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ICT Adoption and Its Role in Enterprise Innovativeness: The Cases of Medium and Large Manufacturing Industries in Adama City, Ethiopia

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ABSTRACT

The purpose of this study was to gain a deeper understanding of the effects of information communication technology adoption on the innovativeness of medium and large-size manufacturing industries in Adama City, Ethiopia. The study employed a qualitative multiple-case study approach, interviewing top managers from five purposefully selected companies. Semi-structured interviews were used for in-depth discussions, and the data was analyzed using a cross-case analysis technique to identify common themes across all companies. The research findings revealed that information communication technology adoption supports the manufacturing industries by increasing production speed, enabling product promotion, performing online orders, and improving communication and organizational work structure. However, adoption is hindered by internal issues like unskilled workers, uncommitted managers, reluctant investors, financial limitations, and external challenges such as supply shortages, expensive equipment, poor education and policy systems, political instability, and lack of international payment options like PayPal and credit card bank services. Despite supporting innovation, information and communication technology used in manufacturing remains limited due to internal and external factors. The study recommends increased awareness training and government action on infrastructure, policy, and education to improve information and communication technology adoption.

INTRODUCTION

Technological innovation is a driving force behind development. This is evident in how countries are often categorized as developed or developing based on their level of technological adoption and innovation (Institute & Asfaw, 2021). Today, information communication technologies (ICTs) are widely recognized as an essential tool for developing business strategies that improve the competitiveness of the manufacturing industries worldwide (Enríquez et al., 2015). Across the globe, manufacturers are in a race to digitally reinvent themselves. They are crafting plans to leverage cutting-edge technology and build internal expertise, all to boost their bottom line (Bhatti et al., 2024).

According to a study by Ribeiro da Silva et al. (2019), recent emerging technologies like robotics and three-dimensional (3D) printing are enabling innovation that changes the nature and contents of manufacturing. Furthermore, a study by Kusairi et al. (2023) found that growth in mobile phone and internet use, along with foreign investment, all had a positive effect on economic growth. Therefore, digital manufacturing helps to reduce product development cycles and costs, increasing time-to-market and product quality (Cardoso et al., 2017). In line with this, research by Barba-Sánchez et al. (2024) suggests that strong IT capabilities lead to better firm performance by fostering a digital mindset and company-wide digital transformation.

However, digital technology's role in manufacturing value-added may differ according to the country's economy (Wulansari et al., 2020). Thus, the recently established Ethiopian manufacturing industry's ICT systems and

equipment are advanced and mostly made in China, Italy, Germany, Japan, and South Korea; however, most factories still use basic or intermediate technologies. Medium and large-scale manufacturing industries (MLMIs) are one of the country's sectors that are expected to play a significant role in boosting economic growth, job creation, and foreign exchange earnings. However, the sector is dominated heavily by small firms with a focus on low-value and low-technology products (Oqubay, 2019). To address this, the government is actively promoting rapid and sustainable technological development and growth through the establishment of industrial parks (Eshetie, 2018). Consequently, while good government drives people to use technology at home, businesses with more knowledgeable workers are the ones most likely to use technology and support their innovation in research and development (Billon et al., 2017). However, while managers who see value in ICT are more likely to adopt new work practices, the impact on profits and market share hinges on how long those practices have been in place (Omol, 2023).

Recent empirical evidence confirms the transformative power of integrating ICT into manufacturing sectors in the 21st century boosts business growth, improves product design, and enhances overall enterprise performance (Solomon & van Klyton, 2020; Ekuobase & Olutayo, 2016). Furthermore, innovation is a critical driver of industrial competitiveness (Freeman & Soete, 2017). Therefore, companies can foster innovation through internal research and development (R&D) or by adopting existing technologies such as ICT (Li et al., 2022). According to a study by Hoque et al. (2016), the use of ICT in medium enterprises can support managing resources, reducing transaction costs, and gaining access to the rapid flow of information. However, while ICT enables manufacturing firms to embrace innovation, particularly in product and marketing innovation, they do not boost a firm's ability to create entirely new products or processes (Ben Khalifa, 2023). On the other side, Aboal & Tacsir (2018) found that ICTs have a greater impact on innovation and productivity in services companies than manufacturing firms.

Standard innovation measures included in the Oslo manual were product, process, marketing, and organizational innovation (OECD & Eurostat, 2018). Accordingly, the framework of this study was developed based on technology, organization, and environment (TOE) technology adoption theory and analyzed the organization-level aspects along with environmental considerations of ICT adoption and innovation based on empirical data collected from sample companies (Chiu et al., 2017).

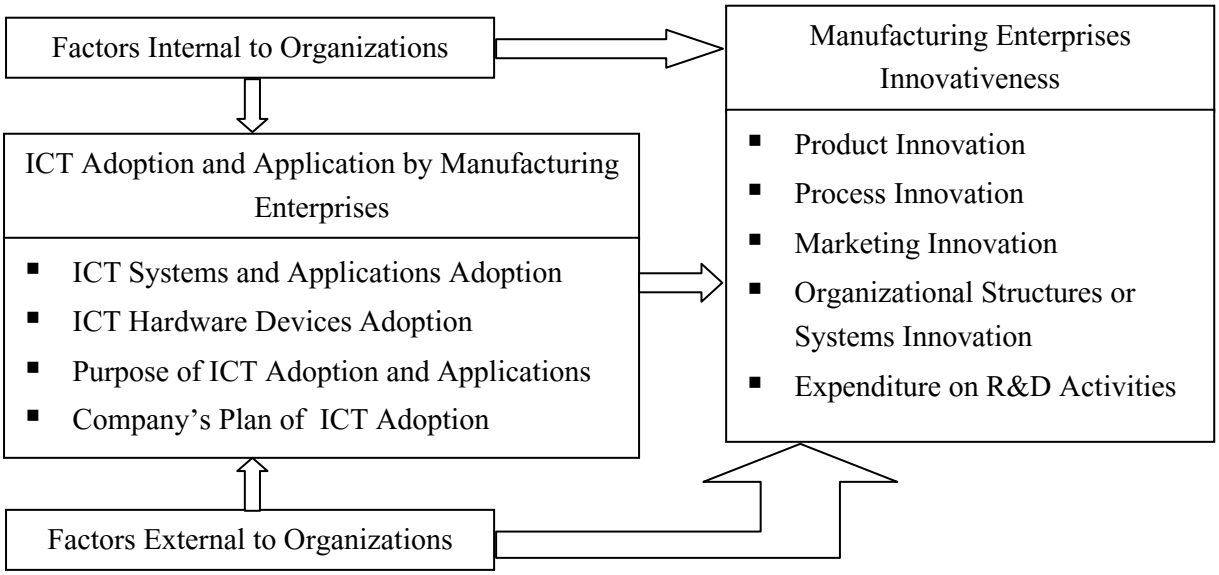

Figure 1. Conceptual Framework (Customized from TOE framework)

According to a study by Fu & Hou (2015), conducted on manufacturing firms in Ghana, ICT can foster innovation. Moreover, ICT supports enterprises in decision-making decreases processing time and error rate, and increases the efficiency and effectiveness of operations (Tewari & Misra, 2015). However, adoption across firms has been not equal and different for domestic and foreign-owned firms,

in particular concerning the effects of international competitive pressure and firm size (Khan, 2017). Furthermore, factors such as strong leadership commitment, access to skilled personnel, and appropriate technology selection all play a crucial role in successful ICT implementation (Anjum, 2019; Kim et al., 2018). On the other side, Large firms have a distinct advantage in terms of resource availability for ICT adoption compared to SMEs with limited financial and human resources (Mwai, 2016; Dota. Moreover, Despite ICT innovations, SMEs often struggle to leverage their business to a higher level (Neirotti & Pesce, 2019). Seclen-Luna et al. (2022) also found that digital technologies tend to boost both sales and productivity. However, the impact can vary depending on the type of technology used, the company's size, and the gender balance in management. Interestingly, the effect on sales is more pronounced for large manufacturers, while for SMEs, the impact is stronger on productivity. However, Kusuma et al. (2020) found gender had no impact on SME ICT adoption, but age, management status, and business experience mattered more.

A study showcases the potential benefits of ICT within Ethiopia's manufacturing sector. For instance, Enterprise Resource Planning (ERP) systems can significantly improve delivery times. Digital platforms not only directly boost supply chain capabilities, but these improved capabilities also play a key role in translating the benefits of digital platforms into better operational performance (Hautala-Kankaanpää, 2022). Computer-Aided Process Planning (CAPP) offers advantages like lower training costs and easier implementation in Ethiopian manufacturing (Atna & Ramchandra, 2015). This states that Ethiopia's technology innovation scene is more about adapting existing technologies for everyday use, rather than creating entirely new inventions (Desta, 2018). However, supply chain integration in Ethiopian manufacturing remains limited and heavily reliant on traditional methods like phone calls and letters (Georgise et al., 2014). This limited in-house design and development capability hinders the sector's overall economic contribution (Wagaw, 2017) and (Haile et al., 2017).

Despite the growing need for digitalization, there is a limited understanding of how Ethiopian manufacturers leverage digital tools for innovation. Therefore, this study was conducted in selected medium and large manufacturing industries (MLMIs) in Adama City, Ethiopia to fill the gap in the literature by answering the following three questions: (1) to what extent do MLMIs in Adama City adopt and use ICT? (2) how do the adoption and application of ICTs affect MLMI's innovation efforts? And (3) What factors influence ICT adoption and application in MLMIs?

METHODS

Research Design

A qualitative multiple-case study design was chosen to explore the nexus between ICT adoption and innovation in manufacturing industries. Because, given the nature of this study's research questions, qualitative case study research is deemed to be the most suitable approach as it helps answer the "why", "what" and "how" of a given phenomenon (Saunders et al., 2019).

Data Sources and Instruments of Data Collection

To gather in-depth primary information, the study used face-to-face, semi-structured interviews lasting 15-30 minutes with participants. This approach aligns with qualitative research methods by Adams et al. (2014) that qualitative research may well engage in in-depth interviews specifically semi-structured interviews that tend to last around one hour and start by asking straightforward questions from a simple introduction to detailed discussions to yield a vast amount of rich information. The study also used secondary data from the 2015 World Bank Ethiopian enterprise survey.

Study Area and Target Population

The study focused on medium and large manufacturing industries in Adama City, Ethiopia, which has a mix of public, private, and industrial park companies. Due to some non-operational businesses, a qualitative case study approach with a selected few companies was chosen.

Sampling Techniques and Sample Size Determination

The study purposefully selected five medium and large manufacturing industries in Adama City and interviewed 15 key informants (3 per company). Because the purposive sampling technique is the most suitable technique to answer the research questions based on the researcher's judgment (Saunders et al., 2019). While qualitative studies typically involve fewer participants, a multiple-case approach strengthens the evidence and understanding (Yin, 2018). Therefore, legally registered medium and large manufacturing

industries were chosen, considering ownership status such as local or foreign, their societal impact, economic contribution, and R&D history.

Furthermore, key informants included company administrators, operation, production, sales, ICT, and HR managers due to a person who has had an experience with an event such as a decision-making process, an implementation process, organization management, or part thereof based for case studies (R. Ponelis, 2015).

Table 1. Sample Companies

Sectors Type	Size	Ownership	Investors
Apparel and Clothing Factory	Large	Government-Foreign Joint-venture	Foreign
Wool Textile Subsector Factory	Large	Government-Foreign Joint-venture	Foreign
Flour and Biscuit factory	Large	Private Limited Company	Domestic
Chemical and Detergent Factory	Medium	Private Limited Company	Domestic
Cable Manufacturing	Medium	Private Limited Company	Domestic

Data Analysis Methods

A cross-case synthesis approach was used to analyze data gathered from case companies, while a cross-case synthesis technique is the best and only applicable to multiple case studies (Yin 2018). Therefore, narrative descriptions were used to identify similarities and differences in ICT adoption and innovation among companies. Additionally, the study analyzed overall ICT adoption and innovation in Ethiopian manufacturing using secondary data from the 2015 World Bank survey with descriptive statistics such as tables, frequency counts, percentages, charts, and figures.

RESULTS AND DISCUSSION

Due to data limitations, the researcher first analyzed the overall Ethiopian manufacturing firms' ICT adoption using the 2015 World Bank survey through descriptive statistics and subsequently, the qualitative data from Adama city manufacturers were analyzed through narrative descriptions.

Quantitative Analysis

ICT Adoption Indicators

The available ICT-related variables in the 2015 World Bank Ethiopian manufacturing enterprise survey data set are email use and website ownership. First, Enterprises were asked if they use email to communicate with clients or suppliers. The results show that while 56% of surveyed manufacturers use email, some firms in the garment (1) and furniture (2) sectors lacked awareness about their email usage. Therefore, the survey results show moderate email use and a potential knowledge gap in some sectors regarding their email usage. This suggests a need for awareness campaigns in these sectors.

Table 2. Email Use

Sectors	Do not know	User	Non-user	Total	% User
Food	0	44	45	89	49.4
Nonmetallic mineral	0	16	47	63	25.4
Garments	1	21	13	35	60.0
Furniture	2	15	12	29	51.7
Publishing, printing	0	24	3	27	88.9
Plastics & rubber	0	21	6	27	77.8
Leather	0	17	5	22	77.3
Fabricated metal products	0	11	11	22	50.0
Chemicals	0	10	4	14	71.4
Textiles	0	10	3	13	76.9
Basic metals	0	10	3	13	76.9
Wood	0	4	4	8	50.0
Machinery and equipment	0	1	4	5	20.0
Total	3	204	160	367	56.0

Source: Own computation from the 2015 World Bank enterprise survey

Second, Enterprises were asked if they had a website. The results show that only 29.7% of surveyed manufacturers had websites. However, the chemical sector had the highest adoption (78.6%), while other sectors remained below 50%. Therefore, despite low website adoption in Ethiopian manufacturing, the chemical sector thrives with higher adoption, suggesting potential benefits for others.

Table 3. Website Ownership

Sector	Do not know	Owner	Non- owner	Total	% Owner
Food	0	26	63	89	29.2
Nonmetallic mineral	0	9	54	63	14.3
Garments	1	12	22	35	34.3
Furniture	2	2	25	29	6.9
Publishing, printing	0	9	18	27	33.3
Plastics & rubber	0	11	16	27	40.7
Leather	0	10	12	22	45.5
Fabricated metal products	0	7	15	22	31.8
Chemicals	0	11	3	14	78.6
Textiles	0	2	11	13	15.4
Basic metals	0	6	7	13	46.2
Wood	0	3	5	8	37.5
Machinery and equipment	0	1	4	5	20.0
Total	3	109	255	367	29.7

Source: Own computation from the 2015 World Bank enterprise survey

Innovation Characteristics

First, the companies were asked during the last three years, if their establishment introduced new or significantly improved products or services. The results show that only 41.4% of Ethiopian manufacturing industries are product innovators. Sectors like Furniture, Plastics & Rubber, Leather, and Machinery & Equipment have innovation rates above 50%, while others fall below.

Table 4. Product Innovation

Sector	Innovator	Non- innovator	Total	% Innovator
Food	28	61	89	31.5
Nonmetallic mineral	17	46	63	27.0
Garments	17	18	35	48.6
Furniture	17	12	29	58.6
Publishing, printing	12	15	27	44.4
Plastics & rubber	16	11	27	59.3
Leather	12	10	22	54.5
Fabricated metal products	8	14	22	36.4
Chemicals	6	8	14	42.9
Textiles	5	8	13	38.5
Basic metals	6	7	13	46.2
Wood	4	4	8	50.0
Machinery and equipment	4	1	5	80.0
Total	152	215	367	41.4

Source: Own computation from the 2015 World Bank enterprise survey

Second, Companies were asked during the last three years, if their company introduced any new or significantly improved methods of manufacturing products or offering services. The results show that only 32% of Ethiopian manufacturing industries were innovators of new manufacturing techniques

in the last three years. The textile sector leads innovation in this area, with over 50% of innovative companies, while other sectors are below 50%.

Table 5. Process Innovation

Sector	Innovator	Non- innovator	Total	% Innovator
Food	28	61	89	31.5
Nonmetallic mineral	12	51	63	19.0
Garments	11	24	35	31.4
Furniture	14	15	29	48.3
Publishing, printing	9	18	27	33.3
Plastics & rubber	12	15	27	44.4
Leather	7	15	22	31.8
Fabricated metal products	5	17	22	22.7
Chemicals	5	9	14	35.7
Textiles	7	6	13	53.8
Basic metals	5	8	13	38.5
Wood	1	7	8	12.5
Total	116	246	362	32.0

Source: Own computation from the 2015 World Bank enterprise survey

Thirdly, Enterprises were asked during the last three years, if their company introduced new or significantly improved marketing methods. The results show that only 27.6% of Ethiopian manufacturing industries were innovators of new marketing methods in the last three years. The textile (53.8%) and chemical (50%) sectors lead in marketing method innovation, while the wood sector has not innovated new marketing methods, and others were below 50%.

Table 6. Marketing Innovation

Sector	Innovator	Non-innovator	Total	% Innovator
Food	27	62	89	30.3
Nonmetallic mineral	13	50	63	20.6
Garments	3	32	35	8.6
Furniture	9	20	29	31.0
Publishing, printing	8	19	27	29.6
Plastics & rubber	10	17	27	37.0
Leather	6	16	22	27.3
Fabricated metal products	4	18	22	18.2
Chemicals	7	7	14	50.0
Textiles	7	6	13	53.8
Basic metals	6	7	13	46.2
Wood	0	8	8	0.0
Total	100	262	362	27.6

Source: Own computation from the 2015 World Bank enterprise survey

Fourthly, Enterprises were asked during the last three years, if their company introduced any new or significantly improved organizational structures or management practices. The results show that only 24.6% of Ethiopian manufacturing industries were innovators of new organizational structures in the past three years. Innovation in this area was limited across all sectors (below 50%).

Table 7. Organizational Structures and Systems Innovation

Sector	Do not know	Innovator	Non-innovator	Total	% Innovator
Food	0	24	65	89	27.0
Nonmetallic mineral	0	8	55	63	12.7
Garments	0	6	29	35	17.1
Furniture	1	8	20	29	27.6
Publishing, printing	0	7	20	27	25.9
Plastics & rubber	0	8	19	27	29.6
Leather	0	8	14	22	36.4
Fabricated metal products	0	4	18	22	18.2
Chemicals	0	5	9	14	35.7
Textiles	0	5	8	13	38.5
Basic metals	0	4	9	13	30.8
Wood	0	2	6	8	25.0
Total	1	89	272	362	24.6

Source: Own computation from the 2015 World Bank enterprise survey

Fifthly, Enterprises were asked what during the last three years the establishment spent on formal research and development (R&D) activities, either in-house or contracted with other companies, excluding market research surveys. The results show that R&D spending was below 50% in all sectors, with chemicals (35.7%) and textiles (23.1%) having the highest investments, and one furniture company was unsure about R&D investment.

Table 8. Expenditure on R&D Activities

Sector	Do not know	Spend	Not spend	Total	% Spend
Food	0	10	79	89	11.2
Nonmetallic mineral	0	4	59	63	6.3
Garments	0	2	33	35	5.7
Furniture	1	4	24	29	13.8
Publishing, printing	0	2	25	27	7.4
Plastics & rubber	0	3	24	27	11.1
Leather	0	2	20	22	9.1
Fabricated metal prod	0	2	20	22	9.1
Chemicals	0	5	9	14	35.7
Textiles	0	3	10	13	23.1
Basic metals	0	1	12	13	7.7
Wood	0	1	7	8	12.5
Total	1	39	322	362	10.8

Source: Own computation from the 2015 World Bank enterprise survey

Overall, a survey on innovation in Ethiopian manufacturing industries reveals low innovation rates. Therefore, the study recommended that manufacturers improve their competitiveness and profitability by investing in R&D, fostering creativity, and focusing on new products.

Email Use Vs Percentage of Innovator Firms

The results show that 31% of firms use email however, 13% of firms are organizational systems innovators, 15% of firms are marketing methods innovators, 18% of firms are manufacturing techniques innovators and 23% of firms are product and service innovators respectively. Therefore, while email usage is high (31%), innovation adoption is lower (13-23%). This suggests firms might need to leverage ICT more for innovation.

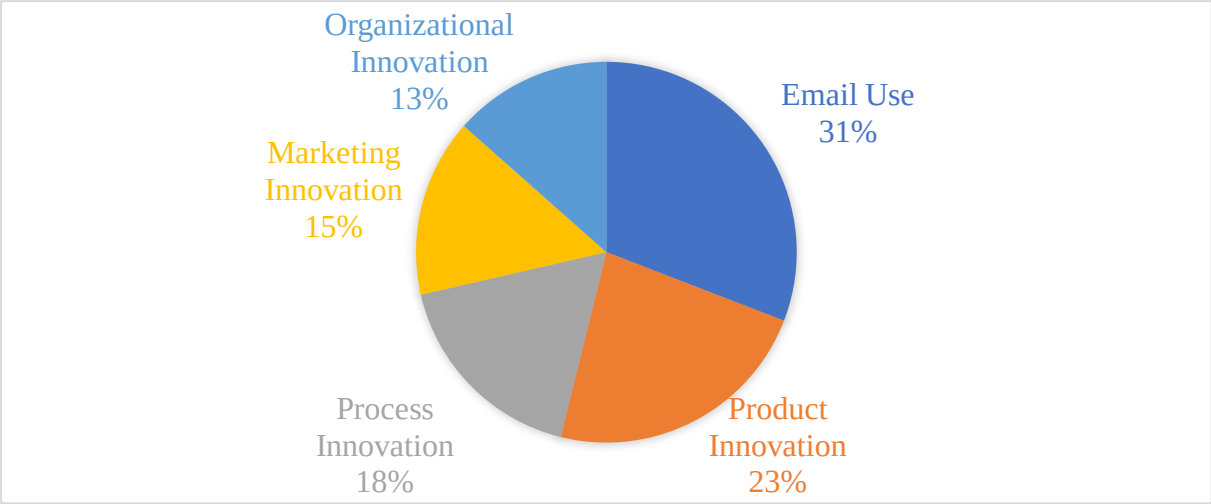

Figure 2. Email Use Vs Percentage of Innovator Firms

Website Owner Vs Percentage of Innovator Firms

The results show that despite low website adoption (19%), firms prioritized product innovation (27%) and process innovation (20%) over marketing (18%) and organizational innovation (16%).

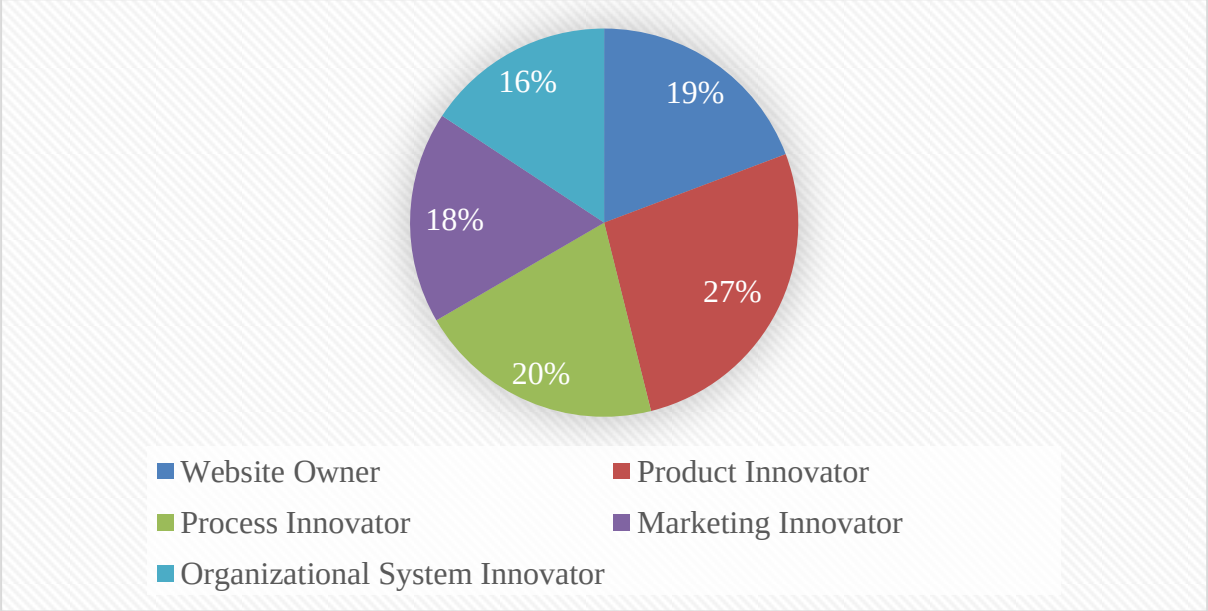

Figure 3. Website Owner Vs Percentage of Innovator Firms

Comparison of Firms by Types of Innovation

The results show that manufacturing firms prioritize product innovation (152 firms) followed by process (116), marketing (100), and organizational innovation (89).

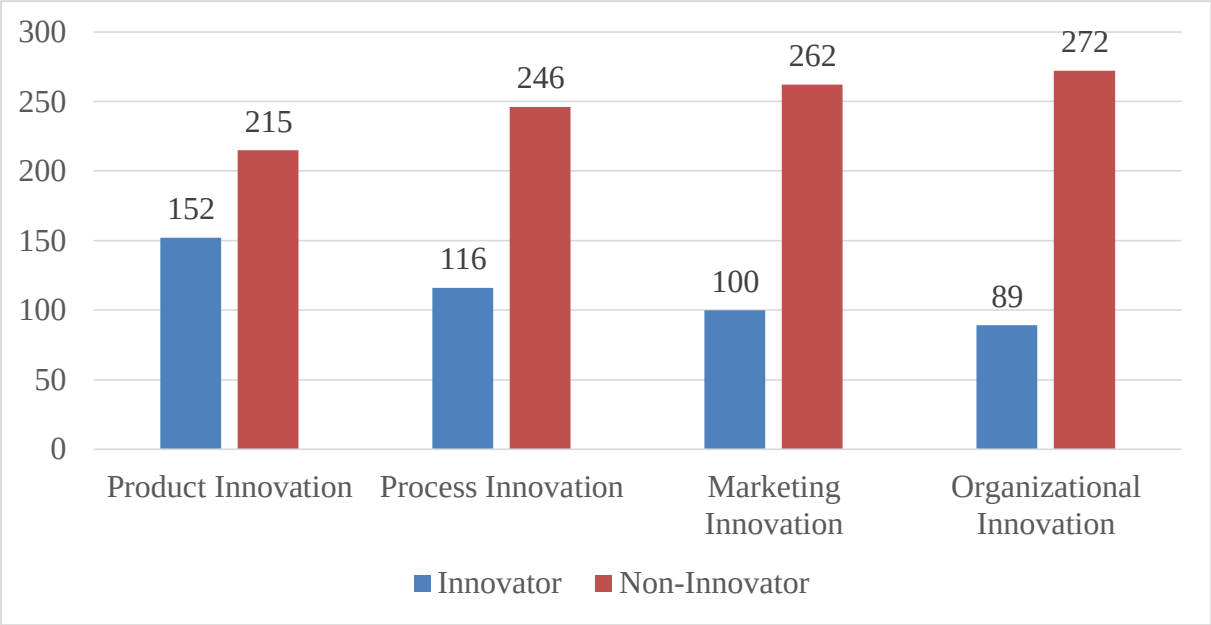

Figure 4. Comparison of Firms by Types of Innovation

Qualitative Analysis

Indicators of ICT Adoption

Case companies were asked have you implemented ICT in your company? If 'Yes', What types of ICT Systems and application software are used in your organization? The interview results show that all companies used basic ICT (internet, email, social media). Advanced systems (ERP, SAP, websites) were limited and varied by industry needs. For example, medium-sized cable companies partially used ERP and websites. This suggests that as companies grow, the need for more advanced ICT systems might increase.

Table 9. ICT System and Application Software

Case Companies	Responses
Apparel and clothing manufacturing	SAP, Email, Facebook, Telegram and the Internet
Wool textile subsector manufacturing	SAP, Email, Facebook, Telegram and the Internet
Flour and biscuit manufacturing	ERP, Email, Facebook, and the Internet
Chemical and detergent manufacturing	Email, ERP, Website, Facebook, Telegram, messenger and Internet
Cable manufacturing	Partially developed ERP and Website, Email, Telegram, Facebook and Internet

Source: Field data, 2022

Secondly, companies were asked what ICT device was used to access the implemented ICT Systems in their company. The interview results show that basic ICT (computers, printers, office phones) adoption was widespread across all companies. Laptops, mobile phones, and advanced security tools (fingerprints, digital cameras) were less common and varied by industry. Notably, only textile firms used smartphones at the official level. This suggests that companies might be comfortable with traditional communication methods but potentially lag in adopting mobile technology and advanced security measures.

Table 10. ICT Hardware Devices

Case Companies	Responses
Apparel and clothing manufacturing	Computers, Printers, Mobile and Office phones, Fingerprint and Security Control Camera
Wool textile subsector manufacturing	Computers, Printers, Laptops, Mobile and Office Phones, Fingerprint devices and Security Control Camera
Flour and biscuit manufacturing	Computers, Printers, Office Phones, Surveillance Camera and Fingerprint devices
Chemical and detergent manufacturing	Computers, Digital Camera, Printers, and Office Phones
Cable manufacturing	Computers, Laptops, Printers, and Office Phones

Source: Field data, 2022

Thirdly, enterprises were asked for what purpose their company uses the implemented ICT Systems. The interview results show that all companies utilized a network for shared resources (printers) and communication (email, phones, social media). Computers and printers handled routine tasks like design, planning, and reports. Advanced systems varied by sector: Cable manufacturing companies lacked fully implemented ERP, while others used SAP/ERP for data management. Additionally, specific sectors employed specialized systems: quality control in chemicals, inventory in cables, and security/attendance with cameras and fingerprints in textiles and flour/biscuit firms. This highlights the limited and diverse adoption of advanced ICT across participating sample manufacturing sectors.

Table 11. ICT Adoption and Application Purpose

Case Companies	Responses
Apparel and clothing manufacturing	CAD, CAPP, HR information and report management, security control, communication, promotion, and announcement, for learning, meeting, and collaboration.
Wool textile subsector manufacturing	HR, security and report management, communication, CAD, CAPP, promotion, meeting, support and news.
Flour and biscuit manufacturing	HR information and report management, security control, communication, planning, promotion, for online support.
Chemical and detergent manufacturing	Quality management, report & payroll processing, communication, promotion, planning, and, finding news.
Cable manufacturing	Partially implemented Inventory system, planning, report & payroll processing, communication, promotion, to finding news.

Source: Field data, 2022

On the other hand, interviewees appeared to have concerns about the negative side of internet usage. For instance, the Chemical and detergent manufacturing company's IT manager said: "*Sharing software online* (*email, Google Drive, open source*) *can reduce knowledge richness by providing pre-built solutions without understanding the underlying code*".

This suggests a need for Ethiopian companies to find a balance between leveraging the internet and promoting a deeper understanding of the technology they use.

Fourthly, enterprises were asked if they have a plan to use ICT-related emerging technologies. If 'Yes', what specific technologies are they? The study results show that despite individual plans for specific software (SAP, E-commerce website, etc.), none of the MLMIs aimed to develop entirely new ICT products. Their focus was on adopting existing technologies, as shown in Table 12 below. This suggests a cautious approach towards ICT by Ethiopian manufacturing companies. They might prioritize proven solutions over the risks involved in developing entirely new technologies.

Table 12. Firms' Plan for ICT Adoption

Case Companies	Responses
Apparel and clothing manufacturing	Fully developed SAP systems
Wool subsector textile manufacturing	E-Commerce website
Flour and biscuit manufacturing	Cnet and Peachtree software
Chemical and detergent manufacturing	Oracle Database systems
Cable manufacturing	Fully developed website and ERP

Source: Field data, 2022

Measures of Enterprise Innovativeness

Product Innovation

First, companies were asked has your firm ever developed any new or significantly improved products due to ICT usage. If yes, please explain the products and how ICT helped you. The interview results show that new products were not developed in all sample companies as a result of ICT involvement. However, the interview results with the administrators of each case company indicate that ICTs supported the manufacturing process enhancement; building relationships, creating market linkage, and organizational systems management. Therefore, this suggests that while new product development may not be the sole outcome, ICT adoption can still bring significant benefits to Ethiopian manufacturers.

Process Innovation

Secondly, companies were asked has their firm ever developed any new or significantly improved processes due to ICT usage. If yes, please explain the processes and how ICT helped you. The results show that while advanced ICT adoption was limited, the study found its use in various ways. Clothing firms used it for fabric design and production reports, while food, chemical, and cable companies used it for daily reports, machine repair, and work orders. This suggests ICT plays a significant role in Ethiopian manufacturing processes.

Marketing Method Innovation

Thirdly, companies were asked has your firm ever developed any new or significantly improved marketing methods due to ICT usage. If Yes, please explain the method and strategies and how ICT helped you. The interview results showed that ICT boosted marketing across manufacturing sectors. Apparel firms use it for online customer interaction and order management. Wool textile companies located stock online. Flour and biscuit manufacturers improved customer development. Chemical, detergent, and cable companies tracked stock levels and researched markets online. Overall, these findings highlight ICT as a key tool for Ethiopian manufacturers to strengthen their marketing efforts and potentially gain a competitive edge.

Organizational Structure and Systems Innovation

Fourthly, companies were asked has your firm ever developed any new or significantly improved organizational systems due to ICT usage. If 'Yes', please explain the organizational systems and how ICT helped you. Interviews revealed ICT benefits across all companies except cable manufacturing. ICT improved communication, security, attendance, payroll, reporting, and overall work structure by centralizing information systems. Cable manufacturing saw partial improvements in HR and website due to limited ICT implementation. In conclusion, the findings highlight ICT as a key driver of operational efficiency and improved management practices in Ethiopian manufacturing.

Expenditure on R&D Activities

Fifthly, companies were asked has your firm ever spent on formal research and development (R&D) activities, either in-house or contracted with other companies. Interviews showed lower and varied R&D spending across sectors. However, Chemical and Textile companies encouraged staff R&D through yearly budgets to compete with local and international markets. Accordingly, the administrators' companies said that: "*The company invested in annual budgets for R&D and encouraged the staff to conduct research and compete locally and internationally*".

This highlights a potential strategy for Ethiopian manufacturers: by prioritizing R&D investment and encouraging employee involvement, companies can potentially boost their competitiveness. The example of chemical and

textile companies provides a specific case study of this approach.

Factors Influencing ICT Adoption and Application by Companies

First, companies were asked what are the major internal organizational factors that limit ICT adoption and application in their enterprise's operation. Interviews revealed internal barriers to ICT adoption: lack of skills, lack of finance, and lack of willingness and commitment of stakeholders. Furthermore, the Wool Textile Company IT manager said that; "*Industry-wide ICT awareness campaigns would require through mass media, workshops, and conferences*".

Additionally, the Cable manufacturing company production manager said that: "*Stakeholder misunderstandings about the benefits of ICT in manufacturing hinder the adoption of new technologies*".

Secondly, companies were asked what are the major external organizational factors that limit ICT adoption and application in their enterprise's operation. The study results show that beyond internal limitations, high ICT infrastructure costs, political instability, industrial and educational policy, and a lack of international payment options such as PayPal and credit card bank services in Ethiopia limited ICT adoption across all companies. Overall, industry-wide awareness campaigns will be crucial for addressing stakeholder misconceptions, promoting ICT adoption, and fostering innovation in Ethiopian manufacturing.

Findings on the ICT Adoption and Application Indicators

The research results revealed widespread use of basic ICT facilities like computers, printers, internet, email, and social media across all participating companies. This aligns with the findings by Fu & Hou (2015) who highlighted the prevalence of basic ICTs in boosting operational speed. Moreover, ICT adoption particularly, big data is essential for businesses that want faster deliveries and greener supplies (Narwane et al., 2021). However, the adoption of more expensive, high-tech systems like Enterprise Resource Planning (ERP), digital cameras, fingerprint systems, and websites was limited and varied across firms. These findings resonate with studies by Mwai (2016), and (Idota et al., 2020) suggesting that resource constraints and knowledge gaps often hinder SMEs from fully exploiting advanced technologies without consistent government support.

The study further revealed that ICT adoption brings significant benefits to manufacturing firms. It simplifies functions like design, planning, report generation, and information management, while also facilitating improved communication. Notably, this result is supported by the findings of Shang et al. (2024) who stated that manufacturing digital success is not one-size-fits-all; it goes beyond just optimizing processes or creating new products. Furthermore, companies with branches outside Ethiopia were more likely to accept online orders, reflecting the influence of international reach on ICT usage patterns, as observed (Khan, 2017). However, Singh et al.(2024) argued that company technology upgrades were independent of industry size, or location. On the other side, a study by AlKoliby et al. (2023) also identified the indirect effects of digital marketing on the sustainable performance of manufacturing SMEs through innovation in full mediation.

Findings from Firm's Innovation Characteristics Due to ICT Usage

The research also investigated how ICT characteristics influence innovation within firms. Findings confirmed that ICTs enhance communication methods, online order processing, production speed, management tasks, and security control. Technologies like email and social media provide a two-way communication model, fostering innovative ways to create and share knowledge that supports business growth. This aligns with Ben Khalifa (2023) who emphasized the role of ICT-enabled information access in boosting a company's innovative capabilities. However, firms benefit more from digital skills if they also have strong technological capabilities, but this effect is bigger in developing economies (Heredia et al., 2022).

Additionally, the study found that ICT facilitates marketing efforts, with participating companies using social media to promote products and services. The interactive nature of these technologies allows joint ventures between the government and foreign investors to receive online client orders. Furthermore, ICT adoption was linked to cost reduction, labor optimization, enhanced organizational capabilities, and improved inter-organizational coordination, mirroring the findings

of Tewari & Misra (2015) who highlighted the efficiency gains associated with modern technological tools. Moreover, Digital tools like the internet and online platforms accelerate technology adoption and transfers (Skare & Riberio Soriano, 2021).

Findings on Factors Influencing ICT Adoption and Application

The study results also identified internal and external factors influencing ICT adoption and application within the participating MLMIs. Internal challenges included a lack of ICT skills, low employee motivation due to inadequate salaries, limited manager commitment stemming from a lack of awareness about ICT benefits, financial constraints, and company work structures. These findings resonate with Anjum (2019) and Kim et al. (2018), who identified organizational factors like owner support, manager commitment, experience, financial resources, and internal technical expertise as crucial for successful ICT implementation.

External factors hindering ICT adoption included cost, infrastructure shortages, supply limitations, the Covid-19 pandemic, political instability, a weak education system, cultural factors, a lack of linkages between firms and relevant institutions, the country's economic situation, and the absence of international payment systems like PayPal and credit card services in Ethiopia. These findings align with Mwai (2016) who identified owner-manager characteristics, firm characteristics, investment costs, and external barriers like infrastructure, cultural limitations, and political and regulatory constraints as key factors impacting ICT adoption in developing countries. A study by Shahadat et al. (2023) also found that perceived cost and government support as key factors influencing ICT adoption in SMEs. However, the perceived cost and technical capacity required for ICT adoption in large manufacturing firms have a positive effect on the procurement performance of the companies (Atisa & Mose, 2024).

CONCLUSION

This study explored how ICT adoption impacted innovation in Adama City's medium and large manufacturing industries. The study results showed that basic ICT use (computers, printers, internet) was widespread, while adoption of more advanced ICT like ERP systems and security cameras remained low. The findings also revealed that implemented ICT technologies increased production speed, online branding and order acceptance, and improved communication and work structures. However, internal limitations (unskilled workers, uncommitted managers, unwilling investors, financial constraints) and external challenges (supply shortages, expensive equipment, poor education, industrial policy, political instability, and lack of international payment systems options like PayPal and credit cards) hindered broader ICT adoption.

REFERENCES

1. Aboal, D., & Tacsir, E. (2018). Innovation and productivity in services and manufacturing: The role of ICT. *Industrial and Corporate Change*, 27(2), 221–241.
2. Adams, J., Khan, H. T. A., & Raeside, R. (2014). *Research methods for business and social science students* (Second edition). SAGE.
3. AlKoliby, I. S. M., Abdullah, H. H., & Suki, N. M. (2023). Linking Knowledge Application, Digital Marketing, and Manufacturing SMEs' Sustainable Performance: The Mediating Role of Innovation. *Journal of the Knowledge Economy*. https://doi.org/10.1007/s13132-023-01157-4
4. Anjum, A. (2019). Information and Communication Technology Adoption and Its Influencing Factors: A Study of Indian SMEs. *Humanities & Social Sciences Reviews*, 7(5), 1238–1253.
5. Atisa, W. O., & Mose, D. T. (2024). ICT Adoption and Procurement Performance of Large Manufacturing Firms in Nairobi City County, Kenya. I*nternational Journal of Social Sciences Management and Entrepreneurship* (*IJSSME*), 8(1), Article 1.
6. Atna, S. M., & Ramchandra, K. R. (2015). Application of Computer-Aided Process Planning in Manufacturing Industries. *International Journal of Engineering Technology and Sciences*, 5.
7. Barba-Sánchez, V., Meseguer-Martínez, A., Gouveia-Rodrigues, R., & Raposo, M. L. (2024). Effects of digital transformation on firm

performance: The role of IT capabilities and digital orientation. *Heliyon*, 10(6), e27725.

8. Ben Khalifa, A. (2023). Impact of research and development (R&D) and information, and communication technology (ICT) on innovation and productivity evidence from Tunisian manufacturing firms. *Economics of Transition and Institutional Change*, 31(2), 341–361.
9. Bhatti, S. H., Sumbal, M. S., Ahmed, A., & Golgeci, I. (2024). Digital strategy for firm performance- the mediating role of digital platform capabilities and digital culture in manufacturing SMEs. *Technology Analysis & Strategic Management,* 0(0), 1–15.
10. Billon, M., Marco, R., & Lera-Lopez, F. (2017). Innovation and ICT use in the EU: An analysis of regional drivers. *Empirical Economics*, 53(3), 1083–1108.
11. Cardoso, W., Azzolini Junior, W., Bertosse, J. F., Bassi, E., & Ponciano, E. S. (2017). Digital manufacturing, industry 4.0, cloud computing and thing internet: Brazilian contextualization and reality. *Independent Journal of Management & Production*, 8(2), 459.
12. Chiu, C.-Y., Chen, S., & Chen, C.-L. (2017). An Integrated Perspective of TOE Framework and Innovation Diffusion in Broadband Mobile Applications Adoption by Enterprises, 6(1), 26.
13. Desta, T. (2018). ICT innovations, entrepreneurship and hubs in East Africa: The case of Ethiopia. *African Journal of Science, Technology, Innovation and Development*, 10(6), 655–664.
14. Ekuobase, G. O., & Olutayo, V. A. (2016). Study of Information and Communication Technology (ICT) maturity and value: The relationship. *Egyptian Informatics Journal*, 17(3), 239–249.
15. Enríquez, L. A., Cuevas-Vargas, H., & Adame, M. G. (2015). *The Impact of Information and Communication Technologies on the Competitiveness: Evidence of Manufacturing SMEs in Aguascalientes*, Mexico. I R, 4, 14.
16. Eshetie, T. (2018). Ethiopia's Manufacturing Industry Opportunities, Challenges and Way Forward: A Sectoral Overview. *Novel Techniques in Nutrition & Food Science*, 2(2).
17. Freeman, C., & Soete, L. (2017). *Economics of industrial innovation*: Third edition (third edition, first issued in hardback 2017). Routledge Taylor & Francis Group.
18. Fu, X., & Hou, J. (2015). *The Innovation Effects of ICT Adoption in Ghana*. 22.
19. Georgise, F. B., Thoben, K.-D., & Seifert, M. (2014). Supply Chain Integration in the Manufacturing Firms in Developing Country: An Ethiopian Case Study. *Journal of Industrial Engineering*, 2014, 1–13.
20. Haile, G., Srour, I., & Vivarelli, M. (2017). Imported technology and manufacturing employment in Ethiopia. *Eurasian Business Review*, 7(1), 1–23.
21. Hautala-Kankaanpää, T. (2022). The impact of digitalization on firm performance: Examining the role of digital culture and the effect of supply chain capability. *Business Process Management Journal*, 28(8), 90–109.
22. Heredia, J., Castillo-Vergara, M., Geldes, C., Carbajal Gamarra, F. M., Flores, A., & Heredia, W. (2022). How do digital capabilities affect firm performance? The mediating role of technological capabilities in the "new normal." *Journal of Innovation & Knowledge*, 7(2), 100171.
23. Hoque, Md. R., Saif, A. N. M., AlBar, A. M., & Bao, Y. (2016). Adoption of information and communication technology for development: A case study of small and medium enterprises in Bangladesh. *Information Development*, 32(4), 986–1000.
24. Idota, H., Bunno, T., & Tsuji, M. (2020). *Impact of ICT on Innovation: The Case of Japanese SMEs. In Disruptive Technology: Concepts, Methodologies, Tools, and Applications* (pp. 1624–1651). IGI Global.
25. Institute, T., & Asfaw, B. (2021). Ethiopian National Innovation survey-2019.
26. Khan, A. M. (2017). Trends in Innovation Activities in Manufacturing Industries Across Development Echelons (SSRN Scholarly Paper 3006430).
27. Kim, M.-K., Park, J.-H., & Paik, J.-H. (2018). Factors influencing innovation capability of small and medium-sized enterprises in the Korean manufacturing sector: Facilitators, barriers and moderators. *International Journal of Technology Management*, 76(3–4), 214–235.
28. Kusairi, S., Wong, Z. Y., Wahyuningtyas, R., & Sukemi, M. N. (2023). Impact of digitalization

and foreign direct investment on economic growth: Learning from developed countries. *Journal of International Studies*, 16(1), 98–111.

29. KUSUMA, H., MUAFI, M., AJI, H. M., & PAMUNGKAS, S. (2020). Information and Communication Technology Adoption in Small- and Medium-Sized Enterprises: Demographic Characteristics. *The Journal of Asian Finance, Economics and Business*, 7(10), 969–980.
30. Li, D., Chen, Y., & Miao, J. (2022). Does ICT create a new driving force for manufacturing? Evidence from Chinese manufacturing firms. *Telecommunications Polic*y, 46(1), 102229.
31. Mwai, E. (2016). Factors Influencing Adoption of ICT by Small and Medium Enterprises in the Hospitality Industry in Kenya. 8.
32. Narwane, V. S., Raut, R. D., Yadav, V. S., Cheikhrouhou, N., Narkhede, B. E., & Priyadarshinee, P. (2021). The role of big data for Supply Chain 4.0 in manufacturing organisations of developing countries. *Journal of Enterprise Information Management*, 34(5), 1452–1480.
33. Neirotti, P., & Pesce, D. (2019). ICT-based innovation and its competitive outcome: The role of information intensity. *European Journal of Innovation Management*, 22(2), 383–404.
34. OECD & Eurostat. (2018). *Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation*, 4th Edition. OECD.
35. Omol, E. J. (2023). Organizational digital transformation: From evolution to future trends. *Digital Transformation and Society*. 3(3).
36. Oqubay, A. (2019). The Structure and Performance of the Ethiopian Manufacturing Sector. In F. Cheru, C. Cramer, & A. Oqubay (Eds.), *The Oxford Handbook of the Ethiopian Economy* (pp. 629–650). Oxford University Press.
37. R. Ponelis, S. (2015). Using Interpretive Qualitative Case Studies for Exploratory Research in Doctoral Studies: A Case of Information Systems Research in Small and Medium Enterprises. *International Journal of Doctoral Studies*, 10, 535–550.
38. Ribeiro da Silva, E. H. D., Shinohara, A. C., de Lima, E. P., Angelis, J., & Machado, C. G. (2019). Reviewing Digital Manufacturing concept in the Industry 4.0 paradigm. *Procedia CIRP*, 81, 240–245.
39. Saunders, M. N. K., Lewis, P., & Thornhill, A. (2019). *Research methods for business students* (Eighth Edition). Pearson.
40. Seclen-Luna, J. P., Vergara, R. I. C., & Valladares, H. L. (2022). Effects of the use of digital technologies on the performance of firms in a developing country: Are there differences between creative and manufacturing industries? *International Journal of Information Systems and Project Management*, 10(1), Article 1.
41. Shahadat, M. M. H., Nekmahmud, Md., Ebrahimi, P., & Fekete-Farkas, M. (2023). Digital Technology Adoption in SMEs: What Technological, Environmental and Organizational Factors Influence in Emerging Countries? *Global Business Review*, 09721509221137199.
42. Shang, M., Jia, C., Zhong, L., & Cao, J. (2024). What determines the performance of digital transformation in manufacturing enterprises? A study on the linkage effects based on the fs/QCA method. *Journal of Cleaner Production*, 450, 141856.
43. Singh, B. J., Sehgal, R., Chakraborty, A., & Phanden, R. K. (2024). Managing digital manufacturing transformation: Assessing the status-quo and future prospects in North Indian industries. *Journal of Strategy and Management*, ahead-of-print(ahead-of-print). https://doi.org/10.1108/JSMA-07-2023-0168
44. Skare, M., & Riberio Soriano, D. (2021). How globalization is changing digital technology adoption: An international perspective. *Journal of Innovation & Knowledge*, 6(4), 222–233.
45. Solomon, E. M., & van Klyton, A. (2020). The impact of digital technology usage on economic growth in Africa. *Utilities Policy*, 67, 101104.
46. Tewari, S. K., & Misra, M. (2015). Information and communication technology: A tool for increasing marketing efficiency. *International Journal of Information Technology and Management*, 14(2/3), 215.
47. Wagaw, M. (2017). Adoption of Computer-Aided Technology (CAx) in Textile and Apparel Industries. *International Journal of Applied Information Systems*, 11(11), 35–42.

48. Wulansari, I. Y., Oktora, S. I., & Yuniasih, A. F. (2020). The impact of information and communication technology on the value added of the manufacturing sector: Comparing Asian countries by income group levels. *Journal of Critical Reviews*, 7(16), 13.
49. Yin, R. K. (2018). *Case study research and applications: Design and methods* (Sixth edition). SAGE.