&D activities and their effect on manufacturing costs. Similar to product innovation, the higher standard deviation points to more divergent views among employees on the impact of R&D. However, 10% strongly disagreed, 12% disagreed, 14% were neutral, 48% agreed, and 16% strongly agreed that R&D has a positive influence.

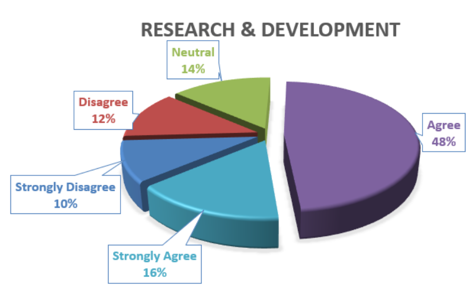

Figure 3. Impact research and development on operational performance (n=98)

Source: own survey, 2024

Finally, the mean score for assembly line was 3.63 with a standard deviation of 0.44, signaling that employees have a moderately positive view of the company's assembly line management and its impact on production efficiency and manufacturing costs. The smaller standard deviation of 0.44 suggests greater consensus among employees, with 4% strongly disagreed, 6% disagreed, 20% were neutral, 60% agreed, and 10% strongly agreed on the positive influence of assembly line management.

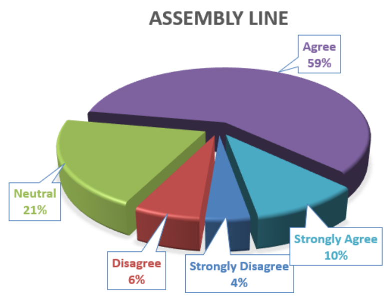

Figure 4. Impact of assembly line on operational performance (n=98).

Source: own survey, 2024

Overall, the descriptive statistics reveal that Ultimate Motors' design process and assembly line management appear to be well-aligned with and meeting production requirements by optimizing factors such as production time and manufacturing cost.

Correlation Analysis

Pearson's product moment correlation coefficient was used to determine the relationship between product design product innovation, R&D and assembly line with operational performance.

Table 4. Norm for Evaluating the Magnitude of a Correlation

S. N	Correlation coefficient (r)	Strength of relationship
1	r < 0.33	Weak relationship
2	r-between 0.34 and 0.66	Moderate relationship
3	r- between 0.67 and 0.99	Strong relationship

Source: Somekh and Lewin, 2005

Table 5. Pearson correlation table

Correlations								
		Product Design	**Product Innovation**	**Research & Development**	**Product Line**	**Production Time**	**Production Efficiency**	**Manufacturing Cost**
Product Design	Pearson Correlation	1	.221	.144	.357	-.279	.179	-.252
	Sig. (2-tailed)		.029	.158	.000	.005	.077	.012
	N	98	98	98	98	98	98	98

Correlations								
		Product Design	**Product Innovation**	**Research & Development**	**Product Line**	**Production Time**	**Production Efficiency**	**Manufacturing Cost**
Product Innovation	Pearson Correlation	.221	1	.823	.056	.170	.083	.164
	Sig. (2-tailed)	.029		.000	.582	.094	.419	.106
	N	98	98	98	98	98	98	98
Research & Development	Pearson Correlation	.144	.823	1	.046	.122	.006	.117
	Sig. (2-tailed)	.158	.000		.653	.230	.951	.252
	N	98	98	98	98	98	98	98
Product Line	Pearson Correlation	.357	.056	.046	1	-.645	.369	-.530
	Sig. (2-tailed)	.000	.582	.653		.000	.000	.000
	N	98	98	98	98	98	98	98
Production Time	Pearson Correlation	-.279	.170	.122	-.645	1	-.344	.884
	Sig. (2-tailed)	.005	.094	.230	.000		.001	.000
	N	98	98	98	98	98	98	98
Production Efficiency	Pearson Correlation	.179	.083	.006	.369	-.344	1	-.103
	Sig. (2-tailed)	.077	.419	.951	.000	.001		.314
	N	98	98	98	98	98	98	98
Manufacturing Cost	Pearson Correlation	-.252	.164	.117	-.530	.884	-.103	1
	Sig. (2-tailed)	.012	.106	.252	.000	.000	.314	
	N	98	98	98	98	98	98	98

Source: own survey, 2024 based on SPSS version 27 software

Based on Somekh and Lewin's (2005) correlation guidelines, product design has a moderate negative relationship with production time ($r = -0.279$, $p < 0.01$) and manufacturing costs ($r = -0.252$, $p < 0.05$), suggesting that improvements in product design moderately reduce both. However, its positive correlation with production efficiency ($r = 0.179$, $p > 0.05$) is not statistically significant. Product innovation shows positive but insignificant correlations with production time ($r = 0.170$, $p > 0.05$), manufacturing costs ($r = 0.164$, $p > 0.05$), and production efficiency ($r = 0.083$, $p > 0.05$), indicating weak or inconclusive relationships. Similarly, research & development exhibits positive but insignificant correlations with production time ($r = 0.122$, $p > 0.05$), manufacturing costs ($r = 0.117$, $p > 0.05$), and production efficiency ($r = 0.006$, $p > 0.05$), suggesting no clear impact. In contrast, the assembly line demonstrates strong and significant correlations, negatively impacting production time ($r = -0.645$, $p < 0.01$) and moderately reducing manufacturing costs ($r = -0.530$, $p < 0.01$), while moderately enhancing production efficiency ($r = 0.369$, $p < 0.01$). These findings highlight the critical role of assembly line improvements in optimizing operational performance.

Partial Least Square Structural Equation Modeling (PLS-SEM) Analysis

Measurement Model Assessment

The researchers used PLS-SEM to analyze the measurement model of this research. The reliability of factor loading (Cronbach's alpha), composite reliability (CR), average variance extracted (AVE), convergent validity, and discriminant validity were examined, and the output is shown in the table 6.

Table 6. Construct validity and reliability (n=98)

Variable	Cronbach's Alpha	rho_A	Composite Reliability (CR)	Average Variance Extracted (AVE)
Manufacturing Costs (MC)	0.919	0.924	0.942	0.804
Product Design (PD)	0.735	0.867	0.797	0.502
Product Innovation (PI)	0.883	0.902	0.916	0.689
Assembly Line (AL)	0.839	0.869	0.898	0.656
Production Efficiency (PE)	0.743	0.906	0.789	0.537
Production Time (PT)	0.876	0.878	0.915	0.729
Research and Development (RD)	0.884	0.958	0.909	0.672

Source: own survey, 2024 based on Smart PLS version 3 software

Reliability

All variables have Cronbach's alpha values above 0.7, which is the recommended threshold, indicating good reliability. The rho_A values are also above 0.7, which is an improvement over Cronbach's alpha and addresses the issue of heterogeneous indicators. The composite reliability (CR) values are all above 0.7, which confirms the reliability of the constructs.

Convergent Validity

The average variance extracted (AVE) values for all variables are above 0.5, which is the recommended threshold for convergent validity. This means the constructs are able to explain more than 50% of the variance in their respective indicators, indicating adequate convergence.

Discriminant Validity

The Fornell-Larcker criterion (Fornell, C., & Larcker, D. F, 1981) is used to assess discriminant validity, which is confirmed in your case. The square root of the AVEs is higher than the correlations between the constructs, indicating that the constructs are distinct and measure different concepts (Hair, 2019).

Table 7. Discriminant validity (Fornell-Larcker criterion) (n=98)

	MC	PD	PI	AL	PE	PT	RD
MC	0.897						
PD	-0.368	0.709					
PI	0.165	-0.016	0.830				
AL	-0.538	0.395	0.054	0.810			
PE	-0.379	0.372	0.045	0.535	0.733		
PT	0.884	-0.415	0.168	-0.657	-0.580	0.860	
RD	0.133	-0.050	0.790	0.042	-0.066	0.147	0.82

Source: own survey, 2024 based on Smart PLS version 3 software

Overall, the measurement model assessment shows that the reliability, convergent validity, and discriminant validity of the constructs are all within the recommended ranges, indicating a robust measurement model.

Structural Model Assessment

After confirming the reliability and validity of the measurement model, the assessment of the structural model is conducted. In this research, bootstrapping method was applied with 1000 replicates and 98 cases to assess the significance of the path coefficients (Hair, 2019).

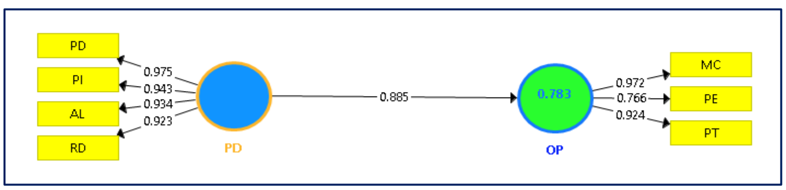

Figure 5. The Effect of product development on Operational Performance

Source: own survey, 2024 based on Smart PLS version 3 software

a. Firstly, the research aims to assess the general objective of the research which is to examine the effect of product development on operational performance in Ultimate Motors PLC.
   The Effect of product development on Operational Performance

Table 8. The Effect of product development on Operational Performance (n=98)

	Path Coefficient	f Square	R Square	Q Square	p-Value
PD -> OP	0.885	0.5	0.783	0.596	0.000

Source: own survey, 2024 based on Smart PLS version 3 software

The analysis reveals a strong, statistically significant, and practically relevant positive relationship between Product Development (PD) and Operational Performance (OP). As shown in Table 8, the path coefficient of 0.885 indicates that PD has a substantial impact on OP, and the large effect size (f^2 = 0.5) further supports the importance of this relationship. Additionally, the high R^2 value of 0.783 suggests that PD explains a significant portion (78.3%) of the variance in OP, while the medium-to-large predictive relevance (Q^2 = 0.596) of the structural model demonstrates its ability to accurately predict the dependent variable. Collectively, these findings provide compelling evidence that effective product development practices are a crucial driver of operational performance in the studied context.

b. Secondly the researcher wants to examine the specific objectives of the research

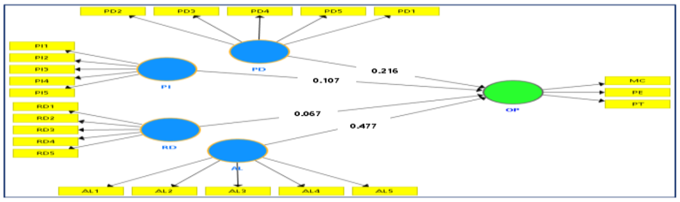

Figure 6. The Impact of product development metrics on operational performance

Source: own survey, 2024 based on Smart PLS version 3 software

Table 9. The Impact of product development metrics on operational performance (n=98)

	R Square	f Square	p-Values
PD	0.216	0.078	0.000
PI	0.107	0.009	0.521
AL	0.477	0.560	0.000
RD	0.067	0.003	0.718

Source: own survey, 2024 based on Smart PLS version 3 software

1) Impact of Product Design on Operational Performance

   Product design significantly influences operational performance, explaining 21.6% of its variance (R^2 = 0.216). The effect size is small to moderate (f^2 = 0.078), with a statistically significant impact ($p < 0.001$). It has a moderate negative relationship with production time and manufacturing costs, emphasizing its strategic role in operational efficiency.

2) Impact of Product Innovation on Operational Performance

   Product innovation does not significantly impact operational performance, explaining only 10.7% of its variance (R^2 = 0.107). The effect size is minimal (f^2 = 0.009), and the relationship is not statistically significant ($p = 0.521$). While prior correlation analysis suggested a positive link, SEM results indicate no direct effect, suggesting a need for a refined innovation strategy.

3) Impact of Research & Development on Operational Performance

   Research and development show no significant impact on operational performance, explaining just 6.7% of the variance (R^2 = 0.067). The effect size is negligible (f^2 = 0.003), and the relationship is not statistically significant ($p = 0.718$). Despite prior correlations, SEM suggests no direct contribution to operational efficiency, questioning the effectiveness of current R&D investments.

4) Impact of Assembly Line on Operational Performance

   The assembly line is a major driver of operational performance, explaining 47.7% of its variance (R^2 = 0.477) with a large effect size (f^2 = 0.560). The impact is statistically significant ($p < 0.001$), reinforcing its crucial role in efficiency and competitiveness. Enhancing assembly line operations should be a strategic priority for operational improvements.

Research Model Equation

The general research model equation for this research can be derived using the values from Table 4.12, which presents the impact of product design metrics on operational performance. The general research model equation for this research can be written as:

OP = 0.885 + 0.216PD + 0.107PI + 0.477AL + 0.067RD + 0.05

Where:

OP = Operational Performance

PD = Product Design

PI = Process Innovation

AL = Assembly Line

RD = Research and Development

$\beta 0$ = Constant/Intercept term = 0.885 (from table 4.5)

$\beta 1$, $\beta 2$, $\beta 3$, $\beta 4$ = Path coefficients (SEM weights) for the independent variables

ε = Error term representing the unexplained variance in OP, which is specified as 0.05 or 5% of the total variance.

This equation shows that Assembly Line (AL) has the largest impact on Operational Performance at 47.7%, followed by Product Development (PD) at 21.6%, Process Innovation (PI) at 10.7%, and Research and Development (RD) at 6.7%. The remaining 5% of the variance in OP is accounted for by the error term.

Hypothesis Testing and Interpretation of Results

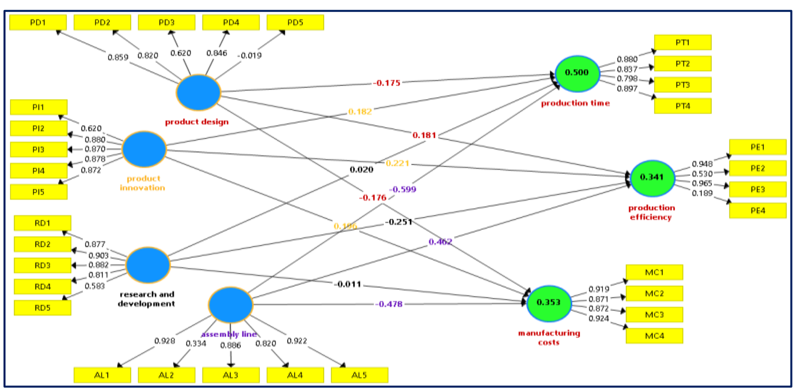

Figure 7. Structural Model Assessment

Source: own survey, 2024 based on Smart PLS version 3 software

Table 10. Impact of product development on operational performance (n=98)

	Path Coefficient	f Square	p-Values
PD -> MC	-0.176	0.040	0.068
PD -> PE	0.181	0.042	0.042
PD -> PT	-0.175	0.051	0.065
PI -> MC	0.196	0.022	0.262
PI -> PE	0.221	0.028	0.204
PI -> PT	0.182	0.025	0.318

	Path Coefficient	f Square	p-Values
RD -> MC	-0.011	0.000	0.953
RD -> PE	-0.251	0.036	0.245
RD -> PT	0.020	0.000	0.926
AL -> MC	-0.478	0.297	0.000
AL -> PE	0.462	0.272	0.000
AL -> PT	-0.599	0.603	0.000

Source: own survey, 2024 based on Smart PLS version 3 software

The findings of this research highlight the significant role of assembly line management in improving operational performance at Ultimate Motors, with strong evidence that it reduces production time (path coefficient = -0.599, p<0.001), lowers manufacturing costs (path coefficient = -0.478, p<0.001), and enhances production efficiency (path coefficient = 0.462, p<0.001). Product design also contributes positively by reducing production time (path coefficient = -0.175, p=0.065) and increasing efficiency (path coefficient = 0.181, p=0.042), although its impact on cost reduction is only marginally significant (path coefficient = -0.176, p=0.068). In contrast, product innovation and R&D investments do not exhibit significant direct effects on operational performance, as their relationships with production time, efficiency, and costs are statistically insignificant. These results suggest that Ultimate Motors should continue prioritizing assembly line management and refining product design strategies to maximize operational efficiency while reassessing the effectiveness of its innovation and R&D initiatives to better align them with measurable performance improvements.

Qualitative Data Analysis

1) product development efforts towards enhancing operational performance

Table 11. product development efforts on enhancing operational performance (n=14)

Responses	Number	Percentage
1. Positive	9	64.3%
2. Negative	4	28.6%
3. Unsure	1	7.1%
TOTAL	14	100%

Source: own survey, 2024

Figure 8. Qualitative Data 1

Source: own survey, 2024

Based on the data provided, I would evaluate the contribution of Ultimate Motors' product development efforts towards enhancing the company's operational performance and competitiveness as generally positive. With 9 out of 14 respondents (64.3%) having a favorable view, it indicates that the majority of employees believe these product development initiatives are contributing positively to the company's operational performance and competitiveness. This suggests the product development efforts are likely having a beneficial impact on factors. However, the presence of some negative (28.6%) and unsure (7.1%) responses implies there are areas for improvement or challenges that need to be addressed to maximize the full impact of these initiatives.

2) Perceived effect of product development Initiatives

Table 12. Ultimate Motors' product development initiatives (n=14)

Responses	Number	Percentage
1. Positive	9	50%
2. Negative	3	21.4%
3. Unsure	4	28.2%
TOTAL	14	100%

Source: own survey, 2024

Figure 9. Qualitative Data 2

Source: own survey, 2024

The qualitative data shows the majority, 7 out of the 14 total respondents, indicated that the impact had been high. This suggests the product development work was successful in driving meaningful improvements to production processes and costs. However, a sizable minority, 3 respondents, felt the impact was low. This divergent perspective points to potential limitations or challenges in fully realizing the expected benefits from the product development efforts within the manufacturing operations. Additionally, 4 respondents expressed uncertainty, being unsure of the true level of impact. The mixed nature of these responses highlights that there may have been variability in how the product development initiatives were implemented or experienced across different parts of the manufacturing function. Further investigation into the specific factors influencing the range of perceptions could help provide a more complete understanding of the initiative's true impact and effectiveness.

Discussion of findings

The findings regarding product design suggest that as Ultimate Motors continues to refine and enhance its design capabilities, there is potential for modest but meaningful improvements in manufacturing costs and production time. While the statistical significance of these relationships was not quite at the commonly accepted 0.05 level, the moderately negative associations indicate product design is a viable lever for driving operational efficiency (Tatikonda & Montoya-Weiss, 2001). The company should persist in its product design initiatives, seeking to further optimize the design process and translate these efforts into more robust operational benefits.

This finding is consistent with more recent research that has found a positive link between product design capabilities and operational performance. However, other studies have presented more mixed results, arguing that the relationship between product design and operational efficiency is more complex and context-dependent (Petersen et al., 2005). Ultimate Motors will need to carefully manage its product design initiatives to ensure they consistently translate into the expected operational improvements. In contrast, the research did not find support for the hypothesis that product innovation initiatives lead to improved production efficiency. This is a concerning finding, as innovation is often viewed as a critical driver of operational performance improvements (Schroeder et al., 2019). Ultimate Motors should closely re-evaluate its approach to product innovation, seeking to better align these efforts with tangible operational outcomes like reduced manufacturing costs and production time. Identifying the root causes behind the apparent disconnect between innovation and efficiency will be an important next step. The lack of a significant relationship between R&D investment and manufacturing costs is also a notable finding. Given the importance of R&D in driving operational enhancements (Prajogo, 2016),this result suggests Ultimate Motors may need to scrutinize the focus and outcomes of its R&D activities. Ensuring R&D efforts are appropriately targeted and delivering measurable benefits to production processes will be crucial.

The standout finding from this research was the strong positive association between effective assembly line management and improvements in production efficiency, manufacturing costs, and production time. This highlights assembly line management as a key competitive advantage for Ultimate Motors (Shah & Ward, 2019). The company should continue to prioritize and refine its assembly line practices, as these efforts are clearly paying dividends and contributing to enhanced operational performance. This finding is well-aligned with recent research on lean manufacturing and operational excellence. (Shah & Ward, 2019) have demonstrated how effective assembly line management, incorporating principles like just-in-time production and continuous improvement, can drive substantial gains in operational efficiency. Ultimate Motors appears to have a strong foundation in these critical assembly line practices, which should be leveraged to support the company's broader operational and competitive strategies.

CONCLUSION

The conclusion of this research confirms that product development strategy has a significant impact on operational performance in the automotive industry, while filling identified research gaps. The four main factors of product development—assembly line management, product design, research and development (R&D), and product innovation—collectively explain 78.3% of the variance in production costs and production efficiency at Ultimate Motors, with assembly line management playing the most dominant role (47.7%), followed by product design (21.6%) and R&D and product innovation (16.2%). These results show the importance of integrating efficient assembly processes and optimizing data-driven design to increase production efficiency while maintaining cost-effectiveness. Theoretically and practically, this research provides empirical validation of the collective impact of product development factors on operational performance. Subsequent research can expand on these findings by exploring their applicability across industries, taking into account external factors such as market dynamics and technological advances that can influence product development strategies. In addition, further investigation into the role of workforce training and digital transformation in optimizing product design and innovation can provide deeper insights into maintaining long-term competitiveness in the automotive sector.

BIBLIOGRAPHY

Akash, T. R., Lessard, N. D. J., Reza, N. R., & Islam, M. S. (2024). Investigating Methods to Enhance Data Privacy in Business, Especially in sectors like Analytics and Finance. *Journal of Computer Science and Technology Studies*, *6*(5), 143–151.

Asikin, M. Z., Azzahra, A., & Afridi, F. K. (2024). Strategies for the Utilization of Information Technology in Micro, Small, and Medium Business Marketing. *American Journal of Economic and Management Business (AJEMB)*, *3*(5), 1–13.

Birdi, K., Clegg, C., Patterson, M., Robinson, A., Stride, C. B., Wall, T. D., & Wood, S. J. (2008). The impact of human resource and operational management practices on company productivity: A longitudinal research. *Personnel Psychology*, *61*(3), 467–501.

Boothroyd, G., Dewhurst, P., & Knight, W. A. (2020). *Product design for manufacture and assembly*. CRC press.

Cedergren, S. (2019). *Performance in product development-the case of complex products*. Mälardalen University.

Cooper, R. G. (2019). The drivers of success in new-product development. *Industrial Marketing Management*, *76*, 36–47.

Dagnaw, M. A., Gebreab, F. T., Melisew, C. G., Tekle, K. C., & Ridzki, M. M. (2025). The Effect of Product Development on Operational Performance: A Case Research of Ultimate Motors. *Journal of Social Science (JoSS)*, *4*(1), 67–77.

Jayaram, J., Oke, A., & Prajogo, D. (2014). The antecedents and consequences of product and process innovation strategy implementation in Australian manufacturing firms. *International Journal of Production Research*, *52*(15), 4424–4439. https://doi.org/10.1080/00207543.2013.849363

Kamalahmadi, M., Shekarian, M., & Mellat Parast, M. (2022). The impact of flexibility and redundancy on improving supply chain resilience to disruptions. *International Journal of Production Research*, *60*(6), 1992–2020.

Kenea, D. A. (2022). The Effect Of New Product Development On Organizational Performance: The Case Of Biscuit Manufacturing Companies In Addis Ababa, Ethiopia. *Annals of the University of Craiova for Journalism, Communication and Management*, *8*(1), 6–22.

Krishnan, V., & Ulrich, K. T. (2021). Product development decisions: A review of the literature. *Management Science*, *47*(1), 1–21.

Netland, T. H. (2016). Critical success factors for implementing lean production: the effect of contingencies. *International Journal of Production Research*, *54*(8), 2433–2448.

Petersen, K. J., Handfield, R. B., & Ragatz, G. L. (2005). Supplier integration into new product development: coordinating product, process and supply chain design. *Journal of Operations Management*, *23*(3–4), 371–388.

Prajogo, D. I. (2016). The strategic fit between innovation strategies and business environment in delivering business performance. *International Journal of Production Economics*, *171*, 241–249.

Schroeder, R. G., Bates, K. A., & Junttila, M. A. (2019). A resource-based view of manufacturing strategy and the relationship to manufacturing performance. *Strategic Management Journal*, *23*(2), 105–117.

Shah, R., & Ward, P. T. (2019). Lean manufacturing: context, practice bundles, and performance. *Journal of Operations Management*, *21*(2), 129–149.

Smith, P. G., & Reinertsen, D. G. (2019). *Developing products in half the time: new rules, new tools*. John Wiley & Sons.

Swafford, P. M., Ghosh, S., & Murthy, N. (2022). The antecedents of supply chain agility of a firm: scale development and model testing. *Journal of Operations Management*, *24*(2), 170–188.

Tatikonda, M. V, & Montoya-Weiss, M. M. (2001). Integrating operations and marketing perspectives of product innovation: The influence of organizational process factors and capabilities on development performance. *Management Science*, *47*(1), 151–172.