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Article

Managerial skills, technology adaptation and firm performance: Mediating role of process innovation and product innovation

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OPERATIONS MANAGEMENT | RESEARCH ARTICLE

Managerial skills, technology adaptation and firm performance: Mediating role of process innovation and product innovation

Nabila Asghar¹, Amira Khattak², Muhammad Hassan Danish³, Ijaz Hussain Bokhari^{3*} and Muhammad Waris⁴

Abstract: The main aim of every organization is to improve performance and productivity, but this is only possible with efficient management techniques and technology that produces results. Thus, the main aim of this study is to analyze the effect of managerial skills and technology adaptation on firm performance and productivity through the mediation channel of process innovation and product innovation using the PLS-SEM technique. The data for this study is collected from 150 managers of manufacturing industrial firms located in Lahore, the second largest city in Pakistan. The present used the purposive sampling technique to achieve the research objectives. The study's empirical findings reveal that managerial skills and technology adaptation are positively and significantly related to process and product innovation. Indirect and total effects show that managers' skills, technology adaptation, process innovation, and product innovation are positively and significantly related to the productivity and performance of firms. The present research is focused on the implementation of new technology and innovation.

Subjects: Development Studies; Production, Operations & Information Management; Primary Industries; Manufacturing Industries;

Keywords: managerial skills; technology adaptation; process innovation; product innovation; performance; productivity

JEL classification: J24; L25; O31; Q55



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1. Introduction

Managerial ability affects knowledge acquisition and innovation, leading to improved firm performance and productivity (Duan et al., 2022; Neamah et al., 2022; Kasongo et al., 2023). The underlying objective of every business is to improve the effectiveness and outcomes of the organization; however, prior literature signifies the role of competent leadership, effective management, and productive staff. Prior literature indicates the role of managerial skills and competencies in addressing organizational concerns about performance and productivity (Murphy, 2020). In recent years, management systems have significantly changed to focus on performance and productivity, which are also influenced by managerial skills (Gleeson & Husbands, 2011). Managerial skills and technology adoption are significantly linked and can provide positive outcomes (Cockburn et al., 2018; Walker et al., 2011). However, unlike studies of corporate organizations focusing on product innovations to improve performance, the focus in public organizations is on service innovations. Process or product innovation minimizes manufacturing time and costs, increases product quality, and better fulfills consumer demands (Gunday et al., 2011; Najafi-Tavani et al., 2018). Innovations are crucial to the creation of products and the quick delivery of goods and services. Practical managerial skills are necessary to foster product development or process innovation within a firm as they anticipate consumer needs and develop new ideas for the sustainability of an organization.

SMEs in Pakistan follow traditional practices and techniques, particularly in the manufacturing industry, resulting in losing the competitive positive in a current competitive environment. Prior literature reports that SMEs from the manufacturing sector fail to access external knowledge, innovative technology adoption, lack of intellectual resources, adoption of appropriate strategies, and managerial skills. In addition, recent literature claims that managerial skills and competencies are significantly linked with adopting innovative technology, access to external knowledge, and technology transformations. Adopting new technologies is an efficient method for businesses to boost productivity and performance. Management and managers are crucial in ensuring that technology adaptation benefits the business and boosts performance (Pfano & Beharry, 2016). A manager with the finest management abilities is vital in planning technological adaptation and the step toward corporate success.

Effective management of all aspects (for example, strategy formulation, decision-making, leadership, change management, and stakeholders' relationships) influences the firm activities that drive growth and sustainability. Managerial skills refer to the abilities and competencies that managers possess and utilize to achieve organizational success (Asamoah et al., 2021). Using efficient managerial skills can lead firms to develop and attain their goals and objectives. Various factors influence managerial performance, such as the working environment, training, job stress, job satisfaction, motivations, leadership style, organizational culture, and employee personality traits. The management competencies model always progresses and validates managerial abilities while boosting organizational skills toward achieving an organization's objectives and goals (Isfahani et al., 2015). To meet organizational objectives and goals, managers devise effective strategies utilizing technical and strategic capabilities to organize organizational resources, oversee procedures, guide their employees, and plan for change or implement it (Asamoah et al., 2021; Hoffman & Shipper, 2012). Technologies are critical in helping organizations achieve their goals and objectives while spending minimal time and money. Using technology, employees produce more work with less effort. Technology development influences organizational productivity and efficiency through changes in techniques and policies (Bustinza et al., 2019; Hempel & Martinsons, 2009). Most organizational experiments are produced by rivalry, technological progress, alluring employee performance, sharper growth, and new, competent leadership and management (Cockburn et al., 2018; Madsen et al., 2005).

Past studies have observed a significant effect of managerial skills and technical advancements on business productivity, efficiency, and performance (Ahmad & Ahmad, 2021). Previous studies have either analyzed the impact of managerial skills and role on product and process innovation (Begum et al., 2022; Simamora, 2021) or the impact of technology on productivity (Hempel & Martinsons, 2009; Pfano & Beharry, 2016) or the impact of product innovation on productivity and performance (Domnich, 2022; Siepel et al., 2021). The current study differs from earlier ones: first, it will assess how managerial skills and technology adaptation affect product innovation and process innovation in enhancing the productivity and performance of firms, and second, it will examine the direct and indirect impacts of managerial skills and technological advancement on a firm's performance and productivity. Moreover, the present study also contributed to the literature in Pakistan, where innovation is minimal due to low growth at the micro and macro levels. This research will also provide some policy recommendations for improving management and technical skills among employees, which aid in decision-making and innovation in the production process, lower production costs, and increase productivity. By boosting productivity and performance through technology adaptation, process improvement, and product development, innovations are crucial for the development of organizations and the success of businesses. The present study also pays close attention to management innovations and analyzes how they relate to organizational productivity and performance. Innovations create or adapt new technologies, concepts, things, and activities. Implementing an innovation involves its inception, adaptation, decision, and execution (Amabile, 1988; Cockburn et al., 2018). Innovations are implemented after being accepted and routinely used by users (workers, clients, and consumers). As a result, innovation requires adaptability and delivery of our contribution to organizational performance and productivity. The productivity and performance of a company can be improved via management innovations, technological advancements, and investment in R&D (Amornkitvikai et al., 2022; Shen et al., 2022). The rest of this study is organized as follows. A literature review regarding the relationship between managerial skills, technological advancement, and firms' performance is discussed in section 2. Data, methodology, and variables are described in section 3, while section 5 presents a detailed analysis of the structural model. Finally, in conclusion, recommendations are discussed in section 5.

2. Literature review

The relationship between managerial skills, technological advancement, and business productive performance has received more attention in recent years. Effective technology management (Ramanathan, 1990; Yu et al., 2018) is crucial in raising productivity and business expansion. According to Leo, the adoption of new technology and advancement in production techniques are what drives product development. As much as employee performance, team performance can be impacted by managerial skills and qualities (Singell, 1993; Swanson et al., 2020). Prior literature indicates a significant positive relationship between R&D and technological progress (Chow, 2004; Shen et al., 2022). Furthermore, the literature also documented the elements that influence the organization's productive performance and the effects of the factors on managerial skills, managerial roles, and technological advancement (Najafi-Tavani et al., 2018; Raheman et al., 2008). Beaudry and Francois (2010) reveals that developing managerial skills is critical for applying technological change and technology upgrading. Ghalandari (2012) shows that technical, cognitive, and human skills positively impact the company's productivity.

2.1. Managerial skills and productive performance

Managers with advanced managerial skills and approaches can inspire people, raising the organization's performance and output (Neamah et al., 2022; Singell, 1993). Vargas-Hernández and Vega (2017) investigated the significance of managerial and leadership skills in inspiring a team and an individual to complete their work effectively and efficiently, significantly impacting an organization's productivity. Lee et al. (2018) point out that managerial skills and expertise significantly impact organizational policies, such as the adoption of technology, quality of products, and efficiency of the work.

Siebers et al. (2008) findings reveal that management skills are significantly related to organizational productivity and performance. Managerial skills can affect an employee's capacity to increase production and obtain a competitive edge. Managerial skills improve a manager's capacity and capability, which inspires organizational teams to execute and produce more effectively. Superior managerial leadership skills impact employees by providing proper guidance and utilizing resources to meet corporate goals (Abbas & Yaqoob, 2009; Domnich, 2022). Effective leadership programs help individuals inside the firm gain the leadership traits they need to perform more effectively and professionally to increase productivity and the company's overall growth (Pirzada et al., 2013).

Beaudry and Francois (2010) found that increasing productivity and efficiently using resources depend more on managerial skills. Managerial skills must be acquired to implement technological change and technological upgrading successfully. The effects of skill development on employee productivity and overall organizational performance (Duan et al., 2022; Hameed & Waheed, 2011). Business needs to develop the knowledge and skills of their workforce to achieve organizational goals. Managerial skills, including technical, interpersonal, and cognitive skills, significantly and positively affect organizational productivity (Domnich, 2022; Ghalandari, 2012).

Hypothesis 1: Managerial Skills are positively related to firms' performance.

2.2. Managerial role and productive performance

Matemilola et al. (2013) investigated the effects of managerial role and leverage on shareholder returns. The study's findings demonstrated how leverage and managerial roles positively affect shareholder profits. Adebisi (2013) points out that having a good time management role helps businesses perform better and satisfy client demands on time while boosting creativity and productivity and saving time and money. Implementing managerial competencies and a managerial role will enhance, improve, and effectively promote organizational performance in an organizational context (Hawi et al., 2015). A managerial role is most advantageous for setting goals, managing resources, managing conflict, improving communications, performance measuring, decision-making, and increasing business profit (Sharif, 2002). The efficacy and productivity of a company are directly associated with the caliber of its managerial role (Adhvaryu, 2018). Managerial quality, employee productivity, business performance, and profitability can all be improved using managerial roles and training programs. Another study by Lee et al. (2018) found that solid managerial roles can increase productivity, boost a company's reputation, and provide investors with better investment opportunities.

Hypothesis 2: Managerial role is positively related to firms' performance.

2.3. Technology adoption and productive performance

Technology that helps a business achieve its goals and improves its personnel's individual and collective performance should be used. The human resource management department should polish employees' technological aptitudes and encourage them to adopt cutting-edge technologies (Murphy, 2020). According to Coelli (1996) and Kasongo, Sithole, and Buchana (2023), technological improvements make the manufacturing process smoother and more effective, reduce production costs, and shorten production times, raising total productivity. There is a stronger correlation between resource development and technological advancements (Chow, 2004; Jiakui et al., 2023). Technology positively affects the performance and productivity of the business (Shaukat & Zafarullah, 2009). Pirzada and Ahmed (2013) found that adopting new technologies has dramatically improved business performance. Donat (2007) examines how technology has affected small and medium-sized businesses. The study's findings show that technology has a minor impact on the relationship between business strategies and enterprise performance. The study's findings demonstrate that technology helps a business to operate well in terms of cost control.

Hypothesis 3: Technology Adoption is positively related to firms' performance.

2.4. Training and productive performance

Vargas-Hernández and Vega (2017) asserts that managers can benefit from successfully integrating new technology. The efficient use of modern technologies improves performance while cutting costs and production time. According to research by Al Karim (2019), training and development significantly affect organizational performance and productivity. Training and development are the most critical components for businesses because good training increases employee efficiency and effectiveness and helps organizations achieve their goals. Training is crucial for improving the industrial workforce's skills, aptitudes, and skills. Training helps employees become more capable managers, essential for enhancing labor individual productivity and organizational performance (Asghar et al., 2017).

Hypothesis 4: Training is positively related to firms' performance.

2.5. Product and process innovation

Simamora (2021) reveals that higher knowledge, skills, and information are provided by managerial aptitude to gain from risk-taking behavior and to reduce costs to boost industrial performance through process and production innovation. Siepel et al. (2021) find a positive association of STEM, management, and creative skills with the firms' performance and growth through product innovation. Amornkitvikai et al. (2022) use the manufacturing census data in Thailand and find that managerial skills and investment in R&D bring innovation and positively affect the productivity of medium- and large-scale firms. Shen et al. (2022) show that technology and management innovation positively and significantly enhance organizational performance (Neamah et al., 2022). Kasongo et al. (2023) analyzed the impact of investment in innovation on technological advancements and productivity. The results of their study reveal that investment in technology adoption brings product or process innovation, which significantly increases labor productivity.

In the modern era, Artificial intelligence and the adoption of new technology have become essential components of the firm's productivity. Czarnitzki et al. (2023) use the data of German firms and reveal that firms using AI technology are producing and selling 14% more than non-users of AI. Moreover, investment in software is also positively associated with the firm's productivity and performance. Ben Khalifa (2023) also finds that firms enhance their profitability by investing in research development and information and communication technology through product and process innovation. Moreover, technological innovation is also positively associated with green production of firms (Jiakui et al., 2023).

Hypothesis 5: Managerial skills, manager role, and technology adoption are positively related to product and process innovation.

Hypothesis 6: Product and process innovation positively affect firms' performance.

Following a review of the previous literature and past research, it has been observed that there is a considerable and positive relationship between management skills, technological advancement, and productive performance. This approach differs significantly from similar research in that it first employs management expertise and technological advancement. Secondly, this study is particularly significant since it may be Pakistan's first cross-sectional analysis to identify managerial ability and technological advancement as factors for examining productivity correlations through the mediating effects of process and product innovation.

2.6. Conceptual framework

Managerial skills play a vital role in an organizational context, including organizational culture, leadership, support, and teamwork. Employees are inspired and motivated by the influence of all these elements on management skill improvement to meet company goals and objectives. Management skills have a significant influence on both employee performance and corporate productivity. Leadership. Communication, inspiration, decision-making,

and problem-solving are among the talents that enhance managerial skills. Leadership has a significant impact on the innovative process within an organization. Every corporation needs innovations to accomplish its goals in a way that satisfies its customers. Practical managerial skills and organizational (process, product) innovations are the most critical factors for an organization’s growth. The conceptual framework of this study is further explained in Figure 1.

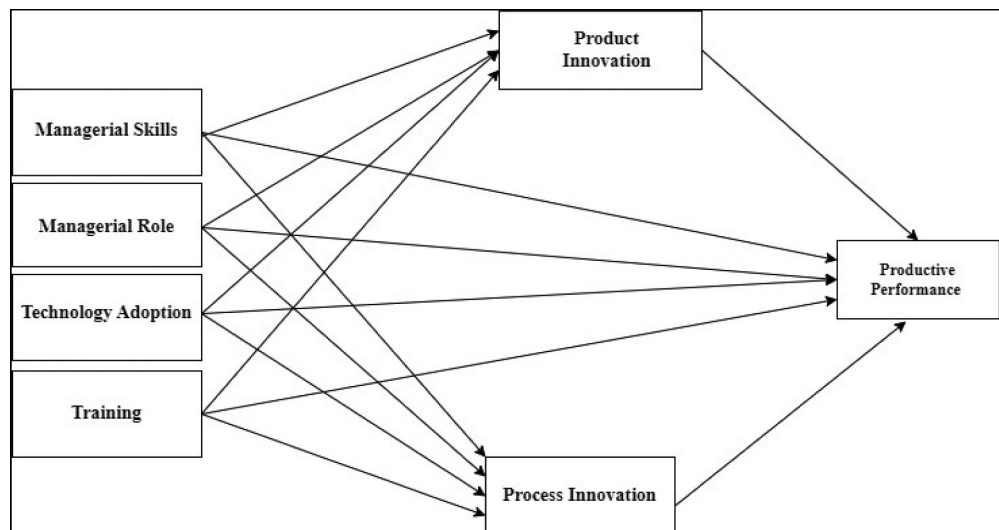
3. Data and research methodology

The present research is conducted through primary data by interviewing managers from Lahore, Pakistan’s manufacturing, trading, and service sectors. Lahore zone is one of the largest industrial areas and covers more than 600 SMEs and large-scale industries. Managers of manufacturing firms were communicated before data collection, and informed consent was obtained from all participants for our research. Out of which 300 managers of different industries were visited personally by the authors and the data collection team, 168 managers responded to our questionnaire. After data completion, the sample of 150 companies was selected for analysis, and redundant data was abolished in the final sample. A sample size of 150 is sufficient for an SEM analysis (Wolf et al., 2013). The present study uses SMART-PLS for the SEM analysis.

The survey is based on research by Smith (2008) titled “Evaluation of entrepreneurial abilities.” Questions for the current study have been crafted from earlier pertinent studies (Alegre & Chiva, 2008; Ghalandari, 2012; Suresh & Kodikal, 2015). After carefully reviewing the extensive literature from earlier studies, the questionnaire for the study was adapted from the existing literature per the research requirements. There are two sections to the questionnaire. Part “1” of the questionnaire asks for personal information about the manager, employees, and organization.

In contrast, part “2” of the questionnaire asks about management skills and roles and their responsibilities in an organization and questions concerning technology adoption, innovation, and business productivity. Both structured and open-ended questions are included in the questionnaire. For the analysis factors, including management skills, managerial role, technological adaptation, innovation, and company performance, a five-point Likert scale with values 1 to 5 is utilized. Additionally, the questionnaire asks about the manager’s or employee’s age, education, training, and experience.

Figure 1. Conceptual framework of study.



3.1. Measurement of variables

3.1.1. *Dependent variable: productivity and performance (PP.)*

Productivity and performance are examined with the help of the Likert scale by six items on the Likert scale (1 Strongly disagree to “5” = strongly agree). Research questions include whether firms’ productivity is improved with managerial skills, innovations, increased flexibility, and technology. Respondents of firm managers were asked to choose one option against each question from the given Likert scale.

3.1.2. *Process innovation (PI.)*

Any business sector can gain from innovation in terms of increased revenue. The organization’s ability to survive in the marketplace depends on innovation. The most fantastic strategy to reduce the production process cost and quickly deliver goods to customers is to innovate processes. Six questions on a Likert scale (1 Strongly disagree to “5” = strongly agree) are used to examine process innovation regarding production and delivery, changes in techniques, enhanced manufacturing process, decreased cost due to process innovation, competitiveness, and strategic focus on process innovation.

3.1.3. *Product innovation (PRI)*

Product innovation in any business area generates many financial advantages for that industry. The organization’s innovation ability is the key to its survival in the marketplace. The best method to reduce costs and improve product values and features to meet client demands is to innovate the products (Joseph et al., 1990). This research uses a five-point Likert scale to measure product innovation. Four factors—higher technical specifications, customer contentment, enabling better products and services to consumers, and encouragement to build new and superior products for customer satisfaction—are used to quantify product innovations.

3.1.4. *Technology adaptation (TA.)*

The organization’s performance and productivity increased dramatically because of technology adoption. For a company to survive and thrive, technological adaptation is essential. The Likert scale judges how well technology has been adapted (strongly disagree weighted as one and strongly agree weighted as 5). A total of 14 items are used to assess technology adaptations, including adapting new technology, robust analytical tools, cost reduction, training in new technology, control of product or service quality, significantly improved data collection, decision-making, quicker processes, operational efficiency, improvement in collaboration activities, and on-time delivery of goals. Organizations consider all these variables when assessing how technological advancements have affected productivity.

3.1.5. *Managerial skills (MS.)*

Any company’s greatest asset is skilled management. This study includes 14 skills to examine the effect of managing skills on productivity. The scale for managerial aptitude ranges from (1’ as strongly disagree to “5” as strongly agree). Managerial skills include “management interest to raise employee productivity, participating in the performance management process, consistency in a good performance, clear direction, understanding employee problems, treating employees with respect, sharing employee opinions with management, making decisions on the spot, adapting to technological changes, and training employees.”

3.1.6. *Managerial role (MR.)*

Managers have a crucial role in increasing organizational productivity. Managerial duties include “friendly organizational environment, communication with workers, taking responsibility, employee participation in decision making, and employee recognition.” The managerial role is also measured using a 5-point Likert scale (1’ as strongly disagree to “5” as strongly agree).

Table 1. Reliability and validity analysis

	Loadings	CA	CR	AVE
MR1	0.897	0.942	0.959	0.853
MR2	0.936			
MR3	0.929			
MR4	0.931			
MS1	0.709	0.958	0.963	0.649
MS2	0.698			
MS3	0.832			
MS4	0.863			
MS5	0.856			
MS6	0.831			
MS7	0.819			
MS8	0.832			
MS9	0.782			
MS10	0.767			
MS11	0.812			
MS12	0.779			
MS13	0.851			
MS14	0.825			
PI1	0.918	0.900	0.923	0.668
PI2	0.918			
PI3	0.926			
PI4	0.897			
PP1	0.636			
PP2	0.643	0.866	0.896	0.524
PP3	0.800			
PP4	0.783			
PP5	0.836			
PP6	0.795			
PP8	0.738			
PRI1	0.809	0.935	0.954	0.837
PRI2	0.864			
PRI3	0.845			
PRI4	0.757			
PRI5	0.744			
PRI6	0.875			
TA1	0.814	0.967	0.971	0.703
TA2	0.854			
TA3	0.793			
TA4	0.868			
TA5	0.856			
TA6	0.825			
TA7	0.835			
TA8	0.873			

(Continued)

	Loadings	CA	CR	AVE
TA9	0.885			
TA10	0.798			
TA11	0.828			
TA1	0.814			
TA12	0.902			
TA13	0.763			
TA14	0.836			

Source: Authors' calculations.

Table 2. Convergent Validity

		1	2	3	4	5	6	7
1	Managerial Role							
2	Managerial Skills	0.511						
3	Process Innovation	0.808	0.836					
4	Product Innovation	0.809	0.841	0.729				
5	Productive Performance	0.683	0.718	0.682	0.662			
6	Technology Adoption	0.621	0.640	0.592	0.591	0.759		
7	Training	0.024	0.054	0.078	0.015	0.135	0.107	

3.1.7. Training (train.)

Recent studies show a strong correlation between employee performance and training (Abbas, 2014; Imran et al., 2014; Tahir et al., 2014). The average number of training days over a year calculates employee training. Inside and outside training days are included in the training average days.

3.2. Reliability and validity analyses

Table 1 presents the reliability and validity analysis of all instruments and variables used in a Likert scale. The loadings values, Cronbach alpha, composite reliability, and average variance extracted meet the minimum threshold and ensure the items used to measure the latent constructs meet the reliability and validity criterion (Mehralian et al., 2020).

3.2.1. Convergent validity

Convergent validity is assessed using the HTMT technique. The strict criterion outlines a threshold value of 0.85 (Gold et al., 2001), while the lenient criterion outlines a threshold value of 0.90 (Kline, 2011). The findings of the present study latent constructs meet the convergent validity criterion (Table 2).

3.3. Methodology

This study examines how management skills and technological adaptation influence firm performance through the mediating factors process and product innovation. Therefore, to capture the direct and indirect effects of independent variables on mediating and dependent variables, the structural equation model (SEM) is used for testing hypotheses in Smart-PLS. Making parameter estimates accessible for the associations between unobserved variables is one of the distinctive characteristics of SEM. SEM ultimately produces a route analysis that offers parameter estimates for the direct and indirect relationships between observable variables.

Table 3. Direct association

	Coeff.	SD	T-Values	P-Values
Managerial role -> Productive Performance	0.034	0.087	0.391	0.696
Managerial Skills -> Productive Performance	0.189	0.086	2.203	0.028
Process Innovation -> Productive Performance	0.145	0.053	2.739	0.006
Product Innovation -> Productive Performance	0.141	0.067	2.119	0.034
Technology Adoption -> Productive Performance	0.450	0.054	8.404	0.000
Training -> Productive Performance	0.049	0.031	1.591	0.112

4. Results

4.1. Testing of hypotheses

A direct association among the latent constructs was reported in this section. The findings of direct association indicate that managerial skills ($\beta = 0.189$, $t = 2.203$, $p = 0.028$), process innovation ($\beta = 0.145$, $t = 2.739$, $p = 0.006$), product innovation ($\beta = 0.141$, $t = 2.119$, $p = 0.034$), and technology adoption ($\beta = 0.450$, $t = 8.404$, $p = 0.000$) are significantly and positively linked with productive performance of SMEs. The current study's findings align well with existing literature, affirming that the managerial role is a vital component influencing product and process innovation (Badir et al., 2020). The result of the direct relation is reported in Table 3.

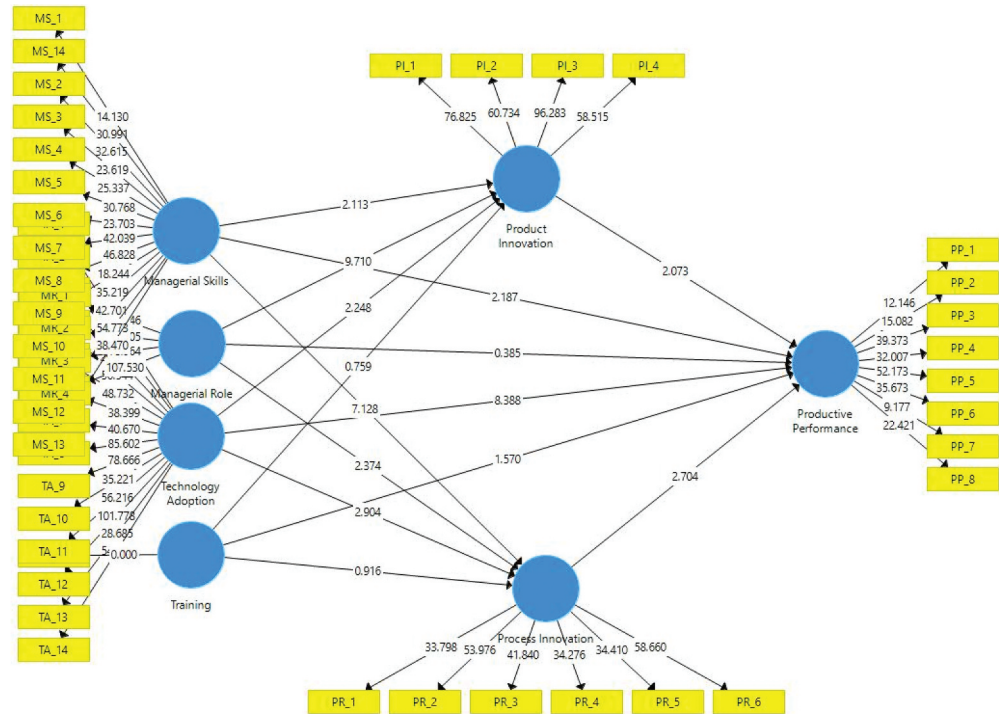
The results of indirect association indicate that managerial role ($\beta = 0.201$, $t = 2.412$, $p = 0.016$), managerial skills ($\beta = 0.545$, $t = 7.249$, $p = 0.000$), technology adoption ($\beta = 0.098$, $t = 2.870$, $p = 0.004$) significantly and positively linked with the process innovation. In contrast, training indicates a positive yet insignificant association at a 5 percent significance level. In addition to that, managerial role ($\beta = 0.648$, $t = 9.719$, $p = 0.000$), managerial skills ($\beta = 0.161$, $t = 2.096$, $p = 0.036$), technology adoption ($\beta = 0.084$, $t = 2.305$, $p = 0.021$) indicate a significant and positive link with product innovation. In contrast, training indicates a negative and insignificant association at a 5 percent significance level.

The results of the mediating relationship indicate that process innovation ($\beta = 0.029$, $t = 1.856$, $p = 0.063$) insignificantly and positively mediates the association between managerial role and productive performance. Moreover, process innovation significantly and positively mediates the relationship between managerial skills and productive performance ($\beta = 0.079$, $t = 2.519$, $p = 0.012$). While in the case of process, innovation fails to mediate the relationship between technology adoption, training, and productive performance ($\beta = 0.014$, $t = 1.791$, $p = 0.073$; $\beta = 0.004$, $t = 0.806$, $p = 0.420$).

Furthermore, product innovation significantly and positively mediates the association between managerial role and productive performance ($\beta = 0.092$, $t = 2.025$, $p = 0.043$). In addition, product innovation positively yet insignificantly mediates the association between managerial skills, technology adoption, and productive performance ($\beta = 0.023$, $t = 1.461$, $p = 0.144$; $\beta = 0.012$, $t = 1.536$, $p = 0.125$). However, product innovation negatively and insignificantly mediates the association between training and productive performance of SMEs at a 5 percent level of significance ($\beta = -0.003$, $t = 0.649$, $p = 0.516$).

Figure 2 shows the direct effects of independent variables on mediating and dependent variables. Results of the structural model show that technology adaptation and managerial skills

Figure 2. Structural model for the relationship between managerial skills, technology adaptation, and firm’s performance: mediating variable-product innovation.



are positive and significant. In addition to those, managerial skills are significantly related to product innovation, which is further significantly related to the performance of firms. While managerial role and training are not statistically significant with product innovation, it is positively related to PRI. Firms’ performance increases by a 0.5 standard deviation (SD) score by the product innovation and is statistically significant at a 1% level. These results are consistent with the previous study conducted by Wang et al. (2021), which reveals that product innovation indirectly affects the firm’s performance in China. Product innovation is critical for the organization’s growth since it is required for customer happiness and boosts efficiency (Vargas-Hernández & Vega, 2017).

Table 4. Indirect association

	Coeff.	SD	T-Values	P-Values
Managerial role -> Process Innovation	0.201	0.083	2.412	0.016
Managerial role -> Product Innovation	0.648	0.067	9.719	0.000
Managerial Skills -> Process Innovation	0.545	0.075	7.249	0.000
Managerial Skills -> Product Innovation	0.161	0.077	2.096	0.036
Technology adoption -> Process Innovation	0.098	0.034	2.870	0.004
Technology Adoption -> Product Innovation	0.084	0.036	2.305	0.021
Training -> Process Innovation	0.027	0.029	0.915	0.360
Training -> Product Innovation	-0.020	0.026	0.767	0.443

Table 4 presents the results of the indirect effects of the structural model on the relationship between managerial skills, technology adaptation, and productive performance, where the mediating variables are process and product innovation. Process innovation significantly and positively mediates the association between managerial roles, managerial skills, technology adoption, and productive performance, while in the case of training, it is positive yet insignificant. Table 5 represent the empirical findings affirm that product innovation significantly and positively mediates the association between managerial role and productive performance. Product innovation fails to mediate the association between managerial skills, technology adoption, and productive performance, while in the case of training, it is negative yet insignificant.

A summary of the above model is presented in Table 6, which shows that out of 22 hypotheses, 14 are supported while the remaining eight are not. Managerial skills and technology adoption are significantly and positively related to process and product innovation. Moreover, both mediators (PI and PRI) are significantly related to the productivity and performance of firms. This study confirms MS, PI, and PRI's significant role in productivity, which is essential for any firm's managerial decisions.

5. Discussion and conclusion

The underlying objective of businesses is to maximize productivity to maximize profitability and contribute significantly towards economic growth. Productivity is critical globally since the economy and policymakers demand it. Technological advances significantly impact the strategies and policies of all organizations and institutions. While competition is undoubtedly a source of business problems, these developments will also improve employee productivity and career development, which is impossible with managerial skills and roles. The present study is designed to analyze the impact of managerial skills and their role on form performance while using process and production innovations as mediators. Past studies have observed the role of managerial skills and technical advancements on productivity, efficiency, and performance or the role of product and process

Table 5. Total Effects				
	Coeff.	SD	T-Values	P-Values
Managerial role -> Process Innovation -> Productive Performance	0.029	0.016	1.856	0.063
Managerial role -> Product Innovation -> Productive Performance	0.092	0.045	2.025	0.043
Managerial Skills -> Process Innovation -> Productive Performance	0.079	0.031	2.519	0.012
Managerial Skills -> Product Innovation -> Productive Performance	0.023	0.016	1.461	0.144
Technology Adoption -> Process Innovation -> Productive Performance	0.014	0.008	1.791	0.073
Technology Adoption -> Product Innovation -> Productive Performance	0.012	0.008	1.536	0.125
Training -> Process Innovation -> Productive Performance	0.004	0.005	0.806	0.420
Training -> Product Innovation -> Productive Performance	-0.003	0.004	0.649	0.516

Source: Authors' calculations.

innovation on productivity and performance (Andre Cavalcante, 2013). However, the current study differs from earlier ones: first, it will assess how product and process innovation affects a firm's performance through mediation, and second, it will examine the direct and indirect impacts of managerial skills and technological advancement on a firm's performance and productivity. Moreover, the present study also contributes to the literature in Pakistan, where innovation is minimal due to low growth at the micro and macro levels.

The reliability of management skills is closely associated with the competitiveness and efficiency of the firm. Management role skills and training programs successfully enhance the efficiency of managers, the productivity of staff, company output, and profitability. Practices related to human resources are essential for improving organizational performance and growth. The organizational leader with strategic experience abilities, technical knowledge, and motivational skills will motivate workers toward an organizational vision, personally improve employee performance, and achieve the firm's goals. A manager is in charge of providing direction and guidance (Khan & Jalees, 2017; Khan et al., 2021). The study's results confirm that practical managerial skills are most important to enhance a company's performance. Organizations focus on delivering appropriate training to improve management skills. Research findings illustrate that managerial skills are most beneficial in achieving goals, managing resources, managing conflict, improving communication, and measuring performance decision-making (Olowu, 2015).

The current study aims to evaluate the role of managerial skills, technology adoption, and training toward productive performance with the mediating role of product and process innovation. The study comprises polling the managers of 150 manufacturing industrial firms in one of the major industrial cities, Lahore-Pakistan. The current study's findings reveal that industries' productivity and performance are significantly influenced by managerial skills, managerial role, technological adaptability, process innovation, and product innovation, both directly and indirectly. The empirical findings of PLS-SEM indicate the medium effect size of technology adoption toward productive performance. In addition to that, managerial skills and managerial roles also indicate a small size effect on product and process innovation.

The current study revealed that managerial skills significantly and positively contribute to product/process innovation and productive performance. In addition, the results indicate that managerial skills positively correlate with technology adoption, which leads to process and product innovation. The results of the current study well aligned with the existing literature, which affirms that managerial skills and competencies significantly and positively lead to higher productivity or performance (Neamah et al., 2022). The results of our study align with previous literature that managerial skills are necessary to guide employees to achieve organizational goals (Abbas & Yaqoob, 2009), which raises productivity (Domnich, 2022; Ghalandari, 2012). The findings conclude that strong managerial skills support setting goals, allocating resources, resolving conflicts, and increasing efficiency to boost process and product innovation, improving the manufacturing industry's productivity.

In addition, the current study's findings indicate that the managerial role is insignificantly yet positively linked with productive performance; however, it is significantly linked with product and process innovation. According to Simamora (2021), managerial aptitude provides more excellent knowledge, skills, and information that can be used to benefit from taking risks, cutting expenses, and improving industrial performance through process and production innovation. Previous studies indicate that time management is crucial for firms as it allows them to allocate resources efficiently and prioritize tasks effectively. This leads to improved workflow, reduced stress levels, and improved overall performance (Adebisi, 2013). Additionally, implementing managerial competencies and roles enhances organizational performance and fosters a culture of accountability and responsibility among employees (Hawi et al., 2015).

Table 6. Models summary

	Coeff.	SD	T-Values	P-Values	f-square
Managerial role -> Productive Performance	-0.03	0.09	0.39	0.70	
Managerial Skills -> Productive Performance	0.19	0.09	2.20	0.03	
Process Innovation -> Productive Performance	0.15	0.05	2.74	0.01	
Product Innovation -> Productive Performance	0.14	0.07	2.12	0.03	
Technology Adoption -> Productive Performance	0.45	0.05	8.40	0.00	0.301
Training -> Productive Performance	0.05	0.03	1.59	0.11	
Managerial role -> Process Innovation	0.20	0.08	2.41	0.02	
Managerial role -> Product Innovation	0.65	0.07	9.72	0.00	0.264
Managerial Skills -> Process Innovation	0.55	0.08	7.25	0.00	0.136
Managerial Skills -> Product Innovation	0.16	0.08	2.10	0.04	
Technology adoption -> Process Innovation	0.10	0.03	2.87	0.00	
Technology Adoption -> Product Innovation	0.08	0.04	2.31	0.02	
Training -> Process Innovation	0.03	0.03	0.92	0.36	
Training -> Product Innovation	-0.02	0.03	0.77	0.44	
Managerial role -> Process Innovation -> Productive Performance	0.03	0.02	1.86	0.06	
Managerial role -> Product Innovation -> Productive Performance	0.09	0.05	2.03	0.04	
Managerial Skills -> Product Innovation -> Productive Performance	0.02	0.02	1.46	0.14	
Managerial Skills -> Process Innovation -> Productive Performance	0.08	0.03	2.52	0.01	
Technology Adoption -> Process Innovation -> Productive Performance	0.01	0.01	1.79	0.07	
Technology Adoption -> Product Innovation -> Productive Performance	0.01	0.01	1.54	0.13	
Training -> Process Innovation -> Productive Performance	0.00	0.01	0.81	0.42	
Training -> Product Innovation -> Productive Performance	0.00	0.00	0.65	0.52	

Source: Authors' calculations.

In addition, product innovation significantly and positively mediates the relationship between managerial role and productive performance, while process innovation mediates at a 10 percent significance level. The current study's findings align well with the existing literature, which claims that the managerial role significantly and positively improves productive performance through product and process innovation (Adhvaryu, 2018; Hawi et al., 2015; Siepel et al., 2021).

The empirical findings of the current study indicate that technological adoption is significantly and positively linked with process and product innovation, which leads to higher productive performance. The findings of the present study well aligned with the existing literature, which affirms that technology adoption is vital for businesses to survive in highly competitive environments and to achieve the targeted productivity (Murphy, 2020, Kasongo et al., 2023; Shaukat & Zafarullah, 2009). Technology advances improve the efficiency and effectiveness of the manufacturing process, lower production costs, and speed up production times, increasing overall productivity (Kasongo et al., 2023). Therefore, managerial skills, role, and technological adoption are crucial factors in firms' performance, as this study also demonstrates with the support of prior research literature.

5.1. Recommendations

The present research focuses on implementing new technology and innovation in products. Therefore, firms may use these methods and abilities to accomplish their goals. Organizations may use various techniques to raise employee interest in achieving their objectives through rewards, incentives, and the implementation of recognition programs. Firms should provide in-depth training courses for staff members about technical advancements, product developments, and manufacturing process changes. Organizations also hold training sessions to raise the technical, management, and decision-making abilities needed to incorporate new technologies and innovations into their processes and products. Managerial skills are significant to the implantation of new technology efficiently to decrease the implementation cost and effectively use organizations' resources. Decision-making skills are most important for organizations to make an effective decision at the right time for effective performance and increased productivity.

This study may be extended by including other industrial cities in Pakistan to validate the current study's findings. The current study's context is restricted to manufacturing and trade companies in the Lahore region. This research has included several respondents, making it possible to conduct a similar study by enlarging the sample size. Other human resources techniques (compensation, career planning, and employee) can also be used to obtain more significant outcomes in the future, as this research primarily examined the impact of management skills and technological advancement on productivity.

5.2. Limitations and future research directions

The present study collected data using survey-based methods from managers of 150 Lahore-based manufacturing sector firms. The current research is limited to more than one central hub of the manufacturing sector due to a lack of survey funding and a meager response rate from firms' managers. Future studies need to extend the data collection from other cities in Pakistan, which are the major contributors to the manufacturing sector. The present study considered the managers as respondents for the present study. Future studies need to focus on manager operations and lower-level management. Future studies must consider factors such as managerial characteristics or attributes to predict the manufacturing sector's process, product innovation, and productive performance. The present research provides implications for policymakers to encourage investment in technology and innovations by lowering the cost of financing, as it will benefit industries at the micro level and enhance overall economic growth. The present study also provides direction to educators for industry and academia linkage to train graduates during the study so that they would have the potential to adopt technology and generate new ideas in product innovation and process innovation to enhance the business activities in a country.

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Supplemental material

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Correction

This article has been corrected with minor changes. These changes do not impact the academic content of the article.

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