PRODUCT AND PROCESS TECHNOLOGICAL INNOVATION AND FIRM'S PERFORMANCE IN SOUTH AFRICAN AUTOMOTIVE AND AUTOMOTIVE PARTS INDUSTRY

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ABSTRACT

With rapid technological innovations in the global automotive industry, the appreciation of the issues and decision-making for managers becomes relevant. An investigation is undertaken to determine whether product and process technological innovation options selected produce a measurable positive impact on firm performance and how the impact should be effectively assessed to inform managerial decision-making. An online survey, using a questionnaire, was undertaken among knowledgeable people conveniently sampled in selected firms, including managers and executives in production and sales functions, business development, CEOs and equivalent. The results showed a positive and significant relationship between product and process innovation, but not between product technological innovation and organisational performance. Similarly, no significant positive relationship was found between process innovation and firm performance. Segmentation by level of seniority, however, showed that results at lower and top management levels showed a negative correlation between all innovation and organisation performance, while middle management level results showed a positive correlation between process innovation and organisation performance. The findings suggest a lack of

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common understanding and unified purpose among management levels in the South African automotive industry on the critical role of technology innovation in driving competition, which may be a disadvantage for the sector, given the growing external competition.

Keywords: product innovation, process innovations, firm performance

1 INTRODUCTION

1.1 Research background/context

The South African automotive industry contributes about 5.3% of the country's Gross Domestic Product (GDP), and it is currently experiencing a shift in the matrix of car sales, with Chinese brands increasingly taking their share in the South African market [1]. Chinese brands in the South African market offer fresh, affordable products with new technological features, which can be seen as a threat to old players in the automotive market. Rapid technological innovations in the automotive industry, like self-driving motor vehicles, data analytics, data sensors, 360-degree-view camera systems, and lane assist and sleep detection systems, propel different entities to change their business models [2]. Digital transformation in the automotive industry enables businesses to innovate and change their business models to stay competitive in the market [3]. The use of technological innovation is vital for the growth, sustainability and success of business in the automotive industry [4].

Technological innovations are at the centre of the current evolution in the automotive sector. Artificial intelligence (AI), the Internet of Things (IoT), and 5G connectivity are among the innovations that are transforming the industry as enablers of interconnected systems and autonomous driving systems [5]. Machine learning (ML) is changing how vehicles are designed, manufactured and maintained. Robotics and automation are therefore increasingly being adopted in the manufacturing process of vehicles, allowing for a high degree of efficiency [6]. The objective of this study is to analyse the association between product and process technological innovation and firm performance in South Africa's automotive manufacturing industry.

2 LITERATURE REVIEW

2.1 Innovation

Innovation is described by Taylor [7] as the process of creating and implementing novel ideas, methods, products, services and solutions that yield significant improvements and value. The Organisation for Economic Co-operation and Development (OECD), a membership-based organisation of over thirty developed countries, initially classified innovations into two main categories, namely product innovation and process innovation. This segmentation was later expanded to include services like marketing and organisation [8]. For purposes of this paper, this study limits the scope to product and process innovation, and to the automotive industry. Koelmel et al. [9] found that technological innovations, such as advancements in electrification, connectivity, autonomous driving, artificial intelligence, and machine learning, amongst others, are changing the automotive industry on a global level. Changing consumer preferences, environmental regulations, and growing competition associated with lower prices of electric vehicles (EV) encourage transformational activities in the automotive industry. This is evidenced by global sales in electric vehicles increasing to over 17 million in 2024, an increase of about 26% over the previous year, with about half the sales attributed to China [10]. Autonomous driving technology, enabled by innovations like machine learning, sensors, and AI, represents a paradigm shift in the automobile sector [11]. Henao-García et al. [12] found that product and process innovations propel businesses towards economic growth and improved financial performance. Chen et al. [4], in studying the entire automotive supply chain industry in China, found that digital technology innovation impacts the performance of firms in the automotive industry.

2.2 Product innovation

Product innovation occurs when there is a major alteration in the features of current goods or when completely new and unique products are created [8], [13], new goods and services are released [14] or when there is an improvement in product functionalities attained by the customer [15]. Obtaining adequate capital investment to make new goods and services is important to the long-term viability of innovative operations [14]. In the automotive industry, embedded systems or innovative control systems have transformed the products from basic control systems to sophisticated systems that are mostly connected to engine control units (ECU), which enhance the interconnections, safety, communications networks, and decision-making, with some automotive manufacturers incorporating in their vehicles the capability to perform self-driving functions [16]. Saharti [17] notes that research and development (R&D), which is associated with product innovation, has an impact on firm performance.

2.3 Process innovation

Process innovation is defined in an earlier version of the Oslo manual [18] as:

> *"the implementation of a new or significantly improved production or delivery method',*

while a later version [8] expands the definition to include innovation in marketing and organisation, which may not suit this paper. This includes significant changes in techniques, equipment and/or software. Chigbu [19] found that job automation and automation of manufacturing factories are rapidly increasing in the automotive industry in South Africa, leading to less demand for labour and increased production efficiency and output. According to Sonko [16], the embedded systems or innovative control systems are shaping and changing the automotive industry with the introduction of artificial intelligence systems that can make decisions in real time, and businesses are changing their manufacturing processes to accommodate the changing environments. The changing environments, according to Chigbu [20] and Deonarain [21], necessitate joint human-machine interaction and collaboration, which in turn requires training and development of the workforce in the automobile manufacturing sector. Chigbu et al. [19] observe that there was increased human and machine collaboration in the South African automotive industry during the COVID-19 pandemic, although they also raise concern that the automation of manufacturing activities has contributed to the high unemployment rates in developing countries, including South Africa.

2.4 Product and process innovation

It is suggested that Toyota's operational processes, which allow for creative thinking and open innovation, lead to new product features and processes, suggesting a direct link between process innovation and product innovation [22]. For example, Chigbu et al. [20] found that changing environments led to the automation of processes and new products with AI abilities, necessitated by the need for automated processes in the automotive manufacturing sector in South Africa. Bogetoft's study [21] of several firms indicates that combining product innovation with process innovation drives higher performance in both the short and long run. With this background information, this study proposes the following hypothesis:

> ***H0: Product innovation has a positive correlation with process innovation.***

2.5 Innovation and firm performance

Gerguri-Rashiti [23] states that innovation is an important factor in determining the success of a business. Both financial and non-financial metrics may be used to highlight the effects of innovation on a company's performance [24]. There are several examples of this. Yang [25] states that innovative activities improve profitability by introducing fresh products and enhanced processes, leading to improved income and reduced expenditure. Sales growth and production output are used to rank the best companies in the automotive industry [1]. Furthermore, Becerra-Vicario [26] found that the use of technology and optimised methods of production led to high return on assets (ROA). Good financial management propels companies to invest in innovative activities, leading to improved firm performance [27]. Nwiepe and Grend [28] found that customer satisfaction and client loyalty, which are driven by product quality, improve sales and enhance profitability.

2.6 Measurement of innovations

Scholars have shown interest in understanding the measurement of product innovation and its impact on performances of organisations. Björk [29] states that measuring innovation is difficult and complex, but emphasises its importance for any firm that aims to achieve its innovative objectives. Nathan [30] used descriptive statistics analysis to measure the impact of new product performance in Small and Medium-sized Enterprises (SMEs) in the UK, which yielded positive results. Similarly, Feng [31] utilised descriptive statistics to measure the relationship between service innovations and the firm's performance, which yielded favourable results. Correlation and regression analyses were used by Gupta [32] to measure the relationship between product innovations and the firm's performance, with data obtained by means of a survey. Their findings yielded a positive relationship between product innovation and the firm's financial performance, but a negative correlation between process innovation and the performance of the firm. In a study to test performance in the automotive industry, Lascu [33] likewise obtained data by means of a survey, while hypothesis testing was conducted using statistical methods.

2.7 Product innovation and firm performance

The performance of a company is directly and favourably impacted by product innovation [34]. Yu [35] found a positive return on investment when measuring new product innovation performance, with product quality indicating a significant overall improvement. Despite findings from several scholars that product innovation has a positive impact on a firm's performance, Shouyo [36] argues that innovation may be resisted and even rejected outright by suppliers, customers and employees if the importance of the innovation initiatives is not recognised. It is of interest whether the same relationship would be observed in South Africa, as some authors hint of contextual differences [37], [17]. From the above arguments, the following hypothesis is proposed:

H1: Product innovation has a positive correlation with a company's performance.

2.8 Process innovation and the firm's performance

Hervas-Oliver [38] found that process innovation reduces manufacturing cost, increases production speed and has a favourable effect on performance. According to Lee [34], the output of process innovation is seen in the improvements in product quality, reduction in/production costs and higher efficiency during the manufacturing. Cherrafi [39] indicates that process innovation improves operational efficiency of the entire supply chain processes and positively affects the performance of a firm. Canh [40] found that process innovation in Vietnamese firms improved business operations, making them more appealing and leading to a positive performance. Katebi [37] found that there is a positive relationship between process innovation and a firm's organisational performance. However, they suggest that country and continent may be moderating factors. These arguments suggest that , while the findings for South African firms may be similar, they could also show differences. Therefore, the study proposes the following hypothesis:

H2: The performance of a company is positively linked with process innovation.

The conceptual model from the hypotheses proposed above is shown in Figure 1.

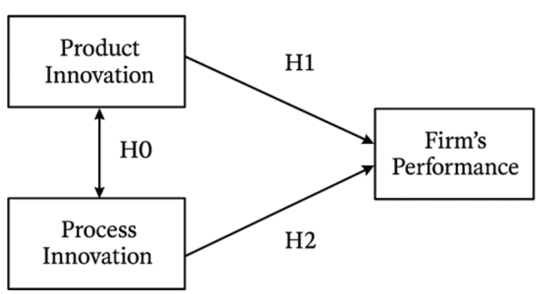

Figure 1 Conceptual model of innovation and firm performance

3 RESEARCH METHODOLOGY

The OSLO manual [8] is identified in the literature as the foremost authoritative guide on the measurement of innovations and is internationally recognised as the standard. Based on the guidelines of the OSLO manual [8], therefore, this study prepared a research instrument with the objective of measuring selected innovation types against firm performance. A quantitative research approach was selected to reach as many people as possible in the target population and reduce subjectivity bias [41]). The study made use of a survey to collect primary data and sought to relate two independent variables (product innovation and process innovation) with a dependent variable (firm performance).

While a longitudinal design is recommended by the OLSO manual [8] and Diaz-Fernandez [42], this study used a cross-sectional design to obtain information on innovation experience from participants. This choice was driven by constraints encountered at the inception of this research. A cross-sectional study is efficient and inexpensive without subjecting the process to any attrition, since information is only collected once from the participants [43]. The survey consisted of four sections, namely demographic, product innovation, process innovation and firm performance, making up a total of 31 questions. Demographic questions covered gender, age, tenure, company age and level of seniority. Product innovation consisted of six questions requiring the use of a 5-point Likert scale from "Strongly Disagree" to "Strongly Agree", including a neutral option. Guidance was obtained from the OLSO manual [8] and the questions were then converted into statements that made them suitable for the selected format of measurement. Scholars like Lee [34] and Tuan [44] also developed product innovation measurement instruments using the definitions and guidelines from the OLSO manual [8]. The process innovation section consisted of five questions, also using a 5-point Likert scale and developed with the guidance of the OLSO manual [8], then converted into statements that made them suitable for the selected format of measurement. The section on the firm's performance consisted of sixteen measurement questions created using a 5-point Likert scale from "Very Strong" to "Very Weak". The performance measurement questions were initially developed by Khandwalla [45] and have been used by other scholars like Miller [46] and Cragg [47]. The performance questions were both financial and non-financial key performance indicators (KPIs) that companies can use to measure performance, namely profitability, sales growth, financial resources (liquidity and investment capacity), production output, ROA), quality of the goods and services, public image, and client loyalty.

A questionnaire was distributed electronically to participants who held the following positions within firms: innovators, production/manufacturing managers, general managers, business analysts, sales executive managers, sales managers, business developers, COOs, CEOs, and similar positions. The survey included three response options for management level, namely lower management, middle management, and top management, selected to be broad enough to accommodate a wide range of job titles across different organisations. The survey link was sent via email, WhatsApp, Facebook and LinkedIn platforms.

Participants were obtained using convenience sampling. Initially, the survey was distributed on LinkedIn and Facebook platforms. However, as response was slow, a decision was made to have face-to-face consultations to ensure a better response. Respondents were sent a link via WhatsApp/email messaging systems to enable them to complete the surveys. While doing the consultations, complex company structures were identified; for instance, the Toyota Group has three main operations, namely the Toyota brand, the Lexus brand and the Hino truck brand. Toyota and Lexus operate as separate businesses, with Hino operating as a separate subsidiary. On the other hand, the retail distribution side of the business is affiliated with multiple entities who have the rights to use the Toyota brand name as their trading name. These entities, such as Motus Toyota and Bidvest McCarthy Toyota, among others, have their own financial reporting. Innovations have varying effects on these entities, whether emanating from the Toyota brand or from their own initiatives.

Only respondents who were willing and readily accessible participated. This yielded a response rate of 66.67%, considered acceptable for survey-based research and amenable to statistical analysis [48]. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was used to evaluate the data's suitability for multivariate analysis, with the range from 0 to 1 benchmarked, where values below 0.60 indicate insufficient sampling for factor analysis and values above 0.80 are deemed meritorious [49]. Cronbach's alpha [50] factorial analysis was conducted to test the validity and reliability of the measurement tool. Face validity check was applied to the survey [51]. Statistical Package for the Social Sciences (SPSS) software was used to analyse the data, from which Pearson's correlation and descriptive statistics were extracted to analyse the data obtained from the survey. The interval nature of the data gathered led to the selection of Pearson's correlation coefficient.

4 RESULTS

The results from forty responses will be discussed. While sixty firms were contacted, the forty responses received span the range of targeted respondents. The result is presented by demographic profiles, followed by the Correlation analysis with a drill-down correlation analysis segmented by level of seniority and descriptive statistics. Tests were conducted for validity and reliability. Sales volumes and production output data from NAAMSA were presented as supporting data for the presented results.

4.1 Reliability

Table 1 Cronbach's alpha

Variables	**Cronbach's alpha**
Product Innovation	.874
Process Innovation	.857
PerformAV	.938
PerformCOM	.938

Cronbach's alpha was used to measure the internal validity of the questionnaire tool used for the study and currently indicating an excellent average 0.922 reliability of the questions (Refer to Table 1).

4.2 Validity

Table 2 KMO and Bartlett's Test

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of sampling adequacy.		.754
Bartlett's Test of Sphericity	Approx. Chi-Square	755.489
	df	210
	Sig.	<.001

Factorial analysis was conducted for this study, using a Principal Component Analysis extraction method, with Varimax with Kaiser Normalisation rotation-. The Kaiser-Meyer-Olkin Measure of sampling adequacy indicates a good 0.754 measure (Refer to Table 2).

Table 3 Factorial analysis: Rotational components matrix

Variables	**1**	**2**	**3**
PerformCom_5	.901		
PerformCom_3	.879		
PerformCom_1	.872		
PerformCom_2	.856		
PerformAV_2	.850		
PerformAv_1	.849		
PerformCom_8	.832		
PerformAV_7	.824		
PerformAV_3	.814		
PerformAV_4	.803		
PerformAV_8	.798		
PerformCom_4	.795		
PerformAV_6	.782		

Process_4		.920	
Process_3		.789	
Process_6		.788	
Process_2		.763	
Process_5		.629	
Product_3			.837
Product_1			.827
Product_2			.817

The initial results were not meeting the validity standard required or desired for the study and as such the following variables were eliminated from the validity measurement tests shown in Table 3: product4, product5, process1, performAV5, performcom6 and performcom7. The table shows that all factors have values that are more than 0.6, which means that they are robust and proven to be strong measurements for the study. The performance variables are grouped together in column 1, process innovation variables are grouped together in column 2 and the product innovations are grouped together in column 3.

4.3 Demographic

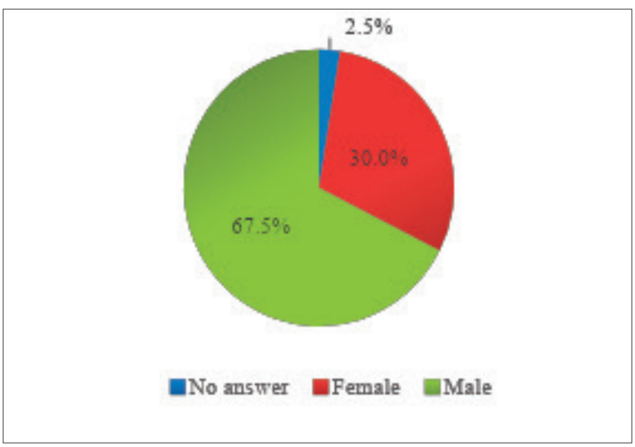

Figure 2 Gender

The gender participant statistics indicate a significantly high participation level among males, who comprised 67.5% of the survey, while females accounted for 30%, and 2.5% remains unspecified (Refer to Figure 2). According to NAACAM [52], 33.4% are in the automotive industry workforce, while 66% are male.

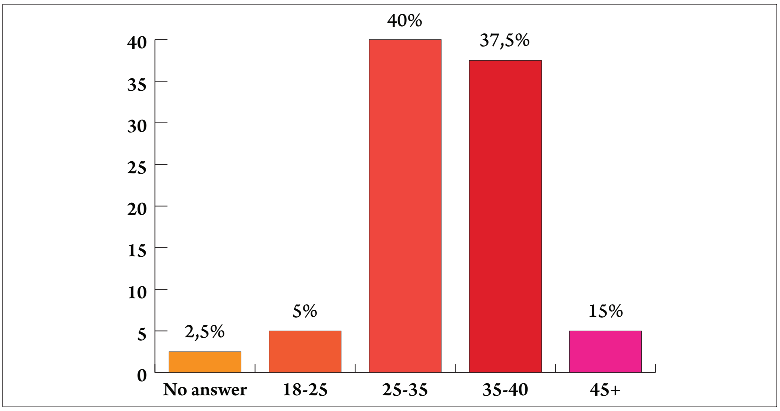

Figure 3 Age

The age demographic statistics show that 40% of participants are between the ages of 25-35, while 37.5% of participants are between the ages of 35-45 and 15% of the participants are 45 and older (Refer to Figure 3).

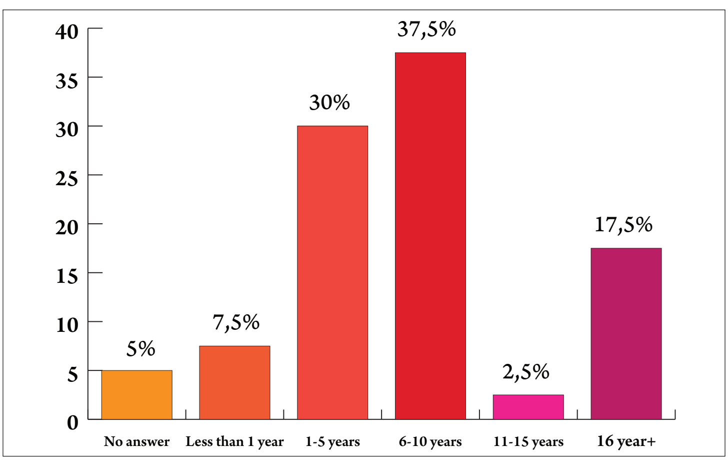

Figure 4 Tenure

The tenure demographics statistics indicate that 37.5%percent of the participants have worked at the same company for six to ten years, while 30% have worked at the same company for one to five years, and 17.5% have worked at the same company for 16 years or more (Refer to Figure 4).

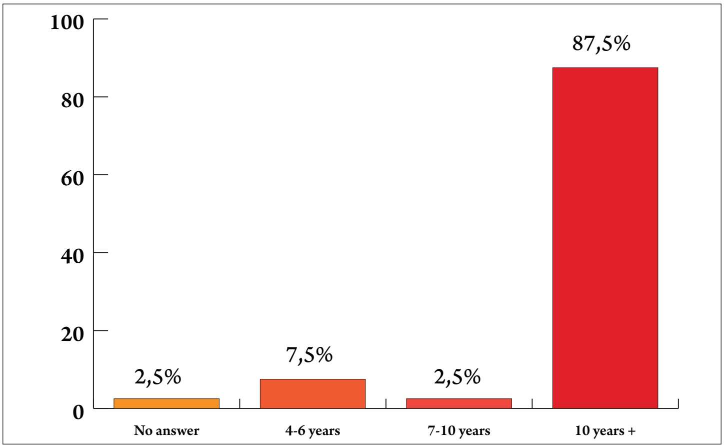

Figure 5 Company age

The demographics indicate that 87.5% of the participants work for companies that were started more than ten years ago, and 7.5% indicated that they work for companies that were started between four to six years ago (Refer to Figure 5).

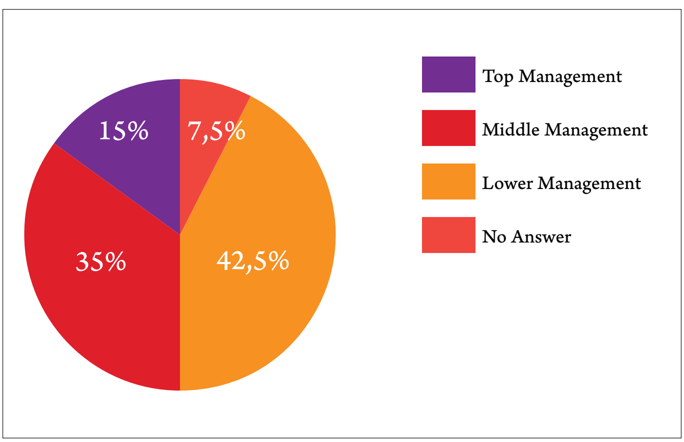

Figure 6 Level of seniority

The highest percentage of participants (42.5%) were at the lower management level, while 35% were in middle management, and 15% in top management (Refer to Figure 6).

4.4 Correlation analysis

Before conducting the correlation analysis, four indices were developed to systematically group related and highly correlated survey items (Refer to Table 4).

Table 4 Index summary

Index Name	**Purpose**	**Items Included**
INDEX-Product	Measures Product Innovation	Product_1, Product_2, Product_3, Product_4, Product_5
INDEX-Process	Measures Process Innovation	Process_1, Process_2, Process_3, Process_4, Process_5, Process_6
INDEX-PerformAV	Performance and Industry Average	PerformAV_1, PerformAV_2, PerformAV_3, PerformAV_4, PerformAV_5, PerformAV_6, PerformAV_7, PerformAV_8
INDEX-PerformCOM	Performance and Comparable Organisations	PerformCOM_1, PerformCOM_2, PerformCOM_3, PerformCOM_4, PerformCOM_5, PerformCOM_6, PerformCOM_7, PerformCOM_8

4.4.1 Main correlation analysis

Table 5 Pearson's Correlations (Summative correlations of the study)

		1	2	3	4
INDEX-Product	Pearson Correlation	--			
	N	39			
INDEX-Process	Pearson Correlation	.705**	--		
	Sig. (2-tailed)	<.001			
	N	39	39		
INDEX-PerformAV	Pearson Correlation	.031	.015	--	
	Sig. (2-tailed)	.850	.928		
	N	39	39	39	

INDEX-PeformCOM	Pearson Correlation	.103	.068	.930**	--
	Sig. (2-tailed)	.533	.683	<.001	
	N	39	39	39	39
**. Correlation is significant at the 0.01 level (2-tailed).					

Main correlation analysis summary (Refer to Table 5):

- Correlation of product and process innovation = 0.705, significant at 0.01 level ($p < 0.01$) → H0 supported;
- Correlation of product innovation and PerformAV = 0.031, not significant → H1 not supported;
- Correlation of product innovation and PerformCOM = 0.103, not significant → H1 not supported;
- Correlation of process innovation and PerformAV = 0.150, not significant → H2 not supported, and,
- Correlation of process innovation and PerformCOM = 0.068, not significant → H2 not supported.

4.4.2 Correlations segmented by level of seniority

The results were segregated by the level of seniority in management ranks to understand the perspective derived from the impact of innovation from different levels of management. Different managerial ranks play a significant role in the decision-making or in influencing the decision-making process, particularly in the innovation initiatives of the business. Data were filtered into three sets, categorised by the three levels of seniority, and it was then used to evaluate the hypothesis. The three categories are as follows: Lower-level management, middle management and top management.

4.4.2.1 Lower-level management

Table 6 Lower-level management correlations

		1	2	3	4
INDEX-Product	Pearson Correlation	1			
	Sig. (2-tailed)				
	N	17			
INDEX-Process	Pearson Correlation	.823**	1		
	Sig. (2-tailed)	<,001			
	N	17	17		
INDEX-PeformAV	Pearson Correlation	-.400	-.437	1	
	Sig. (2-tailed)	.112	.079		
	N	17	17	17	
INDEX-PeformCOM	Pearson Correlation	-.486*	-.435	.883**	1
	Sig. (2-tailed)	.048	.081	<.001	
	N	17	17	17	17
**. Correlation is significant at the 0.01 level (2-tailed).					
*. Correlation is significant at the 0.05 level (2-tailed).					

Summary of lower-level correlations (Refer to Table 6):

- Correlation of INDEX-Product and INDEX-PerformAV = -0.400, not significant → H1 not supported;
- Correlation of INDEX-Product and INDEX-PerformCOM = -0.486*, significant at 0.05 level → H1 Accepted;
- Correlation of INDEX-Process and INDEX-PerformAV = -0.437, not significant → H2 not supported; and,
- Correlation of INDEX-Process and INDEX-PerformCOM = -0.435, not significant → H2 not supported.

4.4.2.2Middle management correlations

Table 7 Middle management correlations

		1	2	3	4
INDEX-Product	Pearson Correlation	1			
	Sig. (2-tailed)				
	N	14			
INDEX-Process	Pearson Correlation	.654*	1		
	Sig. (2-tailed)	.011			
	N	14	14		
INDEX-PerformAV	Pearson Correlation	.356	.542*	1	
	Sig. (2-tailed)	.212	.045		
	N	14	14	14	
INDEX-PerformCOM	Pearson Correlation	.195	.429	.922**	1
	Sig. (2-tailed)	.505	.126	<.001	
	N	14	14	14	14
*. Correlation is significant at the 0.05 level (2-tailed).					
**. Correlation is significant at the 0.01 level (2-tailed).					

Summary of the correlations for middle management (Refer to Table 7):

- Correlation of PerformAV and product innovation = 0.356 → H1 not supported;
- Correlation of PerformAV and process innovation = 0.542*, → H2 accepted;
- Correlation of PerformCOM and product innovation = 0.195 → H1 not supported; and,
- Correlation of PerformCOM and process innovation = 0.429 → H2 not supported.

Performance and industry average - Performance variables:

- Sales growth and process innovation-correlation = 0.652, $p < 0.05$* → Accept H2;

- Financial resources and process innovation: correlation = 0.853, $p < 0.01$ → Strongly accept H2; and,
- Client loyalty and process innovation: correlation = 0.561, $p < 0.05$* → Accept H2.

Performance and comparable organisations - Performance variable

- Financial resources and process innovation: correlation $r = 0.549$, $p < 0.01$ → Accept H2.

4.4.2.3 Top management

		1	2	3	4
INDEX-Product	Pearson Correlation	1	.823**	-.400	-.486*
	Sig. (2-tailed)		<.001	.112	.048
	N	17	17	17	17
INDEX-Process	Pearson Correlation	.823**	1	-.437	-.435
	Sig. (2-tailed)	<.001		.079	.081
	N	17	17	17	17
INDEX-PerformAV	Pearson Correlation	-.400	-.437	1	.883**
	Sig. (2-tailed)	.112	.079		<.001
	N	17	17	17	17
INDEX-PerformCOM	Pearson Correlation	-.486*	-.435	.883**	1
	Sig. (2-tailed)	.048	.081	<.001	
	N	17	17	17	17
** Correlation is significant at the 0.01 level (2-tailed).					
* Correlation is significant at the 0.05 level (2-tailed).					

Summary of top management correlations (Refer to Table 8):

- Correlation of INDEX-Product and INDEX-PerformAV = -0.400, not significant → H1 not supported;
- Correlation of INDEX-Product and INDEX-PerformCOM = -0.486*, significant at 0.05 level → H1 Accepted;
- Correlation of INDEX-PerformAV and INDEX-Process = -0.437, not significant → H2 not supported; and,

- Correlation of INDEX-PerformCOM and INDEX-Process = -0.435, not significant → H2 not supported.

4.5 Descriptive statistics

The analysis of the data from the survey reveals insights into the innovation activities and their performance within the surveyed organisations.

Table 9 Descriptive statistics

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Product Innovation	39	1.00	5.00	3.9987	.85889
Process Innovation	39	1,00	5.00	3.6385	.89683
Perform AV	39	1.00	5.00	2.5449	1.11711
Perform COM	39	1.00	5.00	2.4602	1.12248
Valid N (listwise)	39				

Descriptive analysis summary (Refer to Table 9):

- Product innovation shows a mean of 3.9987 (SD = 0.85889), displaying strong presence;
- Process innovation shows a mean of 3.6385 (SD = 0.89683), also indicating significant activity;
- Performance and industry average scored a mean of 2.5449 (SD = 1.11711), reflecting low perception;
- Performance and comparable organisations scored a mean of 2.4602 (SD = 1.12248), similarly low; and,
- Performance perceptions are uncertain and generally below average, with high variability.

5 DISCUSSION

The discussion section will focus on the three sets of hypotheses, H0, H1 and H2. Descriptive statistics and NAAMSA data will be used to support the discussion.

H0: Product innovation has a positive relationship with process innovation.

The aim of H0 is to establish whether process innovation leads to product innovation, or whether product innovation leads to process innovation. The main finding of the study is that there is a positive, significant correlation between product and process innovation with a correlation of 0.705**, significant at 0.01. H0 was accepted.

H1: Product innovation has a positive correlation with a company's performance.

H1 aims to evaluate whether there is a positive correlation between product innovation and a firm's performance. The findings of this study imply a positive relationship between product innovation and a firm's performance, as shown by the correlation coefficients of 0.031 and 0.103. The correlation may be positive, but statistically not significant. Consequently, H1 is rejected. The results suggest that while product innovation may influence improvements in performance, the effect is not adequate to be considered significant in this study. Ayinaddis [41] found positive relations between product innovations and a firm's performance with a Pearson's correlation of 0.672**, significant at 0.01. The similarity with this study is the application of the measurement tools. However, while the result is positive for both studies, as mentioned, this study indicated insignificant relations with correlations of 0.031 and 0.103.

H2: The performance of a company is positively linked with process innovation.

The aim of H2 was to assess whether there is a positive relationship between process innovation and a firm's performance. Pearson's correlation coefficients of 0.015 and 0.068 show an insignificant positive relationship between process innovation and the organisation's performance. However, H2 was not accepted, since the relationship is insignificant. Ayinaddis [53] found a positive and significant relationship between a firm's performance and process innovations with a Pearson's correlation of 0.591**, significant at 0.01. The similarity with this study is again the application of the measurement tools.

H1 and H2 Segmented by level of seniority

For Lower-level management, both product innovation and process innovation show significant negative correlations between industry average performance and performance against comparable organisations. Specifically, product innovation has a correlation of -0.400 with industry average performance and a correlation of -0.486* with performance against comparable organisations, significant at 0.05 level, while process innovation has correlations of -0.437 with industry average performance and -0.435 with performance against comparable organisations. These negative correlations suggest that improvements in product and process innovation do not translate into better performance in terms of industry average performance and performance against comparable organisations for lower-level management. Consequently, both hypotheses H1 and H2 are rejected for this segment.

For middle management, the correlations displayed varied results. Industry average performance shows a weak positive correlation with product innovation (0.356), which is not statistically significant, and a positive correlation with process innovation (0.542*), significant at the 0.05 level. This shows that process innovation positively impacts performance benchmarked against an average industry performance, supporting H2 (accepted) but not H1(rejected). On the other hand, comparable organisations' performance has very weak and not statistically significant correlations with both product innovation (0.195) and process innovation (0.429). Therefore, both H1 and H2 are rejected for comparable organisations' performance. These findings suggest that while process innovation can enhance industry average performance, it does not have a significant impact on comparable organisations' performance at the middle management level.

Furthermore, a drill down of middle management correlation analysis was conducted, in order to understand the variables which revealed that process innovation is positively correlated with performance. Process innovation has a positive correlation with sales growth (0.652*), significant at the 0.05 level, implying that process innovation is important in enabling sales growth. Financial resources, which include liquidity and investment capacity, have a strong positive relationship with process innovation, with a correlation of 0.853**, significant at the 0.01 level, implying that a healthier financial position supports innovation effort. Client Loyalty positively correlates with process innovation, with a correlation of 0.561*, significant at the 0.05 level, signifying the importance of innovation in sustaining customer relationships. Moreover, performance against comparable organisations shows a positive correlation with financial resources (0.549*, significant at the 0.01 level), implying that financial strength can enhance competitive performance.

For top management, the correlations are predominantly negative. Product innovation has a -0.400 correlation with industry average performance and a 0.486* correlation with comparable organisations' performance, significant at the 0.05 level. Process innovation shows negative correlations with both the industry's average performance (-0.437) and comparable organisations' performance (-0.435), neither of which is statistically significant. These results suggest that product innovation has a considerable inverse association with performance in comparable organisations, while process innovation does not significantly impact performance metrics at the top management level. This could imply that top management may prioritise other strategic factors over product and process innovations when it comes to performance.

5.1 Descriptive statistics

Product innovation scored a mean of 3.998, indicating a strong presence perception by the participants. A standard deviation of 0.85889 was obtained, meaning that most respondents agreed that there is product innovation. The process innovation questions yielded a mean of 3.6385, meaning that most respondents agreed that process innovations exist in their organisations. The standard deviation of .89683 indicates that most responses were leaning towards the agree sections, which strongly confirms that process innovations exist within those organisations. Descriptive statistics firmly confirm that both process and product innovation exist in the surveyed entities.

Performance questions for industry average (Perform AV) indicated a mean of 2.5449, showing the uncertainty that exists among the respondents since most answers expressed a preference for neutrality. A standard deviation of 1.11711, with the range of the answers between 1 (very strong) and 4 (weak), strongly suggests that, while the average response may be neutral, the actual answers varied greatly. This supports some of the findings, particularly of the segmented sections, where middle management shows positive performances, while other tiers of management show negative performances. Similarly, performance questions for comparable organisations in the industry (Perform COM) indicated a mean of 2.4602, which, when rounded off to the nearest number, will be 3 (Neutral). The standard deviation is 1.12248, and the range of answers is between 1 (very strong) and 4 (weak).

5.2 Previous research

Innovation and firm performance findings from previous studies show mixed results. For example, in a study conducted by Na et al. (2019), the findings indicate that product innovation is significantly correlated to the sales growth of the firms, while process innovation negatively correlates with the growth of the firms. On the other hand, Kijkasiwat's [54] study on innovation and firm performance shows a significant positive correlation of 0.318 *** between innovation and firm performance and a substantial favourable relationship of 0.160 *** between financial capital and firm performance. The results are comparable to the segmented findings, where financial resources are positively associated with process innovation. While negative results have been reported in previous studies, most studies show positive results. Ayinaddis [53] found a positive association between product and process innovation with firm performance, yielding correlations of 0.672** and 0.591** respectively. These findings align with the segmented finding on process innovation of middle management, which positively correlates with performance.

5.3 Automotive market

Production of vehicles and sales of vehicles declined immediately after COVID-19 but have steadily recovered in the past five years. These findings suggest that external factors like supply chain disruption and decline in economic activities can lead to downtime for businesses [1]. Despite the harsh economic conditions experienced by the South African market, the market shows signs of resilience, with average sales increasing every year since COVID-19 regulations and supply chain disruptions ended.

Chinese brands like Cherry and GWM are strongly increasing their presence in the South African market, proving that the influence of technological features and sophisticated car design are positively impacting the sales growth of the businesses in the automobile sector [1]. New energy vehicles are also taking a stance in the market, showing that futuristic products with zero emissions may soon dominate the market. For example, major players in the market, like BMW and Mercedes-Benz, have plans in place to rapidly produce cars in this segment, hoping to dominate future markets [55].

6 CONCLUSION, LIMITATIONS AND FUTURE STUDIES

6.1 Conclusion

The main aim of the study was to investigate the connection between product technological innovation, process technological innovation and an organisation's performance. The overall results showed a positive, insignificant association between product and process technological innovations and an organisation's performance. However, findings from segmented results showed a positive and significant relationship between process innovation and an organisation's performance.

Segmented results, which were categorised by level of seniority, painted a mixed picture where top and lower-level management correlations indicated an inverse relationship between product and process innovation and the organisation's performance, while middle management correlations indicated that there is a positive and significant relationship between process innovation and a firm's performance and product innovation presented an insignificant association with performance. The findings from the middle management segment indicated that client loyalty, financial resources and sales growth are correlated to process innovations. These results from middle management are strongly aligned with the literature. By concentrating on process innovation, businesses can get client loyalty and attain a competitive advantage in the market.

Despite the findings used to test our hypotheses, the emergence of Chinese brands in the market cannot be ignored and brings new challenges to the industry, as these brands have already taken a significant portion of the South African market share. By observation, their success suggests that technological features and sophisticated design can enable a new entrant to the market to partake in a share of the market [44]. The success of Chinese brands suggests strong market forces at play by which customers' needs are satisfied via both technological and pricing models.

In conclusion, process and product innovations lead firms to achieve financial and non-financial objectives and enable firms to remain competitive and sustainable in the automotive industry, even in harsh economic conditions.

6.2 Limitations and future research recommendations

A cross-sectional approach for the survey design was used due to time constraints instead of a longitudinal approach recommended by the OLSO Manual [8]. Future research is encouraged to pursue a longitudinal method. This will allow for a more extended timeframe for the study, offering the potential for richer and more comprehensive data compared to the current cross-sectional approach.

During the COVID-19 pandemic, specifically between 2020 and 2022, industrial activity and data collection were disrupted by nationwide lockdowns. Consequently, the findings may show unusual circumstances that are not typical of how the industry functions. Additionally, the limited time and sensitivity of the information made it difficult to collect data from many companies, hence the sample size is limited to only 40 firms.

Future studies could benefit from exploring the relationship between the impact of product innovation and the impact of process innovation on customer satisfaction, particularly in the South African market, in an environment experiencing successful new entrants to the market. Another focus area for future research is the long-term impact of innovation on firm performance while considering additional moderating variables such as government policies, industry competition and technological adoption rates. As this study mainly focused on the management perspective, exploring the customer perspective presents a valuable opportunity for future research.

7 REFERENCES

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