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Review

The Role of Technology and Innovation Management in Enhancing Productivity Management Within Small and Medium-Sized Manufacturing Enterprises (SMEs) in South Africa

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Abstract

This study investigates the role of technology and innovation management (TIM) in enhancing productivity management within small and medium-sized enterprises (SMEs) in South Africa. Using Jenga's Theory of Creativity, Systems Theory, and Schumpeter's Theory, the research seeks to address the gap between technology and innovation features in productivity management. It employs a mixed-methods approach, primarily using quantitative data collected through questionnaires administered to various manufacturing SMEs. Findings reveal that implementing specific technologies in the manufacturing process significantly affects employee productivity and introduces unique operational objectives. The study also highlights experimental solutions used to address implementation challenges, demonstrating SMEs' adaptability and resilience. The outcome independent variables are organizational structure efficiency, organizational leadership efficiency, planning for technologically based processes, planning for production innovation, technology assessment, knowledge management, and production time improvement. The research highlights the importance of a balanced approach to technology integration, as illustrated by Jenga's Theory of Creativity. Systems Theory underscores the interconnectedness of various elements within the productivity management framework, emphasizing the need for strategic planning and effective leadership. The study concludes that targeted technology and innovation management practices can substantially improve productivity and competitiveness in manufacturing SMEs. The developed framework serves as a guide for organizations aiming to enhance their operational efficiency through innovative solutions. Limitation—the paper only zoomed in on technology and innovation management-related attributes.

Keywords: productivity management; technology; innovations management

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1. Introduction

Low productivity is currently a serious challenge facing South African manufacturing SMEs. These SMEs function below the expected manufacturing output levels [1]. Firstly, physical capital, poor physical infrastructure, human resources problems (less efficient labour), material and finance (overhead cost), and energy represent serious problems facing manufacturing industries among SMEs in developing countries—in South Africa, where

low productivity prevails, and SMEs fail to secure market share globally [1]. Secondly, regarding technological capital, manufacturing industries are experiencing business inefficiencies due to a lack of innovation management among employees, as employees lack the educational background to use their creativity to operate machines [1].

In the 2024 Institute of Management Development (IMD) World Competitiveness Yearbook, South Africa is ranked 60th out of 67 countries [2]. According to data released by Statistics South Africa [3], the gross domestic product (GDP) increased by 0.4% in the second quarter of 2024, following a 0.0% growth in the first quarter. On expenditure, real GDP rose by 0.5% in the second quarter, an improvement from the 0.1% decrease in the first quarter of 2024.

South Africa, which has a large formal economy, is notably unequal. Its formal economy coexists with a very low-productivity 'survivalist' informal economy, and unemployment is estimated at around 30% of the labour force [4]. SMEs in the manufacturing sector face numerous challenges in managing productivity effectively [1,5,6]. Despite being crucial contributors to economic growth and employment, these manufacturing SMEs often struggle with limited resources, technology adoption barriers, skill gaps, and competitive pressures [6].

The embeddedness of technological tools and digital applications in the fabric of daily life means that the boundaries between life domains are fluid, i.e., technology management and all domains of SMEs.

Innovation is essential for organizations, particularly in the manufacturing sector, as a process, strategy, or management tool to improve productivity management [7]. Ref. [8] admitted that innovation gives human transformation the capacity to integrate the idea of power to change a phenomenon or event, which has become an essential concept across industries or sectors.

The investigation has established a positive relationship between technology management and innovation management and SMEs' success, survival, growth, and performance [9,10]. The literature has largely informed that manufacturing SMEs, which play a dominant role in their economic sector and have advanced levels of capabilities, always tend to scan and monitor the business environment to identify greater performance strategies to foster productivity improvement. The organization's management of productivity proposes factors that relate to the successful management of the technology and innovation process, and through constant monitoring and evaluation, SMEs can improve their performance [11,12].

Technology and innovation management (TIM) in productivity management provides an understanding at a fundamental level to form a relationship between current happenings and past experiences to solve future problems [13]. Ref. [14] maintained that innovation is often associated with technological feats and is critical to the world economy. According to [15], technological innovation has become a crucial feature in managing global competitiveness and helps companies deal with the creation of new products and services. Ref. [9] posited that managing technological innovation requires the critical contributions of cross-functional learning (i.e., between R&D, marketing, and production) and cross-disciplinary learning (i.e., between mechanical engineering, software, and opto-electronics), both within and across the boundaries of the firm (on cross-functional learning). Hence, however, sustainability and multifunctionality require knowledge and innovation of a different nature from the more conventional challenge of food security: more product (or functional) innovations than process, organizational, and marketing innovations, and not just technological innovations. Therefore, more complex innovations and knowledge are required [5,16].

The categories of innovation align closely with the conventional distinction between radical and incremental innovation. Radical innovations, characterized by substantial technological novelty and depth, are typically generated within research and development (R&D) laboratories possessing advanced scientific capabilities and strong upstream knowledge linkages. Conversely, incremental innovations are generally developed within smaller engineering or technical units that emphasize practical application, continuous improvement, and maintain strong downstream linkages with customers, users, and markets [9]. The alignment of information technology (IT) management strategies with a firm's competitive strategy has been cited as a critical management issue that influences organizational value activities, exploits changes in competitive scope, and lowers production costs [17].

This study does not seek to introduce an additional variable to the productivity management concept. Instead, its contribution lies in advancing an integrated productivity management framework that provides a holistic understanding of the interrelated attributes influencing the implementation of productivity management within the manufacturing industry.

To provide analytical direction and ensure coherence throughout the investigation, the study is guided by the following research question:

- RQ: To what extent is productivity management in manufacturing SMEs influenced by technology and innovation management?

These research questions frame the manuscript as an in-depth industrial case study that seeks to establish the link between TIM and productivity management in the manufacturing SMEs.

The scientific contribution of this paper lies in TIM and productivity Management in South African SMEs, which contribute to sustainability by demonstrating how structured innovation practices enhance economic resilience, environmental responsibility, and social equity. This study contributes to the existing body of knowledge on productivity management by identifying the key factors that influence effective production in manufacturing SMEs within developing economies, using South Africa as a case study. It further examines the extent to which these factors affect the implementation and effectiveness of productivity management in manufacturing SMEs. From an economic perspective, TIM enhances operational efficiency, organizational competitiveness, and adaptive capacity, thereby improving the long-term sustainability of SMEs operating in dynamic and volatile markets. Accordingly, the integration of TIM into SME productivity management is conceptualized not merely as a mechanism for improving organizational performance, but as a multidimensional strategic enabler of sustainable industrial development, resilience, and inclusive economic growth in South Africa.

2. Study Background

2.1. Theory of Technology and Innovation Management in Productivity Management

Ref. [11] indicated that productivity management and competitive success depend upon an organization's management of the innovation process and proposed factors that relate to the successful management of the innovation process. In today's rapidly evolving digital economy, organizations are constantly striving to boost efficiency, streamline operations, and maximize overall productivity (AdraM). Innovation management is the governance and organization of these innovation processes [18]. Ref. [11] highlighted seven elements of innovation management areas that inform strategies to improve productivity management as follows: input, organization and culture, portfolio management, project management, commercialization, knowledge management, and innovation strategy. Ref. [19] found that leadership plays an important role in developing innovative organizations through an innovation process (idea generation, idea selection, idea development, and

idea diffusion). The capacity of organizations to innovate is determined by multiple factors that relate to their internal organization and market environment. practices embodied in the innovation, then their use will also spread to teachers within or across schools [20].

TIM plays a pivotal role in enabling automation, improving organizational communication and business processes, and strengthening competitiveness in increasingly dynamic markets [21]. As a strategic organizational capability, TIM has become fundamental to modern business operations by supporting informed decision-making, enhancing operational efficiency, improving productivity, and sustaining competitive advantage. It encompasses the integrated management of technological resources, human capabilities, and organizational processes to generate, process, and disseminate information that supports managerial decision-making and operational effectiveness [22].

Beyond its operational role, TIM facilitates the development, adoption, and commercialization of new technologies, products, services, and processes that enhance organizational efficiency, improve quality, and create value. The literature consistently recognizes technological innovation as a key driver of organizational growth, competitive advantage, and long-term performance, particularly in rapidly evolving business environments [23]. Consequently, organizations that effectively integrate technology and innovation into their strategic and operational activities are better positioned to improve productivity, respond to market changes, and sustain long-term competitiveness.

Challenges in Implementing Technology and Innovation Management

Despite its strategic importance, the implementation of TIM remains challenging for many organizations. One of the most significant barriers is the innovator's dilemma, whereby organizations with successful existing business models are often reluctant to adopt innovations that may disrupt established operations or revenue streams [24]. Additional constraints include limited financial and technological resources, inadequate top management support, organizational resistance to change, and insufficient employee capabilities.

Furthermore, rigid organizational structures, bureaucratic decision-making processes, and limited organizational flexibility can impede the generation, diffusion, and implementation of innovative ideas, thereby reducing an organization's capacity to respond effectively to technological and market changes [25]. Nevertheless, the evidence suggests that organizations capable of overcoming these barriers realize substantial benefits, including enhanced operational efficiency, improved product and service quality, increased productivity, and stronger competitive performance [13]. Consequently, the successful implementation of TIM requires not only technological investment but also supportive leadership, organizational agility, and a culture that promotes continuous learning and innovation [13].

2.2. Theories That Underpin Technology and Innovation Management

There are several theories that scholars have used to explain TIM. Theories namely:

- Jenga theory
- System theory
- Schumpeter's Theory

The Jenga theory of creativity and systems theory were drawn upon. The application of this theory covers a broader scope of integrating creativity and technological innovation by adding and subtracting problems and objects to make completely new and complex products or services that overcome the limitations of the previous processes. These theories have been extensively applied across a range of disciplines, particularly in engineering, business management, and information technology, where they provide theoretical and practical guidance for the effective management of technology and innovation across multi-

ple organizational functions [7,11]. Consequently, they offer a robust theoretical foundation for addressing the productivity management challenges facing manufacturing SMEs.

However, the systems theory, as developed by Von Bertalanffy in 1937, is classified under the Domain of Individual Field Interaction (DIFI). A system is a group of interacting components that conserves some identifiable set of relations with the sum of the components plus their relations (i.e., the system itself), conserving some identifiable set of relations to other entities (including other systems) [26]. Notably, the theory acknowledges that technology relies on products, processes, places, and people. In the social context, technology is a construction that explains the actions embedded within certain contexts to create meaningful change in the workplace [27]. The advantage of systems theory is its potential to provide a trans-disciplinary framework for a simultaneously critical and normative exploration of the relationship between our perceptions and conceptions and the worlds they purport to represent [26].

One of the principal theoretical foundations of TIM is Schumpeter's Theory of Innovation, which conceptualizes technological innovation as the primary driver of economic development through the process of creative destruction. Schumpeter argued that innovation continuously transforms market structures by replacing obsolete products, processes, and business models with more efficient and competitive alternatives, thereby stimulating productivity growth and long-term economic development [28]. Extending this theoretical perspective, Ref. [29] advanced the concept of disruptive innovation, demonstrating how emerging technologies can fundamentally reshape industries by displacing incumbent firms that fail to adapt to technological change and evolving market conditions.

The strategic significance of technological innovation has been extensively validated in empirical literature across a broad range of industrial contexts. For example, Ref. [30] reported that organizations adopting digital technologies, including artificial intelligence (AI) and automation, experience significant improvements in operational productivity, process efficiency, and managerial decision-making. Similarly, Ref. [31] found that organizations implementing comprehensive digital transformation strategies consistently achieve superior organizational performance, characterized by enhanced operational agility, innovation capability, and responsiveness to dynamic market conditions. Collectively, these theoretical and empirical perspectives reinforce the central role of TIM as a strategic capability that enables organizations to improve productivity, strengthen competitive advantage, and sustain long-term organizational performance in increasingly technology-driven environments.

3. Materials and Methods

3.1. Data Acquisition

A rigorous review of the literature on productivity management in manufacturing SMEs was undertaken to establish the theoretical foundation of the study. The review comprised two complementary approaches: a bibliometric analysis to map the intellectual structure of the field and identify research gaps, and a Systematic Literature Review (SLR) to identify, critically evaluate, and synthesize the existing evidence on the impact of Technology and Innovation Management (TIM) on organizational productivity management. Drawing on these approaches, the study sought to develop a comprehensive understanding of the relationship between TIM and productivity management while identifying areas requiring further scholarly attention. The combined use of bibliometric analysis and SLR enabled a systematic, transparent, and objective evaluation of the literature, providing an integrated overview of technology management, technological innovation, information management systems, and organizational productivity, as well as the interrelationships among these constructs.

Primary data were subsequently collected using a structured questionnaire (Appendix A) administered to 354 respondents [7,32,33]. The use of a standardized questionnaire ensured that all participants were exposed to an identical set of questions, thereby enhancing the consistency and reliability of the data collection process [34]. Accordingly, the questionnaire was designed to obtain empirical evidence aligned with the study's research objectives and to facilitate the statistical analysis of the determinants of productivity management in manufacturing SMEs.

A quantitative research approach was adopted because it is well suited to identifying the factors and attributes that influence productivity management and to determining the relative contribution of each factor within the South African manufacturing SME sector. The questionnaire was developed from the findings of the bibliometric analysis and SLR conducted during the first two phases of the study. It comprised four sections, with the first section collecting respondents' demographic and organizational characteristics, together with other contextual information considered necessary to address the research objectives. The remaining sections focused on measuring the constructs associated with technology and innovation management and productivity management.

The quantitative research approach (see Figure 1) was selected because it facilitates the generation of objective, reliable, and generalizable findings. It was considered particularly appropriate for examining the underlying dimensions of productivity management and the structural relationships among the identified factors within the South African manufacturing industry. Data obtained from the questionnaire survey were analyzed to determine the key factors influencing productivity management and to assess the relative contribution of each factor to organizational productivity. Ultimately, the study sought to identify the critical determinants of effective productivity management and to develop a best-fit productivity management framework for manufacturing SMEs operating in developing economies, using South Africa as the empirical context.

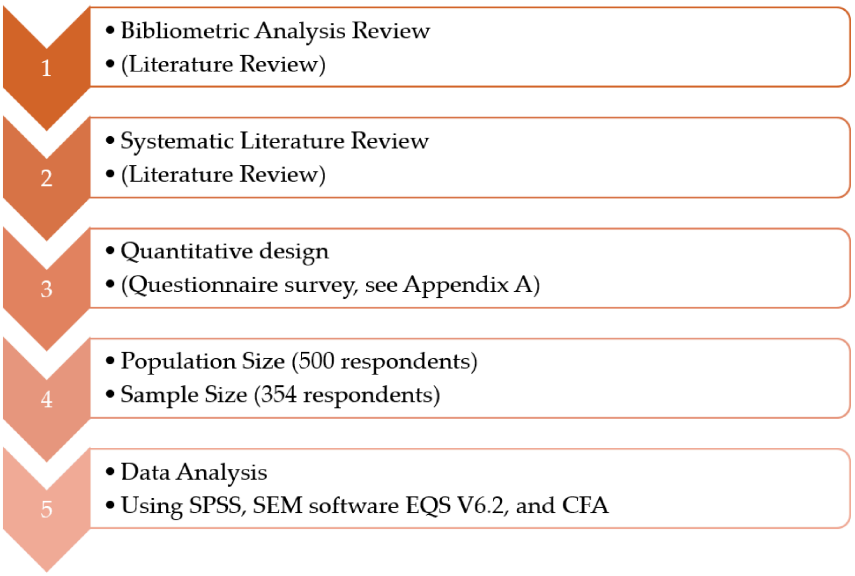

Figure 1. Research Methodology Approach.

3.1.1. Observed Variables

The research instrument was designed to measure the exogenous latent construct, TIM, by measuring its underlying dimensions through a series of observed indicator variables. These indicator variables constituted the measurement items included in the questionnaire, while a separate section captured the demographic characteristics of the respondents. The latent construct and its associated indicator variables were specified based on the

conceptual framework and extant literature. Table 1 provides a comprehensive overview of the latent construct and its corresponding measurement indicators used in this study.

Table 1. Conceptual framework indicator variables.

Main Variables	Variables
Technology and Innovation Management-related attributes (TIM)	
	Collaboration among the production team
	Technology integration
	Technology management
	Vision for technological use
	Strong management leadership
	Organizational structure efficiency
	Organizational leadership efficiency
	Planning for the technologically based Process
	Planning for production innovation
	Increase production team participation
	Collaboration amongst employees
	Learning abilities
	Timely and accurate feedback
	Production feedback
	Culture change
	Technology assessment
	Knowledge management
	Technology access
	Technical support
	Virtual progress meetings
	Virtual progress reporting
	Record keeping
	Production time improvement

3.1.2. Data Collection

The questionnaire (Appendix A) was administered in person to respondents from the indigenous manufacturing SMEs included in the study sample by the researcher and trained fieldworkers. The use of self-administered, face-to-face structured questionnaires is widely recognized as an effective data collection method, as it generally yields high response rates [35]. Although respondents were sufficiently literate to complete the questionnaire independently, the researcher and fieldworkers provided clarification whenever required to ensure accurate interpretation of the questions. On average, each questionnaire required approximately 15–20 min to complete. Upon completion of the data collection process, a total of 354 completed questionnaires were obtained and subsequently submitted to the Statistics Department at the University of Johannesburg for data capturing and preparation for statistical analysis.

3.1.3. Data Analysis from the Questionnaire Survey

Data analysis comprised the coding of responses, data cleaning and screening, and the selection of appropriate statistical techniques for analyzing the data. Questionnaire coding involved the identification, classification, and assignment of numerical codes to respondents' answers, using both pre-coding and post-coding procedures where appropriate [36]. Data cleaning and screening were undertaken concurrently with data collection to ensure completeness, accuracy, and consistency of the responses. In this study, the majority of the questionnaire items were pre-coded, while a limited number of open-ended responses required post-coding after data collection. Each response category was assigned a unique numerical code to facilitate statistical analysis. The coded data were subsequently captured in the Statistical Package for the Social Sciences Version 20.0 (SPSS) for preliminary analysis. The selection of the statistical techniques was guided by the research problem, research objectives, the nature of the data, and the assumptions underlying each analytical procedure [35]. Consistent with the objectives of the study, both descriptive and inferential statistical analyses were conducted, together with an assessment of the goodness-of-fit of the proposed framework where applicable. To enhance the validity, reliability, and interpretability of the findings, multiple analytical techniques were employed. The questionnaire data were initially processed using SPSS and subsequently exported to EQS Version 6.2, where Structural Equation Modelling (SEM) was performed to test and validate the proposed framework.

Inferential statistical analysis was employed to examine the relationships among the constructs of the proposed productivity management framework and to establish the hypothesized cause-and-effect relationships between the variables. Inferential statistics enable conclusions about a population to be drawn from sample data [37]. In this study, Confirmatory Factor Analysis (CFA), correlation analysis, and Structural Equation Modelling (SEM) constituted the principal inferential statistical techniques. SEM was utilized to develop, test, and validate the productivity management framework, while the statistical significance of the relationships among the latent constructs was evaluated using p-values [38]. As noted by [35], larger p-values indicate weaker evidence of an association between variables, whereas smaller p-values provide stronger evidence of statistically significant relationships. Accordingly, the level of statistical significance for this study was established at $p \leq 0.05$, corresponding to a 95% confidence level [35].

The proposed productivity management framework comprised several latent (unobserved) exogenous constructs that were measured indirectly through observable indicator variables. Within the SEM framework, a distinction is made between true score variance and measurement error variance, thereby allowing parameter estimates to account explicitly for measurement error. Before estimating the structural model, CFA was conducted for each exogenous construct to assess the adequacy of the measurement model and determine its goodness-of-fit before proceeding with the structural analysis [33].

The selection of EQS Version 6.2 as the primary SEM software was based on its capability to perform robust estimation procedures for non-normally distributed data. In particular, the software utilizes the Satorra–Bentler scaled chi-square statistic (S–Bχ^2), which provides a more robust and adjusted measure of model fit than the conventional chi-square statistic under conditions of multivariate non-normality [10,14]. Refs. [10,20,35,39] argue that this robust estimation procedure produces more accurate goodness-of-fit statistics than the traditional maximum likelihood chi-square test. Furthermore, EQS provides several estimation procedures suitable for non-normal data, including Robust Maximum Likelihood (RML), making it particularly appropriate for SEM applications involving behavioral and management research.

Furthermore, the selection of EQS Version 6.2 and SPSS Version 20.0 was justified by several practical and methodological considerations:

- EQS Version 6.2 provides a user-friendly graphical interface that facilitates model specification, estimation, and interpretation.
- The software offers a comprehensive range of goodness-of-fit indices for evaluating measurement and structural models [40].
- EQS enables the direct importation of data files from SPSS, thereby simplifying data management and analysis.

Both SPSS and EQS were readily accessible through the University's Postgraduate and Statistics Centre, ensuring efficient access to the software required for conducting statistical analyses.

4. Results

The raw data collected through the questionnaire were extracted, coded, and entered into SPSS for preliminary analysis. Descriptive statistical analysis and EFA were conducted using SPSS to summarize the data and examine the underlying factor structure of the measurement items. Subsequently, the questionnaire data relating to the proposed productivity management framework were exported to EQS Version 6.4 for SEM and model validation [19,39,41]. A total of 354 valid responses were included in the analysis. This sample size was considered adequate for SEM, as previous studies have shown that larger samples generally improve the stability and accuracy of parameter estimates and reduce model fit bias, whereas smaller samples may compromise the reliability and validity of model fit indices [42,43].

4.1. Technology and Innovation-Related Attributes

As presented in Table 2, the suitability of the TIM measurement items for EFA was evaluated using the Kaiser–Meyer–Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity. The KMO value of 0.871 exceeded the recommended minimum threshold of 0.60, indicating that the sample was adequate for factor analysis. Similarly, Bartlett's Test of Sphericity was statistically significant (p = 0.001), which is below the recommended significance level of 0.05 [10,19,36]. These findings confirm that the data satisfy the assumptions for factor analysis, as KMO values greater than 0.60 are generally considered indicative of adequate sampling adequacy and factorability [44,45].

Table 2. KMO and Bartlett's test of Technology and innovation-related attributes.

KMO and Bartlett's Test		
Kaiser–Meyer–Olkin Measure of Sampling Adequacy.		0.871
Bartlett's Test of Sphericity	Approx. Chi-Square	6962.073
	Df	253
	Sig.	0.001

Furthermore, the statistically significant result obtained from Bartlett's Test of Sphericity (p = 0.001 < 0.05) demonstrates that the correlation matrix differs significantly from an identity matrix, indicating the presence of sufficient intercorrelations among the TIM variables. This finding confirms the multivariate suitability of the data for factor analysis and supports the application of EFA to identify the underlying latent factor structure [10,19,32]. Consequently, the TIM measurement items were considered appropriate for factor extraction and subsequent construct validation.

Table 3 presents the extraction values for the TIM variables following factor extraction, with all values exceeding the recommended threshold of 0.10 [34,46]. The extraction values indicate that each TIM variable contributes meaningfully to the extracted factor structure and is therefore suitable for inclusion in the EFA. These results demonstrate that all measurement items exhibit adequate communalities and are appropriately represented within the extracted components, confirming their suitability for subsequent factor interpretation and construct validation [32].

Table 3. Communalities of Technology and Innovation-related Attributes.

Code	TIM Variables	Initial	Extraction
TIM 1	Collaboration among the production team	1.000	0.737
TIM 2	Technology integration	1.000	0.719
TIM 3	Technology management	1.000	0.573
TIM 4	Vision for technological use	1.000	0.732
TIM 5	Strong management leadership	1.000	0.781
TIM 6	Organizational structure efficiency	1.000	0.757
TIM 7	Organizational leadership efficiency	1.000	0.798
TIM 8	Planning for the technologically based process	1.000	0.805
TIM 9	Planning for production innovation	1.000	0.843
TIM 10	Increase production team participation	1.000	0.669
TIM 11	Collaboration amongst employees	1.000	0.793
TIM 12	Learning abilities	1.000	0.728
TIM 13	Timely and accurate feedback	1.000	0.787
TIM 14	Production feedback	1.000	0.706
TIM 15	Culture change	1.000	0.821
TIM 16	Technology assessment	1.000	0.798
TIM 17	Knowledge management	1.000	0.841
TIM 18	Technology access	1.000	0.811
TIM 19	Technical support	1.000	0.811
TIM 20	Virtual progress meetings	1.000	0.804
TIM 21	Virtual progress reporting	1.000	0.786
TIM 22	Record keeping	1.000	0.764
TIM 23	Production time improvement	1.000	0.801

Extraction Method: Principal Component Analysis.

Table 4 shows that the latent root or Kaiser's criterion retains factors with eigenvalues > 1.0 for the total variance explained for the technology and innovation-related attribute [39]. Five factors with eigenvalues > 1.0 were explored as 8.936, 3.301, 2.513, 1.652, and 1.265, which explain 38.856%, 14.350%, 10.927%, 7.183%, and 5.5046%, respectively. Therefore, the five factors represent a cumulative percentage of 75.665 variance, highlighting the significance of all twenty-three variables of the technology and innovation attribute measured.

Table 4. Total Variance Explained by Technology and Innovation-related Attributes.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
TIM 1	8.936	38.850	38.850	8.936	38.850	38.850	7.812
TIM 2	3.301	14.350	53.200	3.301	14.350	53.200	3.253
TIM 3	2.513	10.927	64.128	2.513	10.927	64.128	2.998
TIM 4	1.652	7.183	71.310	1.652	7.183	71.310	6.238
TIM 5	1.265	5.501	76.811	1.265	5.501	76.811	2.046
TIM 6	0.711	3.091	79.902				
TIM 7	0.698	3.033	82.935				
TIM 8	0.467	2.030	84.965				
TIM 9	0.430	1.868	86.833				
TIM 10	0.383	1.667	88.500				
TIM 11	0.325	1.415	89.915				
TIM 12	0.300	1.303	91.217				
TIM 13	0.283	1.232	92.450				
TIM 14	0.268	1.167	93.617				
TIM 15	0.240	1.042	94.659				
TIM 16	0.227	0.989	95.648				
TIM 17	0.205	0.893	96.541				
TIM 18	0.170	0.738	97.279				
TIM 19	0.159	0.691	97.970				
TIM 20	0.154	0.669	98.639				
TIM 21	0.148	0.645	99.284				
TIM 22	0.118	0.511	99.796				
TIM 23	0.047	0.204	100.000				

Extraction Method: Principal Component Analysis. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

As presented in Table 5, the pattern matrix for the twenty-three TIM variables highlights the number of factors clustered and the arrangement of variables into five factors. Table 6 shows that the EFA returned five factors, and the variables listed in each factor are interpreted based on their significance. Hence, a common name was given to each of the factors. Therefore, factor 1 is named "**organization knowledge management innovation**", factor 2 is named "**collaborative communication and feedback**", factor 3 is named "**technologically enabled production team collaboration**" factor 4 is named "**technology systems support**", and factor 5 is named "**employee collaborative technology learning support**".

Table 5. Pattern matrix for Technology and innovation-related attributes.

	Component				
	1	**2**	**3**	**4**	**5**
Planning for production innovation	0.866				
Organizational leadership efficiency	0.849				
Planning for the technologically based process	0.848				
Organizational structure efficiency	0.846				
Knowledge management	0.837				
Culture change	0.808				
Production time improvement	0.806				
Technology assessment	0.787				
Vision for technological use		0.830			
Strong management leadership		0.788			
Production feedback		0.710			
Timely and accurate feedback		0.689			
Technology management		0.658			
Technology integration			0.841		
Collaboration among the production team			0.837		
Increase production team participation			0.701		
Virtual progress reporting				0.878	
Record keeping				0.861	
Virtual progress meetings				0.832	
Technology access				0.759	
Technical support				0.755	
Collaboration amongst employees					0.891
Learning abilities					0.734

Extraction Method: Principal Component Analysis. Rotation Method: Oblimin with Kaiser Normalization. Rotation converged in 12 iterations.

Table 6. Factor Correlation Matrix of Technology and Innovation-related Attributes.

Component Correlation Matrix					
Factors	1	2	3	4	4
Organisation knowledge management innovation	1	0.162	0.120	0.498	0.152
Collaborative communication and feedback	0.162	1.000	0.158	0.040	0.136
Technologically enabled production team collaboration	0.120	0.158	1.000	0.200	0.131
Technology systems support	0.498	0.040	0.206	1.000	0.050
Employee collaborative technology learning support	0.152	0.136	0.131	0.050	1.000

Extraction Method: Principal Component Analysis. Rotation Method: Oblimin with Kaiser Normalization.

4.1.1. Factor One: Organization Knowledge Management Innovation

As illustrated in Table 5, eight variables were loaded into the first factor, including planning for production innovation (87%), organizational leadership efficiency (85%), planning for the technologically based process (85%), organizational structure efficiency (85%), knowledge management (84%), culture change (81%), production time improvement (81%), and technology assessment (79%). The variables in this factor clustered a cumulative 38.850% variance.

4.1.2. Factor Two: Collaborative Communication and Feedback

As illustrated in Table 5, five variables were loaded into the second factor, including a vision for technological use (83%), strong management leadership (79%), production feedback (71%), timely and accurate feedback (69%), and technology management (66%). The variables in this factor clustered a cumulative 14.350% variance.

4.1.3. Factor Three: Technologically Enabled Production Team Collaboration

As illustrated in Table 5, three variables were loaded into the third factor, including technology integration (84%), collaboration among the production team (84%), and increased production team participation (70%). The variables in this factor accounted for a cumulative 10.927% variance.

4.1.4. Factor Four: Technology Systems Support

As shown in Table 5, five variables were loaded into the fourth factor, including virtual progress reporting (88%), record keeping (86%) virtual progress meetings (83%), technology access (76%), and technical support (76%). The variables in this factor clustered to a cumulative 7.183% variance.

4.1.5. Factor Five: Employee Collaborative Technology Learning Support

Consequently, the two variables listed in the fifth factor are collaboration amongst employees (89%) and Learning abilities (73%). The variables in this factor accounted for a cumulative 5.501% variance.

However, Table 6 presents the component correlation matrix for the TIM variables, illustrating the relationships among the extracted factors. The correlation coefficients are approximately 0.300, indicating a moderate degree of association between the clustered factors, consistent with the recommendations of [32]. These results suggest that the extracted factors are related yet sufficiently distinct, thereby supporting the validity of the underlying factor structure and confirming the appropriateness of retaining the identified clusters for subsequent analysis.

4.2. Measurement Model, Technology and Innovation-Related Attribute (TIM) Construct

The discussion in this section presents the development and validation of a unidimensional measurement model for the TIM construct. A total of 354 valid responses were included in the analysis. The initial measurement model comprised 23 observed indicator variables representing the TIM construct. However, following the preliminary CFA, 16 indicator variables were removed because they did not satisfy the prescribed model fit and measurement criteria. According to [19,33], a well-fitting CFA model is characterized by a standardized residual covariance matrix in which values exceeding ± 2.58 are considered statistically significant, while the residuals should exhibit a symmetrical distribution centered around zero.

Consequently, the final measurement model retained seven (7) indicator variables, namely TIM6, TIM8, TIM9, TIM16, TIM17, TIM22, and TIM23, which demonstrated satisfactory residual covariance values and provided adequate evidence of convergent validity.

Examination of the Bentler–Weeks structural representation further indicated that the TIM measurement model comprised seven observed (dependent) variables, seven corresponding independent error terms, and 14 free parameters, while the number of fixed non-zero parameters was 12. These results confirm that the refined measurement model adequately represents the TIM construct and provides a satisfactory basis for subsequent structural model analysis.

The seven independent indicator variables for the TIM construct were organizational structure efficiency, organizational leadership efficiency, planning for the technologically based process, planning for production innovation, technology assessment, knowledge management, and production time improvement. The indicator variables included in the TIM construct are presented in Table 7. The measurement model illustrated in Figure 2 was evaluated independently before being incorporated into the full latent variable model. The assessment included an examination of the standardized and unstandardized residual covariance matrices, the distribution of standardized residuals, model fit indices, and the statistical significance of the parameter estimates at the 5% significance level. These analyses were undertaken to evaluate the adequacy of the model fit to the sample data and to assess the strength of the hypothesized relationships among the observed variables and the latent construct. In addition, the rho coefficient of internal consistency and Cronbach's alpha were calculated to evaluate the reliability of the measurement scale. The results of these reliability and model fit assessments are presented in the following section for the TIM measurement model.

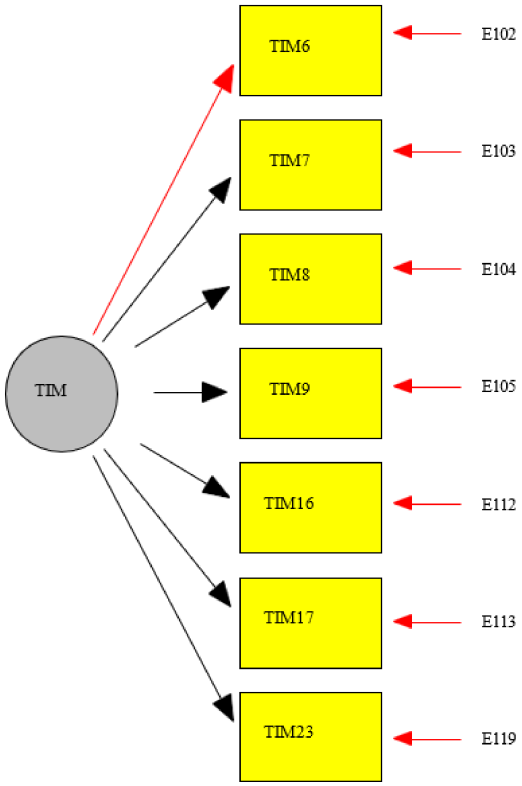

Figure 2. Measurement model of technology and innovation management-related attributes.

Table 7. Measurement model of technology and innovation management-related attributes.

Latent Construct	Indicator Variables	Label
Technology and innovation- related attributes (TIM)	Organizational structure efficiency	TIM6
	Organizational leadership efficiency	TIM7
	Planning for the technologically based process	TIM8
	Planning for production innovation	TIM9
	Technology assessment	TIM16
	Knowledge management	TIM17
	Production time improvement	TIM23

4.3. Diagnostic Fit Analysis: Analysis of Residual Covariance Estimate

Tables 8 and 9 present attributes of unstandardized and standardized absolute residual matrix values. The results indicate that both the average off-diagonal absolute residuals and the absolute residual values were close to zero, suggesting an adequate fit of the measurement model to the observed data. The unstandardized average off-diagonal residual was 0.0122, while the standardized average off-diagonal residual was 0.0163. These values indicate minimal discrepancies between the observed and reproduced covariance matrices. According to [39], a measurement model is considered to exhibit a good fit when the distribution of standardized residuals is approximately symmetrical and centred around zero, with residual values exceeding ±2.58 regarded as statistically significant. In the present study, all absolute residual values were below the recommended threshold of 2.58, indicating that the TIM measurement model provided an acceptable representation of the sample data. Consequently, the model can be regarded as demonstrating satisfactory goodness-of-fit and an adequate measurement structure [7,39].

Table 8. Residual covariance matrix for TIM model (unstandardized).

	TIM6	TIM7	TIM8	TIM9	TIM16	TIM17	TIM23
TIM6	0.000						
TIM7	0.062	0.000					
TIM8	−0.010	0.010	0.000				
TIM9	−0.003	−0.013	0.027	0.000			
TIM16	−0.0015	−0.024	−0.027	−0.022	0.000		
TIM17	−0.006	−0.012	−0.007	−0.003	0.041	0.000	
TIM23	−0.022	−0.000	−0.016	−0.012	0.015	−0.001	0.000

Table 9. Residual covariance matrix for TIM model (Standardized). Standardized Residual Covariance Matrix.

	TIM6	TIM7	TIM8	TIM9	TIM16	TIM17	TIM23
TIM6	0.943						
TIM7	0.727	1.028					
TIM8	0.747	0.807	1.059				
TIM9	0.773	0.835	0.858	1.065			
TIM16	0.755	0.815	0.838	0.867	1.114		
TIM17	0.756	0.816	0.839	0.868	0.848	1.030	
TIM23	0.694	0.750	0.771	0798	0.779	0.780	0.930

Average Absolute Standardized Residual = 0.0119; Average Off-Diagonal Absolute Standardized Residual = 0.0159; % falling between −0.1 + 0.1 = 100%.

A further examination of the frequency distribution of standardized residuals revealed that 99.99% of the residual values were distributed within the acceptable range of −0.1 to +0.1, indicating a close correspondence between the observed and model-implied covariance matrices. Only 0.01% of the residual values fell outside this range, suggesting minimal model misspecification. These findings provide further evidence that the TIM measurement model adequately represents the observed data and exhibits a satisfactory overall fit.

These findings indicate that the TIM measurement model demonstrated an acceptable fit to the sample data, with only minimal discrepancies between the hypothesized model and the empirical covariance structure. Consequently, the diagnostic assessment provided sufficient evidence to support the adequacy of the measurement model, thereby justifying the application of additional goodness-of-fit tests to evaluate and confirm its overall suitability and measurement validity comprehensively.

5. Discussion

The CFA results demonstrate that the TIM construct provides a reliable and valid representation of technology and innovation-related attributes within manufacturing SMEs. The final measurement model retained seven indicator variables: organizational structure efficiency, organizational leadership efficiency, planning for technologically based processes, planning for production innovation, technology assessment, knowledge management, and production time improvement. These indicators collectively capture the multidimensional nature of technology and innovation management and confirm that the construct adequately reflects the organizational capabilities required to improve manufacturing performance. The diagnostic fit analysis further supports the adequacy of the measurement model. Both the unstandardized and standardized residual covariance matrices produced average off-diagonal residual values that were close to zero, indicating a close correspondence between the observed and model-implied covariance matrices. Moreover, all standardized residuals were substantially below the recommended threshold of ±2.58, confirming the absence of significant model misfit. In addition, 100% of the residuals were distributed within the acceptable range of −0.1 to +0.1, providing further evidence of minimal discrepancies between the hypothesised measurement model and the observed sample data, and supporting the overall adequacy of the model fit. These findings suggest that the retained indicators sufficiently explain the latent construct and provide strong evidence of construct validity and measurement reliability.

From a TIM perspective, the retained indicators represent critical organizational capabilities that enable manufacturing SMEs to respond effectively to technological change and competitive market environments. Efficient organizational structures and effective leadership facilitate strategic decision-making, resource allocation, and organizational adaptability, which are fundamental requirements for successful innovation implementation. Similarly, planning for technology-based processes and production innovation reflects the strategic alignment of technological investments with operational objectives, thereby improving manufacturing efficiency and organizational competitiveness.

The inclusion of production time improvement as a significant indicator highlights the close relationship between technology and operational performance. Improvements in production lead time are commonly associated with enhanced process efficiency, reduced waste, improved resource utilization, and greater responsiveness to customer demand. These operational improvements contribute directly to higher organizational productivity by reducing production costs and increasing output without proportionate increases in resource consumption.

From a sustainability perspective, the validated TIM construct demonstrates that technology and innovation management contributes to the economic, operational, and environmental sustainability of manufacturing SMEs. Strategic adoption of technology enables firms to optimize production processes, minimize material waste, reduce energy consumption, and improve overall resource efficiency. These outcomes support sustainable manufacturing practices by balancing productivity improvements with responsible resource utilization. Furthermore, effective leadership, organizational learning, and innovation planning strengthen the long-term adaptability of SMEs, enabling them to remain competitive in rapidly changing technological and market environments. It also supports the argument that sustainable productivity improvements are achieved through the integration of technological capabilities, organizational leadership, strategic planning, and continuous knowledge development rather than through isolated technological investments.

6. Limitations and Future Research

This study makes a significant contribution to the understanding of productivity management in manufacturing SMEs; however, several limitations should be acknowledged. First, the study was limited to manufacturing SMEs in South Africa, which may restrict the generalisability of the findings to other sectors and developing economies. Future studies should replicate the proposed framework in different industries and countries to enhance its external validity.

Second, the study employed a cross-sectional research design and Structural Equation Modelling (SEM) to examine the hypothesised relationships. Although SEM provides robust model estimation, the findings do not establish causality over time. Future research should consider longitudinal designs to examine changes in productivity management practices and their long-term effects.

Third, the proposed framework was validated using a predefined set of constructs. Future research could incorporate additional organisational, technological, environmental, and contextual variables to improve the explanatory power of the framework. Comparative analyses of alternative measurement and structural models are also recommended.

Finally, the study relied on self-reported data collected through a single questionnaire, which may have introduced common method bias despite satisfactory reliability and validity results. Future studies should utilise mixed-method approaches and multiple data sources to further strengthen the robustness and credibility of the findings.

7. Conclusions

The study reviews the relevance of Technology and innovation management in productivity management. Technology and innovation management directly impact each employee; this has a way of creating unique objectives, with some experimental means of overcoming failures during the process. An employee can learn simpler ways of doing things through technological solutions. The intended results are achievable after persistent trials and mistakes, which make the inventor learn the most appropriate ways of nurturing the elements to achieve desirable and greater objectives. The seven independent indicator variables for the Technology and innovation management constructs were organizational structure efficiency, organizational leadership efficiency, planning for the technologically based process, planning for production innovation, technology assessment, knowledge management, and production time improvement.

The relationship between technology and innovation management-related attributes and productivity management is significant. The overall findings suggest that the influence of technology and innovation management-related attributes in determining overall pro-

ductivity management is direct and statistically significant. This agrees with the assertion by [47], that technology and innovation management gain control over technology and its associated social norms to align one's use of technology with one's values and goals. The result is also consistent with [11,47] that technology and innovation management involve getting people and technologies working together to do what people are expecting and collecting systematic methods for managing the process of applying knowledge. Furthermore, the findings concur with [11,12] that through constant monitoring and evaluation of technology and innovation management, manufacturing SMEs improve their performance and productivity management. This study's result is also in line with findings reported by [9,14] that a positive relationship between technology and innovation management influences manufacturing SMEs' success, survival, growth, and performance. Moreover, the results of this study indicate that technology and innovation management-related attributes are defined by seven variables, namely organizational structure efficiency, organizational leadership efficiency, planning for the technologically based process, planning for production innovation management, technology assessment, knowledge management, and production time improvement.

The significance of technology assessment and knowledge management further demonstrates that sustainable innovation depends not only on the acquisition of new technologies but also on an organization's ability to evaluate technological opportunities and effectively create, share, and utilize knowledge. Manufacturing SMEs often operate under financial and resource constraints; therefore, systematic technology assessment enables firms to prioritize investments that generate the greatest operational and strategic benefits while minimizing implementation risks. Effective knowledge management supports organizational learning, continuous improvement, and innovation capability, which are recognized as essential drivers of long-term competitiveness and organizational resilience.

Overall, the empirical evidence confirms that the TIM measurement model exhibits satisfactory psychometric properties and provides a theoretically meaningful representation of TIM. The validated construct establishes a strong foundation for examining the structural relationships between TIM, productivity management, and organizational performance in manufacturing SMEs.

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Data Availability Statement: No new data was created.

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Abbreviations

TIM	Technology and Innovation Management
SMEs	Small and Medium-sized enterprises
IMD	Institute of Management Development
GDP	Gross Domestic Products
R&D	Research & Development
IT	Information Technology
DIFI	Domain of Individual Field Interaction
SLR	Systematic Literature Review
SPSS	Statistical Package for the Social Sciences
SEM	Structural Equation Modelling
CFA	Confirmatory Factor Analysis
KMO	Kaiser–Meyer–Olkin

Appendix A

Questionnaire of Technology and Innovation Management Attributes (TIM):

It is the process of getting people and technologies working together through the collection of systematic data for managing the process of applying knowledge to extend the production process and operational activities.

The following statements relate to Technology and Innovation Management (TIM) attributes that may influence productivity management in South African manufacturing SMEs. Based on your knowledge and experience, please indicate the extent to which each attribute has been implemented within productivity management practices in South African manufacturing SMEs. Responses should be recorded using the following five-point Likert scale: 1 = No extent; 2 = Small extent; 3 = Moderate extent; 4 = Large extent; 5 = Very large extent.

Table A1. Questionnaire of Technology and Innovation Management Attributes.

Code	Technology and Innovation Management- Related Attributes (TIM)	Extent of Implementation				
		No Extent	**Small Extent**	**Moderate Extent**	**Large Extent**	**Very Large Extent**
	Involvement					
TIM 1	Collaboration among the production team	1	2	3	4	5
TIM 2	Technology integration	1	2	3	4	5
TIM 3	Technology management	1	2	3	4	5
TIM 4	Vision for technological use	1	2	3	4	5
TIM 5	Strong management leadership	1	2	3	4	5
TIM 6	Organizational structure efficiency	1	2	3	4	5
TIM 7	Organizational leadership efficiency	1	2	3	4	5
TIM 8	Planning for the technologically based process	1	2	3	4	5
TIM 9	Planning for production innovation	1	2	3	4	5

Table A1. *Cont.*

Code	Technology and Innovation Management- Related Attributes (TIM)	Extent of Implementation				
		No Extent	Small Extent	Moderate Extent	Large Extent	Very Large Extent
	Users					
TIM 10	Increase production team participation	1	2	3	4	5
TIM 11	Collaboration amongst employees	1	2	3	4	5
TIM 12	Learning abilities	1	2	3	4	5
TIM 13	Timely and accurate feedback	1	2	3	4	5
TIM 14	Production feedback	1	2	3	4	5
	Operations					
TIM 15	Culture change	1	2	3	4	5
TIM 16	Technology assessment	1	2	3	4	5
TIM 17	Knowledge management	1	2	3	4	5
	Tools					
TIM 18	Technology access	1	2	3	4	5
TIM 19	Technical support	1	2	3	4	5
TIM 20	Virtual progress meetings	1	2	3	4	5
TIM 21	Virtual progress reporting	1	2	3	4	5
TIM 22	Record keeping	1	2	3	4	5
TIM 23	Production time improvement	1	2	3	4	5

References

1. Thomas, M.; Boysana, M.; Charles, M. These are first names. In *Productivity Improvement in Manufacturing SMEs*; Taylor & Francis: London, UK, 2017; pp. 14–85. [CrossRef]
2. IMD World Competitiveness. IMD World Competitiveness, 2024. Available online: https://www.imd.org/centers/wcc/world-competitiveness-center/rankings/world-competitiveness-ranking/ (accessed on 23 March 2026).
3. Statssa. SA Economy Grows in the Second Quarter, 30 June 2024. Available online: https://www.statssa.gov.za/?p=17622 (accessed on 15 October 2024).
4. Gelb, A.; Meyer, C.J.; Ramachandran, V. *Development as Diffusion: Manufacturing Productivity and Sub-Saharan Africa's Missing Middle*; United Nations University, World Institute for Development Economics Research: Helsinki, Finland, 2014.
5. Abor, J.; Biekpe, N. How do we explain the capital structure of SMEs in sub-Saharan Africa. Evidence from Ghana. *J. Econ. Stud.* **2006**, *36*, 83–97.
6. Yemane, A.; Gebremicheal, G.; Meraha, T.; Hailemicheal, M. Productivity improvement through line balancing by using simulation modeling (case study almeda garment factory). *J. Optim. Ind. Eng.* **2020**, *13*, 153–165.
7. Somiah, M.K. An Integrated Competitive Advantage Model for Indigenous Construction Firms in the Ghanaian Construction Industry. Doctoral Dissertation, University of Johannesburg, Johannesburg, South Africa, 2018. Available online: https://www.proquest.com/docview/2572697785?pq-origsite=gscholar&fromopenview=true (accessed on 2 September 2022).
8. Aminullah, M. Human Interaction with Creators and Fellow Creatures (Study of Communication Relations of XYZ in Alamin Theory). *Bp. Int. RE-Search Crit. Inst. (BIRCI-J.) Humanit. Soc. Sci.* **2019**, *2*, 85–98. [CrossRef]
9. Christensen, J.F. Corporate strategy and the management of innovation and technology. *Ind. Corp. Change* **2002**, *11*, 263–288. [CrossRef]
10. Luggen, M. *Technology and Innovation Management in New Technology-Based Firms Introducing the PockeTM Concept*; Verlag Industrielle Organisation: Zürich, Switzerland, 2004; Volume 15400, p. 194.
11. Adams, R.; Bessant, J.; Phelps, R. Innovation management measurement: A review. *Int. J. Manag. Rev.* **2006**, *8*, 21–47. [CrossRef]
12. Ortt, J.R.; Van Der Duin, P.A. The evolution of innovation management to-wards contextual innovation. *Eur. J. Innov. Manag.* **2008**, *11*, 522–538. [CrossRef]

13. Vittorio, R.; Rajuddin, W.O.N.; Dewi, N.L.Y. Enhancing Performance and Productivity Through Innovation in Business Management. *Implikasi J. Manaj. Sumber Daya Mns.* **2024**, *2*, 11–18. [CrossRef]
14. Kline, R. *Principles and Practice of Structural Equation Modeling*, 2nd ed.; Guilford Press: New York, NY, USA, 2005.
15. Esposti, R. Knowledge, technology and innovations for a bio-based economy: Lessons from the past, challenges for the future. *Bio-Based Appl. Econ.* **2012**, *1*, 235–268. [CrossRef]
16. Eriksson, H. *Benefits from TQM for Organisational Performance*; Lulea University of Technology: Lulea, Sweden, 2002.
17. Costello, T.; Prohaska, B. 2013 trends and strategies. *IT Prof.* **2013**, *15*, 64. [CrossRef]
18. Musara, M.; Fatoki, O. Has technological innovations resulted in increased efficiency and cost savings for banks' customers? *Afr. J. Bus. Manag.* **2010**, *4*, 1813–1821.
19. Ogunbayo, B.F.; Aigbavboa, C.; Thwala, W. *A Maintenance Management Framework for Municipal Buildings in Developing Economies*; Routledge: London, UK, 2023.
20. Fishman, B.; Marx, R.W.; Blumenfeld, P.; Krajcik, J.; Soloway, E. Creating a framework for research on systemic technology innovations. *J. Learn. Sci.* **2004**, *13*, 43–76. [CrossRef] [PubMed]
21. Chowdhury, R.H. The evolution of business operations: Unleashing the potential of Artificial Intelligence, Machine Learning, and Blockchain. *World J. Adv. Res. Rev.* **2024**, *22*, 2135–2147. [CrossRef]
22. Hera, A.; Al Rian, A.; Faruque, M.O.; Sizan, M.M.H.; Khan, N.A.; Rahaman, M.A.; Ali, M.J. Leveraging information systems for strategic management: Enhancing decision-making and organizational performance. *Am. J. Ind. Bus. Manag.* **2024**, *14*, 1045–1061.
23. Turulja, L.; Bajgoric, N. Information technology, knowledge management and human resource management: Investigating mutual interactions towards better organizational performance. *VINE J. Inf. Knowl. Manag. Syst.* **2018**, *48*, 255–276.
24. Abyad, A. The innovator's dilemma. *Middle East J. Bus.* **2019**, *12*, 10–14. [CrossRef]
25. Haryadi, R.N.; Sunarsi, D.; Erlangga, H.; Nurjaya, N.; Hamsinah, H. Pengaruh Komunikasi dan Motivasi Terhadap Kepuasan Kerja Karyawan PT Timur Jaya Prestasi Cileungsi. *JENIUS (J. Ilm. Manaj. Sumber Daya Mns.)* **2022**, *5*, 702–709.
26. Krippner, S.; Laszlo, A. Systems Theories: Their Origins, Foundations, and Development. In *Systems Theories and A Priori Aspects of Perception*; Elsevier: Amsterdam, The Netherlands, 1998.
27. Malhotra, N.K. *Marketing Research: An Applied Orientation*, 3rd ed.; Prentice Hall: Hoboken, NJ, USA, 1999.
28. Hopp, C.; Antons, D.; Kaminski, J.; Oliver Salge, T. Disruptive innovation: Conceptual foundations, empirical evidence, and research opportunities in the digital age. *J. Prod. Innov. Manag.* **2018**, *35*, 446–457. [CrossRef]
29. Eggers, J.P.; Park, K.F. Incumbent adaptation to technological change: The past, present, and future of research on heterogeneous incumbent response. *Acad. Manag. Ann.* **2018**, *12*, 357–389. [CrossRef]
30. Johnson, P.C.; Laurell, C.; Ots, M.; Sandström, C. Digital innovation and the effects of artificial intelligence on firms' research and development– Automation or augmentation, exploration or exploitation? *Technol. Forecast. Soc. Change* **2022**, *179*, 121636. [CrossRef]
31. Çallı, B.A.; Çallı, L. Relationships between digital maturity, organizational agility, and firm performance: An empirical investigation on SMEs. *Bus. Manag. Stud. Int. J.* **2021**, *9*, 486–502. [CrossRef]
32. Pallant, C. *Demystifying Disney: A History of Disney Feature Animation*; Bloomsbury Publishing: New York, NY, USA, 2011.
33. Aigbavboa, C. An Integrated Beneficiary-Centred Satisfaction Model for Publicly Funded Housing Schemes in South Africa. Ph.D. Thesis, University of Johannesburg, Johannesburg, South Africa, 2013.
34. Brace, I. *Questionnaire Design: How to Plan, Structure and Write Survey Material for Effective Market Research*; Kogan Page Publishers: New York, NY, USA, 2008.
35. Mathers, N.; Fox, N.; Hunn, A. *Surveys and Questionnaires*; The NIHR RDS for the East Midlands/Yorkshire & the Humber: Sheffield, UK, 2007.
36. Pinsonneault, A.; Kraemer, K.L. Survey research methodology in management information systems: An assessment. *J. Manag. Inf. Syst.* **1993**, *10*, 75–105. [CrossRef]
37. Forzano, G. *Research Methods for the Behavioural Sciences*; Cen-gage Learning EMEA: Boston, MA, USA, 2008.
38. Farinha, L.; Ferreira, J.; Gouveia, B. Networks of innovation and competitive-ness: A triple helix case study. *J. Knowl. Econ.* **2016**, *7*, 259–275. [CrossRef]
39. Agumba, J.N. A Construction Health and Safety Performance Improvement Model for South African Small and Medium Enterprises. Ph.D. Thesis, University of Johannesburg, Johannesburg, South Africa, 2013.
40. Tong, D. *An Empirical Study of E-Recruitment Technology Adoption in Malaysia: Assessment of Modified Technology Acceptance Model*; Multimedia University: Melaka, Malaysia, 2007.
41. Mo, J.; Qiu, L.D.; Zhang, H.; Dong, X. What you import matters for productivity growth: Experience from Chinese manufacturing firms. *J. Dev. Econ.* **2021**, *152*, 102677. [CrossRef]
42. Nor-Aishah, H.; Ahmad, N.H.; Thurasamy, R. Entrepreneurial leadership and sustainable performance of manufacturing SMEs in Malaysia: 2020. The contingent role of entrepreneurial bricolage. *Sustainability* **2020**, *12*, 3100. [CrossRef]

43. Musonda, I. Construction Health and Safety (H&S) Performance Improvement—A Client Centered Model. Doctoral Dissertation, University of Johannesburg, Johannesburg, South Africa, 2012. Available online: https://ujcontent.uj.ac.za/esploro/outputs/doctoral/Construction-health-and-safety-HS-performance/9913634407691.2012 (accessed on 17 May 2025).
44. Norusis, M.J. *SPSS for Windows: Base System User's Guide*, Release 5.0; SPSS Incorporated: Chicago, IL, USA, 1992.
45. Eiselen, R.; Uys, T.; Potgieter, T. *Analysing Survey Data Using SPSS13*; University of Johannesburg: Johannesburg, South Africa, 2007.
46. Rehbinder, E. *Do Personal Networks Affect the Success of Foreign Venture Performance?—An Empirical Analysis of Nordic Firms in Poland*; Copenhagen Business School: Frederiksberg, Denmark, 2011.
47. Tammelin, M.; Alakärppä, O. Technology management, networking positions, and work/life boundaries among working adult students. *Technol. Soc.* **2021**, *65*, 101569. [CrossRef]

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