# A Study of Information and Communication Technology (ICT) Adoption in the Indian MSME Manufacturing Sector

**THESIS**

Submitted in Partial Fulfilment

Of the Requirements for the Degree of

**DOCTOR OF PHILOSOPHY**

By

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**2019PHXF0106P**

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**BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI**

**2024**

**BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI**

## CERTIFICATE

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**ACKNOWLEDGEMENT**

I want to express heartfelt and earnest gratitude to my PhD supervisor, Prof Rajesh Matai, Department of Management, BITS Pilani, India and my PhD co-supervisor, Prof Nagesh N. Murthy, Lundquist College of Business, University of Oregon, USA, for their unwavering guidance, encouragement, patience, and support throughout the tenure of my PhD. Their vast research knowledge and experience in the field, deep understanding, and flexible and welcoming attitude have helped me throughout my research. It is truly an honour to be their student, and working under their mentorship has facilitated optimal growth of research and academics. Also writing to express my profound gratitude to the members of my Doctoral Advisory Committee (DAC), Prof Satyendra K Sharma and Prof Rajesh P Mishra, for their continuous feedback, time, patience, and effort in reading my thesis and valuable feedback and suggestions.

I am forever grateful to the administration of BITS, Pilani, Pilani Campus. My sincere regards to Prof. V. Ramgopal Rao (Vice-Chancellor, BITS Pilani) and Prof. Sudhir Kumar Barai (Director, BITS-Pilani, Pilani Campus) for facilitating the pursuit of my research work at such an esteemed university. I am grateful to be a part of the diverse and inclusive Department of Management, BITS, Pilani. I extend my profound thanks to Dr Praveen Goyal (Head of the Department) for facilitating a conducive and healthy environment to conduct this research with great enthusiasm and encouragement. I want to thank the Department of Management and Academic office staff and my fellow research scholars, thanks to Mr. Hari and Mr. Ritesh. Graduate Studies and Research Division, IPCD, BITS The library and other academic departments have patiently welcomed my queries.

I always admire and am blessed with my lovely family, who continually stand with me on all three fronts: my work front, my studies, and my responsibilities towards my family. They sacrificed many things to accommodate my timing. My heavenly adobe father, Shri Om Prakash Joshi, is a guiding source for me to achieve new heights and stand against the odds. My sponsor for all my studies was my mother, Mrs Durga Joshi, and her silent affection. My heavenly adobe Mother-in-law, Mrs Snehlata Pareek, and my father figure, Shri Rajeshwar Pareek, with Rahul and Surbhi Pareek, always stand from the background. I have the same support from my sisters, Mrs Anulekha and Mrs Anita, my nieces Paridhi,

Gargi, Gauri, Mahika, Anupreksha, Divija and My nephew Nityam with cousins and Shri Sunil Pareek for managing my various family affairs quietly.

My loving kids, Aarav and Aashvi, suffered the most during my PhD journey. In their childhood, when they required my most attention and love, they sacrificed their various playful time and supported me in studying. This PhD would not have happened without my loving and best friend, my wife, Mrs Shweta Joshi, who was my shadow all the time and played both the roles of mother and father for kids.

I can only do with taking my colleagues in NPCIL, India and ITER France, especially Mr Sheshpannar GM-CMM and Mr Anand Swaroop Jain. They continually encouraged and helped me to manage my professional and academic life balance. A special thanks to my friends Mr Videha Pathre and Rama Prabhu and the entire CMM department of NPCIL. I will always remember the help in the new organisation by Daphne and Taka during the transition to the new system with the heavy PhD workload.

I cannot do without thanking my friends Krishna, Bhasker, Abhishek, and Tapan, who always discussed my difficulties with an unwavering guiding force.

I dedicate this thesis to the loving memory of my grandmother, Nani, uncle, and aunts.

Finally, every step of my journey would have been incomplete and inconsequential if it were not for the Almighty God, who made me capable of this work. Thank you, Lord Krishna, for all your Blessings and Mercy throughout this journey.

**Aman Kumar Joshi**

## ABSTRACT

The United Nation's 2030 agenda to alter the world set 17 goals for sustainable development. One is eradicating poverty in all forms, which requires sustainable Micro, Small, and Medium Enterprises (MSME) to build a country's economy. Nevertheless, overpopulation, globalisation and resource competitiveness endanger world employment. MSMEs may save the world economy. The pandemic increased input costs, supply chain interruptions, debt, and financial concerns, challenging MSME sustainability.

The growth of Micro, Small, and Medium-Sized Enterprise (MSME) sectors is crucial to India's rapid economic expansion. The digital enterprise sees the business as more resilient and flexible. The 63 million MSMEs with 30 per cent Gross domestic product (GDP) contribution and employing 111 million people are significant contributors to India's growth story. Still, only 65% of MSEs are digital, and most struggle with during-covid business pressure. "Access to finance" is a significant problem MSME faces in most developing countries like India.

Businesses and the world have been online since COVID-19 and globalisation. Technology-driven businesses survive supply chain disruption. Indian MSMEs cannot afford expensive technological Investments. Profit drives competition. Digital Bharat promotes technology adoption in society, including businesses. The Information and Communication (ICT) technology can significantly foster the growth of Indian MSMEs.

This thesis investigates the impact of Information and Communication Technology (ICT) adoption on MSME Manufacturing sector performance in India. The MSME sector is vital for the country's economic development, contributing to GDP, employment generation, and export earnings. However, these enterprises need more access to finance and technological constraints. The advancement of ICT presents an opportunity for MSMEs to overcome these challenges and improve their performance.

ICT tools and technologies can enhance operational efficiency, improve decision-making, enable access to new markets, and facilitate business growth. Moreover, the availability of working capital and short-term borrowing is crucial in ensuring MSMEs' smooth functioning and financial stability. Therefore, exploring the relationship between ICT adoption, financial resources, and organisational performance is essential to provide insights for MSMEs and policymakers.

The study adopts a mixed-method approach in three stages. Stage 1 includes a systematic literature review to find the research gap and develop the conceptual framework and research questions. The second stage is devoted to an initial study with the secondary data set of financial data of MSME applied quantitative analysis using Design of Experiment (DoE) and then a detailed study with all the ICT technology Investment with internal and external factors on MSME financial firm performance parameters. In the Third stage, using panel data with the Design of Experiment technique, the ICT Investment data is validated with Return on Asset.

The research on ICT use is rising worldwide. Their frameworks/theories must still be included to address mediating and moderating factors. A rigorous, transparent, systematic literature review (SLR) is used and provided. The SLR is based on four research questions to maintain research authenticity within the framework. The Systematic Literature Review identified and assessed 135 papers on ICT adoption in MSMEs, notably Manufacturing MSMEs and the technology adoption framework. It analyses articles by adoption framework, ICT crucial success criteria, and MSME adoption performance.

ICT Investments' impact on 300 Indian MSME Manufacturing firm's profits is examined using secondary data from the Prowess database. Using DOE, we evaluated our framework for how an ICT Investment decision strategy in technology maximises profit at the optimal Investment level.

We used the Partial Least Squares Structural Equation Modelling (PLS-SEM) technique to examine the impact of ICT on firm performance to determine which type of technology is most applicable and which firm performance factors are most affected. Specifically, how internal, and external factors influence ICT Investment decisions concerning firm performance.

This study employs a Design of Experiment (DoE) approach based on three important research questions with 2000 company data to validate the findings. The motive of this study is to see the impact of ICT Investment with Gross working capital and short-term borrowing on the Firm's productivity parameter Return on Assets (ROA) with panel data of eight Years.

This study's first conceptual framework categorises ICT technologies by evolution time frame as traditional, contemporary, and emerging, providing the research questions and the financial parameter to measure the impact of ICT on business performance.

The study shows that ICT Investment boosts competitiveness financially. We found that ICT Investment increased firm profitability. At one million rupees, ICT Investment maximises profit. Small firms invest more here. The discovery aids MSME leaders' sustainable business decisions. ICT technology is a cause for concern, with the greatest impact on the Net profit margin as a significant firm performance metric.

The findings of panel analysis are unique and novel, which suggests separate for Micro, Small and Medium. The study identifies that the interaction level of all identified factors maximises ROA at 7%, 5% and 6% for Micro, Small and Medium firms, respectively, with the most influential factors of each type of enterprise. This outcome is an exceptional understanding for future researchers and the stakeholders of MSME to make decisions on the digitalisation of their firm.

Overall, this study contributes to the literature by providing empirical evidence of the link between digital transformation and improved financial outcomes, offering insights for strategic and operational decision-making. The significance of this study lies in the crucial role MSMEs play in the Indian economy as drivers of employment, innovation, and economic growth. This study aims to empower MSMEs with the knowledge and tools necessary to thrive in the digital age and contribute significantly to the nation's economic development by addressing the research objectives.

**Keywords:** Micro, Small, and Medium Enterprises (MSMEs), Information and Communication Technology (ICT) adoption, gross working capital, short-term borrowing, Firm performance, systematic literature review, panel data analysis, Design of Experiment (DoE), PLS-SEM, India, Manufacturing.

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# CHAPTER 1: INTRODUCTION

## 1.1 Background of Study

The Micro, Small, and Medium Enterprises (MSMEs) sector plays a crucial role in the economic development of countries worldwide. MSMEs contribute significantly to GDP, employment generation, and export earnings in India. However, these enterprises often need help with various challenges, such as limited access to finance, technological constraints, and a lack of infrastructure. In recent Years, the advancement of Information and Communication Technology (ICT) has opened new avenues for MSMEs to overcome these challenges and improve their performance.

This pandemic, COVID-19, has created many challenges on the Economic and job front. The Job market has almost collapsed after the strict lockdown imposed by the Government. The Micro, Small and Medium Enterprises (MSME) sector has emerged as a highly vibrant and dynamic sector of the Indian economy over the last five decades (Jewalikar & Shelke, 2017). The Government has created stimulus packages for the Agriculture and MSME sectors to boost economic activities and create a job market. Both sectors are considered the backbone of the Indian economy (Khanzode et al., 2021). The first three industrial revolutions arose from mechanisation, electricity, and IT. Currently, the ICT sector provides a new generation of technologies.

Inclusive growth of the MSME sector can help achieve a 05 trillion Economy target by 2024. The MSME sector has employed the highest numbers, next to the agriculture sector. This sector contributes 8% of the Indian GDP. The MSME Manufacturing sector is a strong pillar of the Indian economy, contributing 45% of total Manufacturing output and employing more than 80 million persons (MSME Data 2019) (Jewalikar & Shelke, 2017). Though SMEs are the backbone of the economy, they need help to sustain modern Manufacturing practices. Interestingly, the MSME production growth rate was not affected during the recession Period of 2008-2010, whereas the growth rate of GDP and industrial production was significantly affected during this Period (Maiti, 2018).

Manufacturing has been recognised as the main engine for the economy's growth. The share of the Manufacturing sector in the Indian National GDP has stagnated at 14-15%. The National Manufacturing Policy of India envisages Manufacturing to reach 25% of

the National GDP by 2022. India represents a vast market and a dual economy with varied demands, potentially developing new technology in MSMEs.

The MSME Manufacturing sector may build and maintain the competitiveness needed to face globalisation's challenges and achieve a sustained growth rate. This industry is mainly export-oriented and has the potential to boost exports by value additions (Maiti, 2018). Government of India initiatives aimed at encouraging MSMEs to get a Competitive advantage (Nagayya & Tirumala Rao, 2013) through the adoption of ICT. This Government started and framed the policy in 2011 to promote and increase the adoption of ICT in the Indian MSME Manufacturing sector. Under the ICT promotion scheme, MSMEs will assist in adopting ICT in MSMEs (Development Commissioner (MSME), 2006). Since twelve Years have already passed since the policy framework, the ICT adoption in the Indian MSME Manufacturing sector is still in the nascent stage (Mohanty & Mishra, 2020) since there is a high degree of uncertainty about the effect of implementing innovative activities in the innovation process (H. Gupta & Barua, 2016). "Access to finance" is a significant problem MSME faces in most developing countries like India (Maiti, 2018). Due to limited resources, MSMEs often lose out to big enterprises regarding financial sustainability and better technologies (N. Sharma, 2017). firms in innovation, flexibility and overhead costs, while on the other, they are limited by the amount of capital, market power and organisational resources (D. Singh et al., 2018).

## 1.2 Research Problem

Information and Communication (ICT) technology can significantly foster the growth of Indian Micro, Small and Medium Enterprises (MSMEs). The digital enterprise sees the business as more resilient and flexible. The 63 million MSMEs with 30 per cent Gross domestic product (GDP) contribution and employing 111 million people are significant contributors to India's growth story. Still, only 65% of MSEs are digital, and most struggle with during-covid business pressure.

This thesis investigates the impact of Information and Communication Technology (ICT) adoption, gross working capital, and short-term borrowing on India's Micro, Small, and Medium Enterprises (MSMEs) performance. The MSME sector is vital for the country's economic development, contributing to GDP, employment generation, and export earnings. However, these enterprises need more access to finance and technological

constraints. The advancement of ICT presents an opportunity for MSMEs to overcome these challenges and improve their performance.

Further, the research problem addressed in this thesis is to investigate the impact of ICT adoption in the Indian MSME Sector. Financial credit is one of the most critical problems for the MSME to finance and run its business with technological advancement. MSMEs are Small, family businesses, and this sector highly depends on Government support. Hence, the ICT adoption decision is vital and depends upon various anchors, especially in Micro and Small firms compared to Medium. The revision in the definition of MSME opens more doors to more Investment by increasing the definition based on Investment of Plant and Machinery in MSME. Thus, the other critical factors for stakeholder ICT Investment decisions vary with the firm type. At the same time, managing gross working capital and short-term borrowing impact ICT Investment and the performance of Indian MSMEs. ICT tools and technologies can enhance operational efficiency, improve decision-making, enable access to new markets, and facilitate business growth. Moreover, the availability of working capital and short-term borrowing is crucial in ensuring MSMEs' smooth functioning and financial stability. Therefore, exploring the relationship between ICT adoption, financial resources, and organisational performance is essential to provide insights for MSMEs and policymakers.

## 1.3 Research Objectives

The primary objectives of this study are as follows:

1. To study the existing adoption theories/framework for Information and Communication Technology adoption in the MSME sector and to suggest a conceptual framework for understanding ICT adoption in the Indian MSME Manufacturing sector.
2. To conduct a preliminary study to examine the relationship between ICT adoption (through ICT Investment) and Indian MSME financial performance (Profit Before Depreciation Interest Tax Amortisation (PBDITA)) while examining the moderating role of Firm Size.
3. To examine the impact of Firm Size, Firm Age, Short-term borrowing, and Government aid on a Firm’s financial performance (Return on Assets(ROA)). To also examine the mediating role of ICT adoption on financial performance (Return on Assets).

4. To examine the impact of ICT adoption intensity (ICT Investment as % of sales), Gross working capital and Short-term borrowing as % of sales on Indian MSME performance (Return on Assets) for Micro, Small and Medium Firms for Pre-COVID (2015-2019) and during Covid Period (2020-2022).

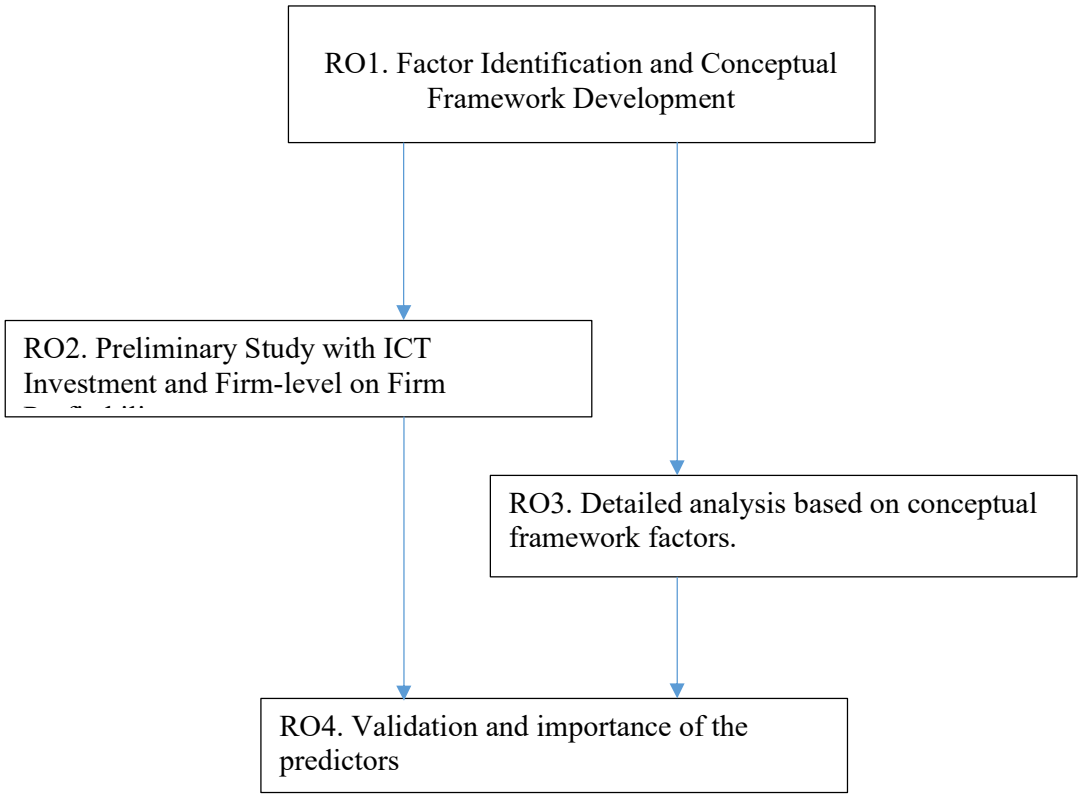


**Figure 1.1 Schematic Diagram for Research Objectives**

## 1.4 Motive and Scope of Study

The motive behind conducting this research was to investigate the comprehensive study to discover the theories responsible for ICT adoption in the literature review and develop a conceptual framework for future studies. Based on the developed conceptual framework to identify the relationship between ICT adoption, external and internal factors with financial resources on organisational performance in the Indian MSMEs Manufacturing sector. The significance of this study stems from the crucial role that MSMEs play in the Indian economy as drivers of employment, innovation, and economic growth. Despite their importance, many MSMEs face challenges, including limited access to financial resources and a lack of technological adoption, further deepened by the COVID-19

pandemic. In addition to the above, the motive is to investigate further the impact of ICT Investment on the panel data on the Firm performance.

The research aimed to address the following key aims:

1. To assess the current level of ICT adoption in Indian MSMEs: The study sought to understand the extent to which MSMEs in India have embraced ICT tools and technologies in their operations. This assessment provided insights into the existing digital landscape within the MSME sector and identified potential factors that responsibly work as moderating factors for ICT adoption decisions and impact the firm performance.

2. To examine and based on the conceptual framework, why the MSME adopted the ICT, what are the roles/impact of internal and external factors on the decisions on ICT and measures the impact of ICT adoption on firm performance through measuring financial parameters: The research explored how adopting ICT tools and technologies affects the management of financial resources within MSMEs. It investigated whether ICT adoption leads to more effective financial planning, budgeting, and resource allocation, enhancing the financial performance of these enterprises.

3. To analyse the relationship between ICT adoption and organisational performance: This study investigated the link between ICT adoption and overall organisational performance in Indian MSMEs. It assessed various performance indicators, such as revenue growth, profitability, productivity, and market competitiveness, to understand how ICT adoption influences these outcomes.

4. To propose recommendations for MSMEs and policymakers: Based on the research findings, this study aimed to provide practical recommendations for MSMEs and policymakers to enhance ICT adoption and the level of ICT Investment differently for Micro, Small and Medium. These studies' recommendations aimed to support MSME managers and other stakeholders to decide on whether ICT should be adopted or not, on what level the ICT Investment should be deployed, with which internal and external factors affect the leveraging ICT tools effectively, access to financial resources, and improving their overall performance and competitiveness.

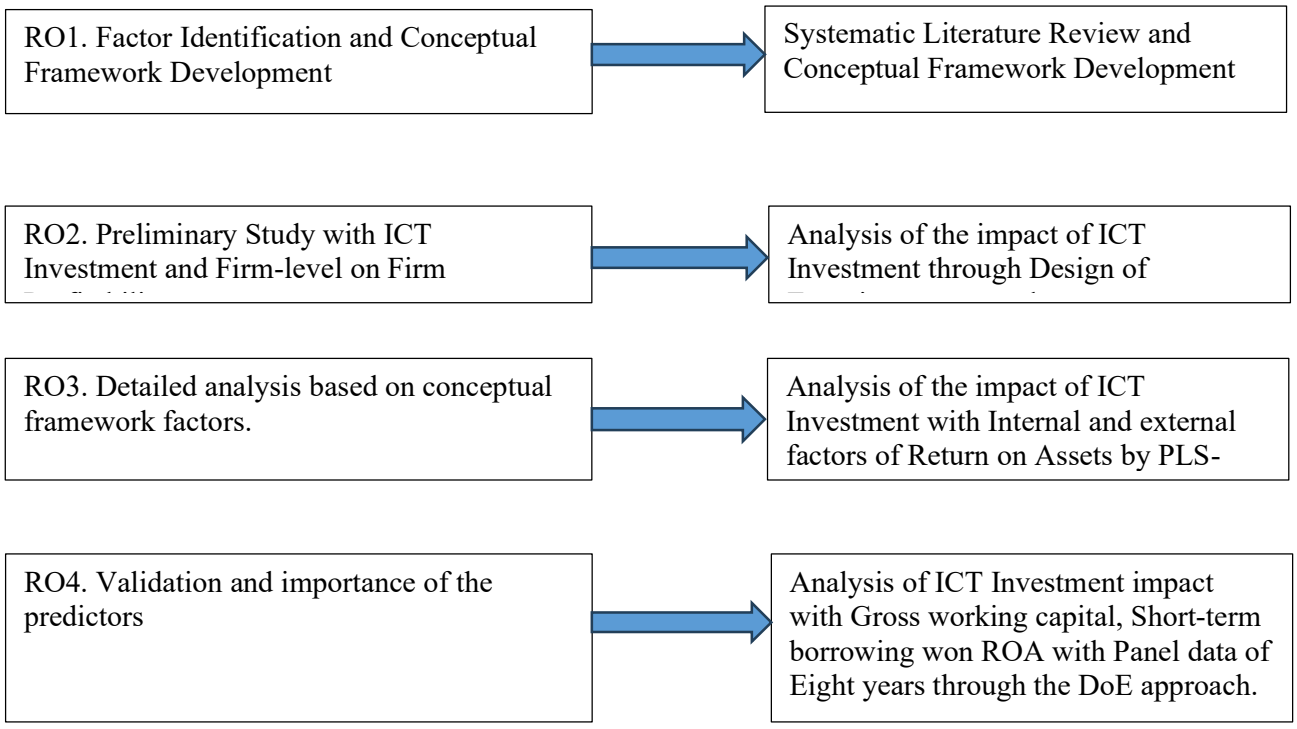


**Figure 1.2 Research Objective and Research Study Approach**

This study aims to analyse only some MSMEs in India partially. Instead, it adopts a representative sampling approach to gather data from diverse MSMEs across different sectors and regions. The findings and conclusions from this research will provide valuable insights into the broader trends and patterns within the Indian MSME sector and serve as a basis for further exploration and analysis.

The scope of this study was intended to contribute to the understanding of ICT adoption, financial resource management, and organisational performance in Indian MSMEs to provide actionable recommendations for MSMEs and policymakers to enhance their competitiveness and sustainable growth.

## 1.5 Research Methodology

This study consists of various research methodologies, and the research methodology is explained in all the respective chapters. The primary purpose is to briefly present research methods in line with the explained scope of this study mentioned in section 1.4. First, identify the factors responsible for ICT adoption, then provide a detailed conceptual framework, and test the impact of ICT adoption in the MSME sector by the performance parameters in financial parameters. This study aimed to study ICT Investment

implications with the role of the responsible factors tested with different statistical approaches on firm performance. The methodologies used are discussed in detail in respective chapters.

## 1.6 Significance of the Study

This study holds several significant implications for various stakeholders:

### *1.6.1 MSMEs:*

The findings of this study will provide valuable insights for MSMEs in India, helping them understand the importance of ICT adoption, working capital management, and short-term borrowing in achieving financial success. MSMEs can make informed decisions regarding technology Investments and financial strategies by identifying the factors contributing to organisational performance. The study will also shed light on the mediating effect of ICT integration and the moderating effect of the COVID-19 pandemic, enabling MSMEs to navigate challenging times and leverage opportunities.

### *1.6.2 Policymakers:*

The study's outcomes will assist policymakers in formulating effective policies and initiatives to promote ICT adoption, improve access to working capital, and facilitate favourable borrowing conditions for MSMEs. By understanding the link between ICT adoption, financial resources, and performance, policymakers can design targeted interventions to foster a supportive ecosystem for MSME growth and development.

### *1.6.3 Researchers:*

This research will contribute to the existing literature by providing empirical evidence on the relationship between ICT adoption, financial resources, and organisational performance in Indian MSMEs. The study will help bridge the research gap in this area and serve as a foundation for future research endeavours. The proposed conceptual framework is the stepping stone for future research.

### *1.6.4 Stakeholders*

This research will contribute and provide insights in detail accordance with the nature of firms, like Micro, Small and Medium enterprises with the level of Investment required, the impact of internal and external factors on the various stakeholders internally or

externally, like Government, Financial institutions, investors, creditors to take the decision and formulate their decisions.

## 1.7 Thesis Structure

The thesis is organised as follows:

Chapter 1: Introduction

This chapter provides a research background, the significance of the MSME Manufacturing sector in India, the problem statement, ICT, and underlying firm performance. Research objectives, the research motive, and the methodology used. Furthermore, this chapter mentions the significance of the current research, and last, it outlines the thesis chapter-wise.

Chapter 2: Literature Review and Conceptual Framework Development

This chapter introduces literature on ICT and various types of ICT technologies. Based on the literature,it summarises the theories and frameworks responsible for ICT adoption. After that, this chapter contains the seven most affecting factors responsible in the MSME sector for ICT, based upon this framework, the conceptual framework designed based on the research gap. It also discusses the firm-performance parameter for the current research to determine their expected relationship with ICT adoption. Finally, the summary and conclusions of this chapter are shown.

Chapter 3: Research Methodology

This study aimed to study firm performance implications with the role of the responsible factors evaluated with different statistical approaches. The brief of all the methodologies used is discussed in this chapter in three phases. This chapter also discussed the data set.

Chapter 4: Measuring the Effect of ICT on MSME Profitability

This chapter discusses the impact of ICT adoption on the profitability of Micro, Small, and Medium-Sized Enterprises (MSMEs) in India. It highlights the role of MSMEs in economic development and their potential for generating income and employment. The chapter emphasises the need for MSMEs to adopt ICT to enhance their competitiveness in the global economy. It also explores the challenges MSMEs face, such as lower productivity and higher costs than large companies. The chapter presents a conceptual framework and research objectives for studying the impact of ICT Investment on

profitability. It discusses the literature review, research methods, and data collection process. The chapter sets the stage for further analysis of the relationship between ICT adoption and profitability in the MSME sector.

Chapter 5: Measuring the Impact of ICT on MSME firm performance paradox.

This research study focuses on the impact of ICT (Information and Communication Technology) Investment on Micro, Small, and Medium Enterprises (MSMEs) performance in the Indian Manufacturing sector. The study aims to answer four research questions related to ICT adoption, external factors (Government and financial credit), internal factors (Firm Size and age), and their influence on firm performance. The research uses a quantitative approach and secondary data from the Prowess database. The findings indicate a positive relationship between ICT Investment and firm performance, highlighting the significance of appropriate ICT utilisation in improving financial performance for MSMEs in India's Manufacturing sector.

Chapter 6: Validating the Impact of ICT along with Gross working capital and short-term borrowing on MSME firm performance in the COVID-19 Period.

The chapter introduces the study, which focuses on the impact of information and communication technology (ICT) Investment on the financial performance of Micro, Small, and Medium enterprises (MSMEs) in the Manufacturing sector. The COVID-19 pandemic has emphasised the need for firms to be financially resilient and explore new business opportunities in the digital era. The chapter discusses the role of ICT in transforming business processes and improving efficiency, competitiveness, and sustainability. It highlights the challenges MSMEs face in accessing credit and the importance of quantifying the commercial value of ICT Investments. The chapter also presents the research questions and hypotheses to be addressed in the study. The subsequent sections provide a literature review on the relationship between ICT and firm performance and discuss the methodology and design of the experiment.

Chapter 7: Conclusion and Recommendations

This chapter summarises the research findings, conclusions drawn from the study, and recommendations for future research and practical implications.

## 1.8 Conclusion

This chapter served as an introduction to this thesis. The context of this investigation was presented first, followed by the MSME status in India. The chapter then described the research queries and objectives pertinent to the study. An explanation of the scope and purpose of the study followed this. The chapter concludes with a summary of this thesis project. This doctoral thesis was planned and executed based on a comprehensive literature review.

# CHAPTER 2: LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

## 2.1 Introduction

After the COVID-19 outbreak, when global supply chain disruptions gripped the globe, the term “resilient” has gained common parlance worldwide. This situation continued for Years and stifled international interest, causing key economies to halt for several months. This pandemic, COVID-19, has produced numerous economic and employment-related difficulties. The job market has nearly collapsed after the rigorous lockdown imposed by Governments in major economies such as India, China, and Europe. This shutdown has halted economic activity and the economy in transition. India took substantial measures to stimulate economic activity and establish a labour market.

ICT-based entrepreneurship is available across business verticals (Alderete, 2017). E-business gives SMEs more market and resource access, according to (K. Zhu et al., 2003). Small firms must innovate to survive global competition (Madrid-Guijarro et al., 2009). The system lost agility when the supply chain stopped, leaving only information flow. India is no exception. Global trade and exports fall, and rising fuel prices hurt the SME sector, contributing most to employment and the Indian GDP. Resilience contributes more to SME growth and sustainability(da Silva et al., 2022). Innovation requires ICT infrastructure reliability, security, and technology (Won & Park, 2020) (Jiménez-Zarco et al., 2015) (Torrent-Sellens et al., 2016).

New IT adoption is always the subject of choice for Small businesses considering its value for business or threat to their business (Macpherson et al., 2005), explained by the Authors (Nguyen et al., 2015) in their paper that IT adoption rates in Small businesses are low and have high failure rates. A time delay usually exists when the management selects a new system and users adopt the approach (C. K. Y. Y. Ho et al., 2020). Many authors have profoundly used Cloud computing as an emerging ICT tool that provides opportunities for fulfilling cloud computing services, providing a different experience (Sultan, 2011) (Sabi et al., 2016).

This literature review focused on enablers and antecedents of adoption due to ICT’s importance in ecosystem development, especially in SMEs. This research seeks to

predict, understand, and propose a conceptual framework for ICT integration across the value chain and business performance evaluation.

Section 2 reviewed SME ICT adoption research to address these issues. ICT began in the mid-1980s and evolved. ICT definition and use in SME Manufacturing have yet to be discussed. This chapter defines ICT from hardware, software, and transmission devices to advanced technologies like AI, IoT, and blockchain. This chapter divides ICT evolution into three phases: traditional, contemporary, and emerging. We also discussed the timeline of articles on SME Manufacturing ICT adoption by different authors.

In section 3 (Methodology), the Systematic Literature Review (SLR) use clear and predefined methods to comprehensively identify, rank and synthesise all related studies to respond to specific studies (Snyder, 2019) (Yan et al., 2021). Therefore, we have used the SLR methodology for this literature review. In this chapter, we have identified 135 articles suitable for study. The unique thing about this review chapter is that we do comprehensive research of journals that have reported on the extant literature based on the subsequent four research questions.

Section 4 (Technology Adoption Theories) discussed technology adoption motivation and antecedents. This chapter summarises all relevant technology adoption theories using paper usage frequencies. To better understand the factors, this study discusses fundamental theories like Technology, Organizational, and Environmental (TOE), Technology Acceptance Model (TAM), and Unified Theory of Acceptance and Use of Technology (UTAUT) from their original authors' papers. New technology adoption depends on Perceived Ease of Use (PEOU) and Perceived Usefulness (PU). The extended TAM depends on the individual's cognitive matching of job goals with system use (job relevance) and output quality. TOE resembles organisational innovation diffusion theory (IDT), and IDT explains leader traits, organisational internals, and external factors. TOE technology adoption depends on technological, organisational, and environmental factors. UTAUT model predicts technology use behaviour using social influence, effort expectancy, facilitating conditions, and performance expectancy as critical factors and experience, gender, voluntariness, and age as moderators.

Section 5 discusses the literature review-based ICT adoption framework in SMEs. These factors affect how well SMEs use ICT on TOE, TAM, and UTAUT frameworks. Most studies on how people use ICTs used only one theory or framework. Few talked about

how age, gender, and trust affect the use of ICT. ICT must be measured in most SME business performance parameters. SME change is driven by how they use ICT and how they lead. SMEs are Small, family-run businesses. The top management must look at change Investments. This chapter looks at the effects of top management education on entrepreneurial culture, decision-making style, and decision-making style. These antecedents are firm-specific related factors because technology success in emerging countries depends on the organisation's context, culture, and values. The TOE model suggests that Firm Size affects technology adoption. Still, a Microstudy examines how Firm Size, culture, and location affect SMEs' adoption decisions. Studies show that technology success requires training. Some do not connect pre-training and training environment intervention involving users' motivation and technology use. SMEs that are intelligent and creative use new technologies. Adoption depends on how new technology is, how much it costs, and how much Investment is required. Smaller businesses must pay more to get loans. Their credit scores make it hard for them to get credit. SME Investments in ICT technology include both new purchases and upgrades. Trust is important. For some authors, trust was the main reason people adopted their ideas, while it was a middle ground for others. The literature review does not look at trust in suppliers, cyber security, or the effects of these things. Government pressure and the TOE framework are crucial in emerging countries like India, where the Government is the primary buyer of SME products. The Government forces SMEs to adopt new technologies to compete with fast-changing business dynamics. Suppliers like direct communication. University, financial, information, and research institutions collaborate on ICT policy research.

Section 6 proposes the conceptual framework for the prospective study; within the conceptual framework, the extent of ICT to measure business performance. Financial, and o name appeared in the papers sorted for this study, and in column 3perational, are the business performance metrics used to evaluate the impact of ICT adoption in the SME sector. We proposed ICT integration on the value chain as a mediator that may influence the business performance of SMEs. This conceptual framework is one of the first to propose that ICT integration affects the entire value chain of SMEs, a neglected area of research in ICT adoption. Three sections with ICT integration are the value chain, the technological attributes, and the application sections. The scope of ICT is the launching point from which we propose categorising all technological advancements in ICT

according to their timeframe, followed by an analysis of their impact on business parameters such as agility, resilience, innovation, transparency, social environment, diversity, equity, and inclusion.

In the last two sections, this study uses a conceptual framework to analyse this research area, frameworks/theories related to technology adoption, theme, context, and critical success factors in SMEs. Most studies focused on a limited number of aspects pertinent to adopting new technology, especially in the SME sector. Before identifying the needs of the nation's SME sector, extensive research is needed. This search is limited to the English-language database, which does not include the entire global database.

### *2.1.1 Information and Communication Technology (ICT)*

Rapid technological advancement has accompanied the development of information and communication technologies (ICT). This change has decreased the price of these technologies, increasing their use. ICT is an acronym that combines two terms: information technology and communication technology. ICT generally refers to integrating hardware and software for a specific application (Nousala et al., 2008). ICT refers to the technological systems that transmit, store, process, display, generate, and automate information dissemination (Chege et al., 2020) (Schubert & Leimstoll, 2007). Some authors define ICT as a combination of software and hardware applications. ICT, on the other hand, can be combined with various technologies to achieve the desired result.

The definition of Information communications technology (ICT) is.

*"An extensional term for information technology that emphasises the role of unified communications and the integration of telecommunications media, computers, and necessary firm software, middleware, storage and audio-visual systems that facilitate users to access, store, share and manage information."*

(*Information_and_communications_technology @ En.Wikipedia.Org*, n.d.)

New, user-friendly ICT tools have proliferated over the past three decades due to the proliferation of ICT innovations (Pradhan et al., 2020). Over the past ten to fifteen Years, the evaluation of ICT has undergone unexpected shifts, and the use of ICT has shifted from early Internet usage to advanced computing technologies. This technological advancement is pervasive throughout numerous industries (Ahuja et al., 2010). The invention of the transistor, a semiconductor device that functions as an electrical switch, gave birth to contemporary ICT (Jorgenson & Vu, 2016). The ICT type also depends on

its application (Welker et al., 2008).

## 2.2 ICT in a broader context

ICTs expand the information society (IS) (Cuadrado-Roura & Garcia-Tabuenca, 2004). ICT includes hardware, software, networks, and the people who provide and maintain the system (Schubert & Leimstoll, 2007). Email and Web-based communication systems are simple, cheap, easy to implement, and flexible (Chiarvesio et al., 2004). The simplest ICT ERP integrates the company's departments and information flow across the value line (Schubert & Leimstoll, 2007). All ICT studies initially focused on how a firm uses its intranet, website, and Internet, as well as how it uses ICT applications like collaborative technologies or simulators (Lopez-Nicolas & Soto-Acosta, 2010) and how it affects its software, hardware, and telecommunications (Becchetti et al., 2003). ICT uses many technologies to codify and store knowledge, including web-based ones like the Internet, groupware, and collaborative systems (Cegarra-Navarro et al., 2010). Initially used for learning, ICT is now learning and upgrading with advanced Manufacturing technology as the industry matures.

In business, we have categorised ICT into three broad types of products used:

1. Traditional ICT computer-based applications.
2. Contemporary ICT-based applications.
3. Emerging ICT applications.

In the literature, ICT is typically used from computers and the Internet to various advanced technologies like IoT and blockchain.

**Table 2.1 Types of Information and Communication Technology**

| Traditional | Contemporary | Emerging |
|---|---|---|
| Broadband | Cloud Computing | 3D printing |
| Computer | Customer Relation Management (CRM) | Advanced robotics |
| Electronic Data Interchange (EDI) | Cyber Security | Artificial Intelligence Mark-up Language (AIML) |
| Email | Local Area Network (LAN) | Blockchain |

| | | |
|---|---|---|
| Enterprise Resource Planning (ERP) | RFID | Edge Computing |
| Fax | Robotics | Internet on Things (IoT) |
| Hardware | Telecommunication (4G) | Location detection technologies |
| Internet | | Machine-to-machine communication (M2M) |
| Software | | Quantum Computing |
| Supplier Relation Management (SRM) | | Smart sensors |
| Telecommunication (3G) | | Telecommunication (5G) |

From Table 2.1, in the traditional form of technology, broadband, computers, and the Internet were widely used in the industry. In reviewing the literature, findings suggest that until 2011, SMEs involved in the Manufacturing sector adopted more complex information technology (IT) tools such as enterprise resource planning (ERP) software or inventory management software (Tan et al., 2010). Furthermore, ICT evolved many stand-alone media, including telephone and mobile telephony, radio, television, video, Teletext, voice information systems and fax, and computer-mediated networks that link a personal computer (PC) to broadband Internet technology (Apulu et al., 2011). These findings summarise the use of ICT mainly in Electronic Data Interface (EDI), ERP, Supplier Relation Management (SRM) and mobile telephony in 3G form. However, other studies have examined the fundamental distinction between access to the infrastructure (i.e., the adoption of a broadband Internet connection) and the adoption of related services (i.e., different broadband software applications) (Colombo et al., 2013).

In the contemporary Period of technology use, from 2013 onwards, the cloud application gained popularity and started to be used widely in the industry. Cloud-based end-user services, such as email or office applications, increasingly find their way into daily business practices, offering new opportunities and capabilities (Alshamaila et al., 2013). The new term, Emerging ICT(EICT), is defined broadly as any new ICT development or improved ICT applications, including time tracking devices, customers and operations information, knowledge management systems, document management systems and

mobile devices (Sunday & Vera, 2018). Several advanced ICT activities, such as enterprise resource planning (ERP) systems, mobile Internet access, and e-commerce practice, have moved to the cloud (Biagi & Falk, 2017), (AlBar & Hoque, 2019), (T. Cragg & McNamara, 2018). Cloud computing (CC) is emerging as a new paradigm of resource acquisition and management of information and communication technologies (ICT) by firms (Loukis et al., 2017). Cloud computing has transformed information and communication technologies (ICT) capabilities through new forms of hosting and delivering ICT services over the Internet (Wakunuma & Masika, 2017). However, ICT advancement has yet to be reached in low-income countries like Cameroon, which still examine SMEs' diffusion of personal computers (PCs) and the Internet (Ntwoku et al., 2017). Using the cloud and its associated migration to the cloud eliminates expensive hardware costs and enables them to unify the hardware, software, data and platform services (Wakunuma & Masika, 2017). This Period has also witnessed a surge in the use of 4G technology and advancement in 5G mobile technology, which has enhanced business use. Many applications have arrived on an individual's mobile phone. This mobile enables accessible business and access to the latest technological advancement with better reach and reliable information.

Industry 4.0 brings new technological advancement in automation and sophisticated emerging technologies. (AlBar & Hoque, 2019) They have opined that ICT technologies such as the Internet, Extranets, Intranets, ERP, and other technologies improve an organisation's services and operations. However, during this Period of Industry 4.0, the pervasiveness of new digital technologies like the Internet of Things (IoT), big data, and simulation approaches based on high-performance computing applied to Manufacturing processes in large organisations (Neirotti et al., 2018) (X. V. Wang & Wang, 2017). The perception of a new ICT technology would influence its adoption decision in SMEs (Hassan et al., 2020). Using ICT allows firms to gain a competitive advantage over their competitors (AlBar & Hoque, 2019). The countries in the EU region understand the priority, and they are giving to use of, especially in frontier technology such as Automation, Artificial Intelligence, Machine Learning, Cyber-Security Systems, Data Analytics Technology, and other smart Manufacturing innovations that enhance universal access to the cyberspace (Pradhan et al., 2020). Still, this is a far-distance target for firms in emerging countries. They rely on fixed telephone lines, mobile phones, radio, satellite systems, videos, computers, network software and hardware, and the equipment and

services related to these technologies, such as emails, video-conferencing, blogs, and social media (Chege et al., 2020). Mobile phones, smartphones, and tablets, among other devices, are embedded in people's daily work (Alderete, 2017) (Kabanda & Brown, 2017).

## 2.3 Methodology for literature review

This study focuses on ICT applications in Small and Medium Manufacturing organisations and tiny businesses worldwide. This study follows a methodological approach similar to that of (Sony & Naik, 2020),(R. Sharma et al., 2020), (Badi & Murtagh, 2019), (Yan et al., 2021), (Despeisse et al., 2022), (da Silva et al., 2022). Systematic Literature Review (SLR) strives to use clear and predefined methods to comprehensively identify, rank, and synthesise all related studies that meet the predefined eligibility criteria to respond to specific studies (Snyder, 2019) (Yan et al., 2021). (Paul & Criado, 2020) in their research paper on the art of writing, the typical systematic literature review can be written using 40–50 to 500 relevant articles; in this chapter, we have covered 135 papers from reputed journals, so it is more than the suggested limits.

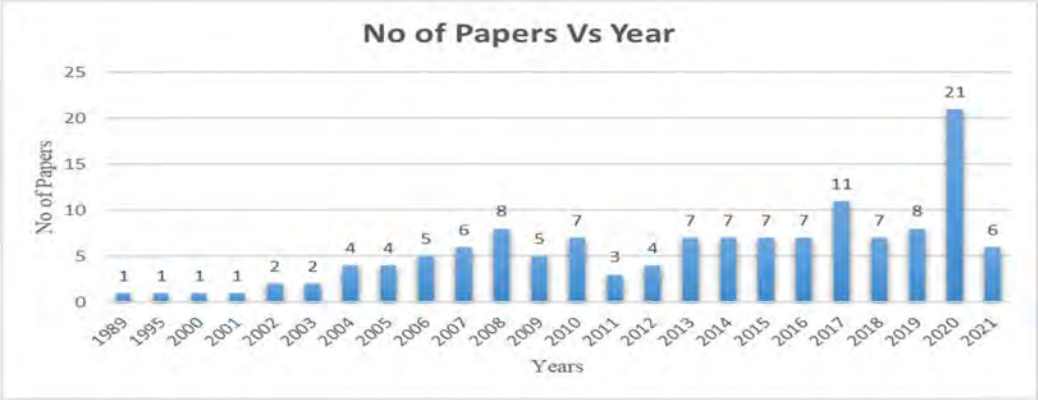


**Figure 2.1 The number of sampled papers published per Year.**

Comprehensive research of journals has reported on the extant literature based on the subsequent four research questions:

1. What is the position of the study and research profile on the existing ICT adoption in the SME Manufacturing sector worldwide?

2. What are the different research themes and factors examined in prior literature on ICT adoption?

3. What models and frameworks are recommended by scholars on ICT adoption in

SMEs?

4. Which ICT technologies are used, with the critical variables and the mediating effects on the value chain on the business performance?

A carefully planned process was used to narrow down a large body of knowledge into a Small, well-chosen group to make this systematic literature review as scholarly as possible. The choice of keywords, which were "ICT," "SME," and "Manufacturing," was to catch the most relevant and meaningful articles on this complex web.

The language was limited to English to keep the understandable papers. This selection made combining different articles and papers easier to provide better expertise on the subject under study. EBSCO, Emerald, Science Direct, Scopus, Springer, Taylor & Francis, Wiley Online, and ProQuest are all the top academic platforms used in this study. Digital space was used to explore the landscape of scholarly discourse.

This study was based on how much data was collected and how well it was narrowed down into a methodological precision based on the research questions. Each research paper went through a symmetrical process of analysis and critical evaluation, which was guided by a review protocol that was carefully made. The plan for this protocol set that the papers related to abstract reading with main characters of ICT, SME and Manufacturing laid the groundwork for creating preliminary search criteria for what to include and what to leave out, defining the boundaries of what is relevant in this constant study. After carefully reading abstracts, keywords, and papers published in high-quality journals, duplication of paper, 583 papers were eliminated from 736.

In the next phase, all the research papers were called to the analysis stage, where their full papers were carefully reviewed, sorted out, looked at, and put together for the elimination of further elimination of 54 papers. This gathering of 99 papers provided a base of literature. However, in the third phase, the references are reviewed in the snowballing search; 36 papers are found suitable and aligned to the subject.

As the summary came down on this scholarly show, 135 articles stood in the light, showing their worth by passing through a strict evaluation process. The process of identifying and selecting relevant articles is depicted in Figure 2.4.

Figure 2.1 shows the number of papers published in the subject area from the Year starting in 1989 to the end of 2020. As can be seen, the study of ICT adoption in the subject area

has increased constantly from 2013 to 2020 and has enjoyed growing popularity over the Years. Figure 2.2 highlights the 13 most cited papers in the sample according to a citation score. The total number of citations in the database Google Scholar has been available. Figure 2.3 provides an overview of the academic peer-reviewed journals that published the most papers. As can be seen, the MIS Quarterly and Journal of Enterprise Information Management (9), the Journal of Small Business Management and International Journal of Information Management (8), Information Technology for Development (4), Information and Management, Information Systems Frontiers, Information Systems Research, the Journal of Manufacturing Technology Management, and Telecommunications Policy (3), Production and Manufacturing Research (2) have been the most popular research outlets. Other summaries cover 71 journals; the remaining journals have published two or fewer papers. These journals are the top ones with high impact factors.

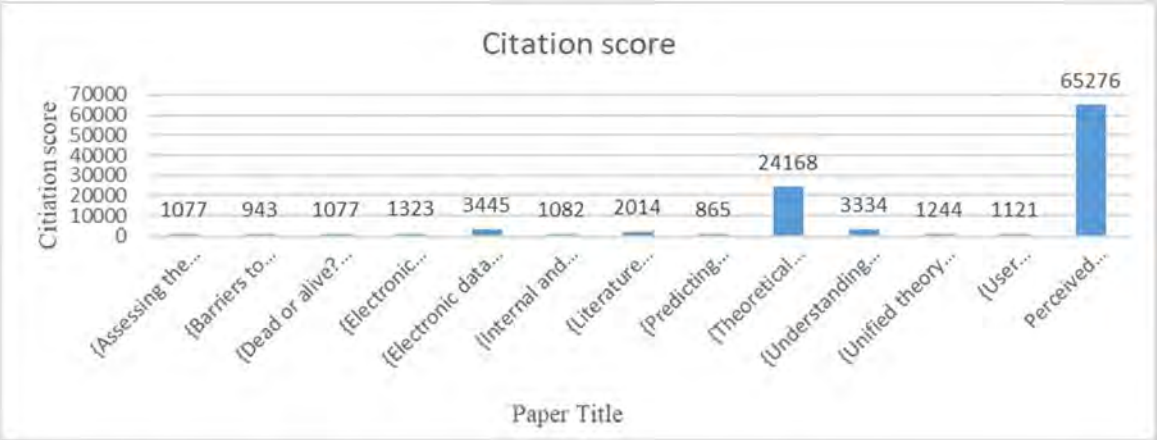


**Figure 2.2 Most cited papers.**

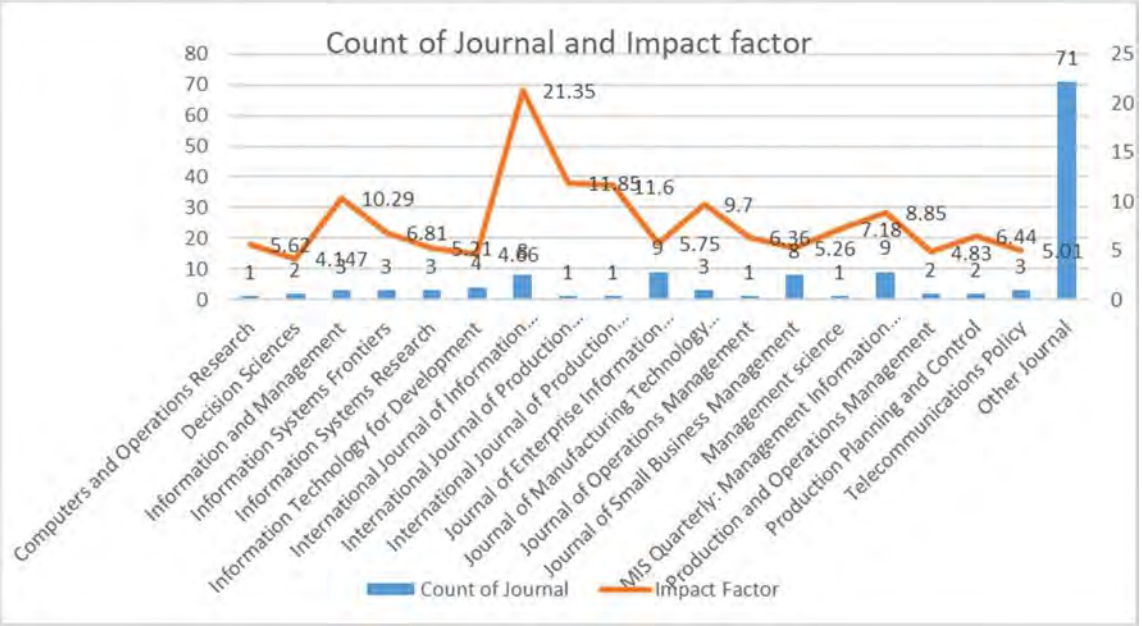


**Figure 2.3 Journals that published the highest number of papers contained in the sample with their impact factors.**

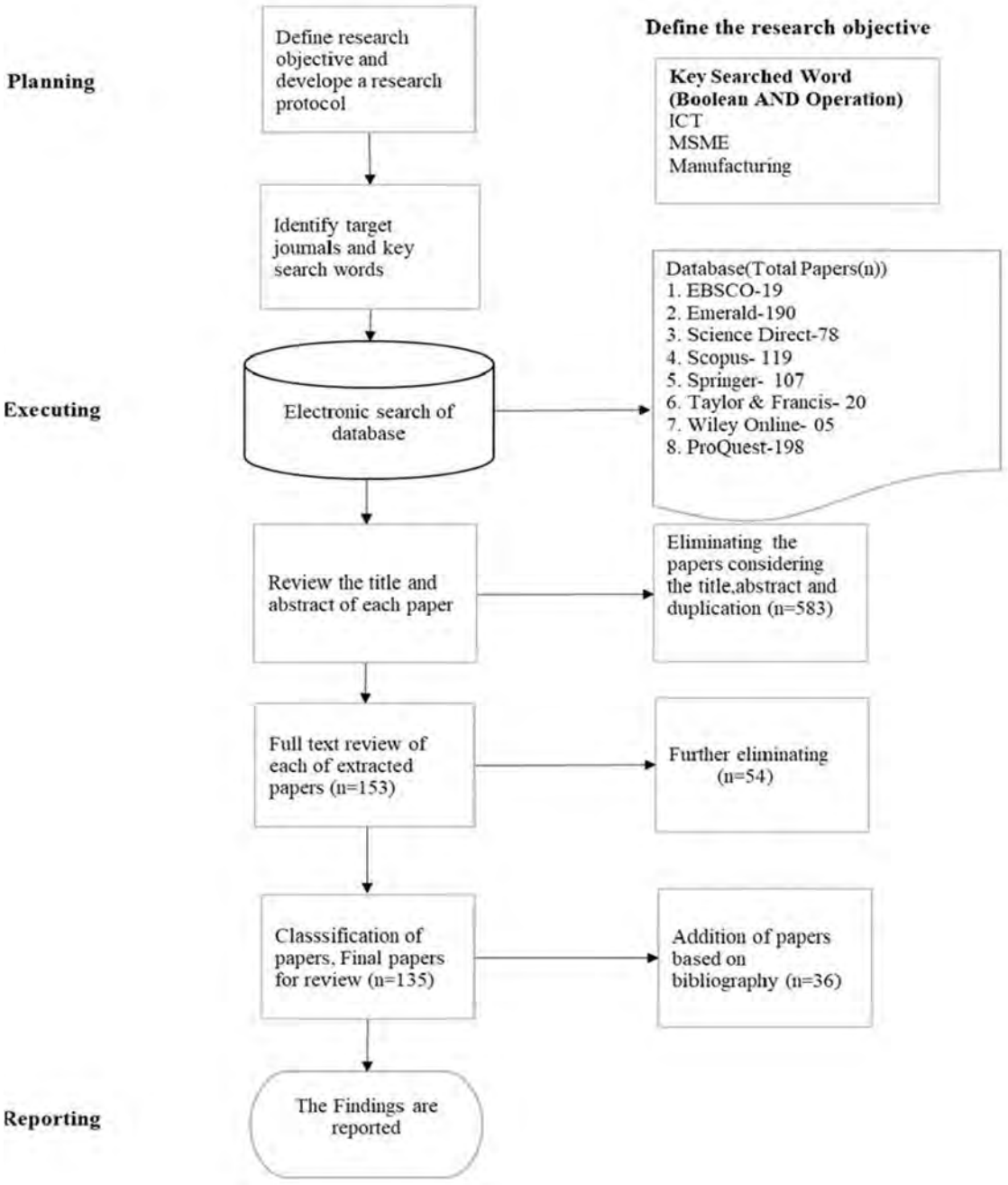


**Figure 2.4 Flowchart for Systematic Literature Review (SLR).**

### *2.3.1 Theories for Technology Adoption*

The Technology Acceptance Model (TAM), Technological, Organisational, and Environmental (TOE), and the Unified Theory of Acceptance and Use of Technology (UTAUT) are the three adoption theories most frequently employed by researchers to explain ICT adoption in SMEs (Table 2.2). Various researchers use these theories below

consistently, and some explicitly define the antecedents based on the factors limiting the underlying theories for ICT adoption. Several researchers have used one of these theories to understand and describe the predictor for SME technology adoption. Nonetheless, several researchers have evolved and modified all three theories over time. In Table 2.2, we elaborate on the number of papers that used the adoption theories for elaborating the factors responsible for describing ICT adoption in SMEs. In column 2, the frequencies represent the total number of theories/frameworks under which their name appeared in the papers sorted for this study. In column 3, the actual frequencies relate to papers in which the theories/frameworks are used to study the ICT adoption in SMEs. Column 4 is the author's name, describing technology adoption using these theories. The TOE framework mainly explains the adoption of various technological innovations. In TAM, two determinants are crucial: perceived ease of use (PEOU) and perceived usefulness (PU). Whereas in UTAUT, behavioural intention is vital to making decisions.

Table 2.2 has revealed that most related theories have been covered and are presented in column 2 with their frequencies. The number of papers related to ICT adoption factors is described in the third column. Of the profoundly used theories, the UTAUT is the least prevalent, with only 4 out of 8 articles discussing ICT adoption in SMEs. TAM and TOE are the maximum numbers to discuss ICT adoption, with a frequency of 11 each. The remainder is either few or one in number.

### *2.3.2 Technology Acceptance Model (TAM)*

Two factors influence technology adoption (Davis, 1989). First perceived ease of use (PEOU), where potential users believe a given application is valuable but that the system is too complex to use, and that the effort required to use the application outweighs the performance benefits. The second is perceived usefulness (PU), which determines whether people use an app to improve their work. TAM states that individuals' evaluations of a new IT application—as captured by perceived usefulness (PU) and perceived ease-of-use (PEOU)—influence whether they use the application (S. S. Kim, 2009). TAM can be used to infer how performance- and effort-specific variables affect intention, according to (Hong et al., 2014). When an organisation adopts a complex system, a single system implementation strategy with training primes users with a high conceptual level can lead users to rely more on PU and less on PEOU in their decision-making (C. K. Y. Y. Ho et al., 2020). Most e-commerce studies use the TAM and find

voluntary behaviour (Pavlou & Fygenson, 2006). In the extended TAM (Venkatesh et al., 2000), an individual's cognitive matching of their job goals with the consequences of system use (job relevance) affects decisions about a system's usefulness, and output quality becomes more critical as job relevance increases.

### *2.3.3 Technological, Organisational and Environmental (TOE)*

Rogers' (1983) Innovation Diffusion Theory (IDT) matches TOE in organisations. IDT's three adoption predictors are leader characteristics (leader's orientation toward change), organisational slack, complexity, centralisation, size, formalisation, interconnectedness, and system openness (K. Zhu et al., 2003). The TOE framework states that a firm can implement innovative practices with the right balance of internal and external drivers after describing technological, organisational, and environmental drivers. Intrinsic motivation made technology easy to use and valuable (Venkatesh et al., 2002); the TOE framework shows three contexts for innovative practices.

1. The technological context: - (Loukis et al., 2017) say that it involves the innovation's technical infrastructure, processes, and capabilities.

2. The organisational context: (Loukis et al., 2017) say that it involves resources and interactions concerned with innovation.

3. The environment: According to (Loukis et al., 2017), factors like stakeholder pressure, the regulatory environment, and competition impact innovation.

## Table 2.2 Theories/Framework Related to ICT adoption.

| Adoption related Theories/Framework | Frequencies of Theories/framework names appeared in the papers under this study | Actual frequencies of Theories/framework used to study ICT adoption in the SME under this study | Authors |
|---|---|---|---|
| Technology Acceptance Model (TAM) | 13 | 11 | (Kohn & Hüsig, 2006), (Lee et al., 2015), (Khalil Moghaddam & Khatoon-Abadi, 2013), (Mohd Salleh et al., 2017), (Abrahamse & Lotriet, 2012), (Hassan et al., 2021), (Ho et al., 2020), (Alam & Adeyinka, 2020), (Pavlou & Fygenson, 2006), (Sabi et al., 2016), (Soong et al., 2020) |
| Technological, Organisational and Environmental (TOE) | 12 | 11 | (AlBar & Hoque, 2019), (Alshamaila & Papagiannidis, 2013), (Loukis et al., 2017), (Abed, 2020), (Kim et al., 2017), (Oliveira et al., 2014), (Tagliavini et al., 2001), (Venkatesh & Bala, 2012), (Zhu et al., 2003), (AL-Shboul, 2019), (El-Haddadeh, 2020) |
| The Unified Theory of Acceptance and Use of Technology (UTAUT) | 8 | 4 | (Soong et al., 2020), (Venkatesh et al., 2008), (Venkatesh et al., 2002), (Dasgupta & Gupta, 2019) |
| Diffusion of innovation theory | 3 | 3 | (Oliveira et al., 2014), (Sabi et al., 2016), (Shaltoni et al., 2018) |
| Strategic alignment model | 2 | 2 | (Gutierrez et al., 2009), (Hua, 2007) |
| Agency theory | 2 | 1 | (Cragg & McNamara, 2018) |
| Absorptive capacity theory | 1 | 1 | (Gray, 2006) |
| "Bring Your Own Device model" (BYOD) | 1 | 1 | (Osborn & Simpson, 2017) |
| Capability maturity model | 1 | 1 | (Marasini et al., 2008) |
| Digital innovation | 1 | 1 | (El-Haddadeh, 2020) |
| Electronic marketing orientation (EMO) | 1 | 1 | (Shaltoni et al., 2018) |
| Techno-Economic model | 1 | 1 | (Guerrieri & Pietrobelli, 2004) |
| Vector Error-Correction model | 1 | 1 | (Pradhan et al., 2020) |
| Benchmarking framework | 1 | 1 | (Ahuja et al., 2010) |
| Information-processing theory | 1 | 1 | (Neirotti et al., 2018) |
| Real Option theory | 1 | 1 | (Becchetti et al., 2003) |
| Resource-based view | 1 | 1 | (Khanzode et al., 2021) |
| Resource-advantage theory | 1 | 1 | (Foroudi et al., 2017) |
| Theory of constraints | 1 | 1 | (Nousala et al., 2008) |
| Classical resources munificence theory | 1 | 1 | (Awa et al., 2015) |
| Commitment–trust theory | 1 | 0 | |
| Concept of dynamic capacities | 1 | 1 | (Sunday & Vera, 2018) |
| Actor-network theory | 1 | 0 | |
| Grounded theory and Cognitive model of decision-makers | 1 | 1 | (Rantapuska & Ihanainen, 2008) |
| Human capital theory | 1 | 0 | |
| SCOT (Social construction of technology) & Innovation diffusion theory | 1 | 1 | (Oni & Papazafeiropoulou, 2014) |
| SECI (socialisation, externalisation, combination and internalisation) model | 1 | 1 | (Lopez-Nicolas & Soto-Acosta, 2010) |
| Social actor theory | 1 | 1 | (Fink & Disterer, 2006) |
| Social identity theory and role congruity theory | 1 | 1 | (Bendell et al., 2020) |
| Strategic choice theory and management fashion theory | 1 | 1 | (Yu et al., 2018) |
| The Theory of Communicative action | 1 | 1 | (Kabanda & Brown, 2017) |
| International Entrepreneurship (IE) theory | 1 | 0 | |
| Theory of planned behaviour | 1 | 1 | (Pavlou & Fygenson, 2006) |

SME owners and managers can address customer pressure, which drives technology adoption in the environment (Abed, 2020). (Villa et al., 2018) The TOE framework helps analyse adoption variables instead of the Technology Acceptance Model (TAM). Since

TOE is simple and details how technological innovations depend on technology, organisation, and environmental factors in the related study (S. H. Kim et al., 2017). (Loukis et al., 2017) The TOE theory provides a general framework for studying the adoption and adaptation of various technological innovations. Structural Equation Analysis is a standard statistical method for TOE framework publications on technology adoption (Villa et al., 2018). According to the authors, technology readiness, standards uncertainty, and process compatibility had synergistic effects, and relationship trust and expected benefits directly affected the adoption of IT-enabled inter-organisational business process standards (Venkatesh & Bala, 2012).

### *2.3.4 Unified Theory of Acceptance and Use of Technology (UTAUT)*

The author (Venkatesh et al., 2003) stated that four key factors are social influence, effort expectancy, facilitating conditions, and performance expectancy. Experience, gender, voluntariness, and age are four moderators in the UTAUT model that predict behavioural intentions to use technology and existing technology used in organisational contexts. (S. S. Kim, 2009) argues that UTAUT can serve as a basis for other longitudinal models of technology use and is better than other models (e.g., TAM, TPB). (Venkatesh et al., 2012) UTAUT2 fused three context-specific factors, i.e., hedonic motivation, habit, and price value, as predictors of behavioural intention in the consumer context. The study (Venkatesh & Zhang, 2010) suggests that culture is equally essential in technology adoption from a scientific and practical standpoint.

## 2.4 ICT adoption framework in SMEs

In this study, the findings suggest that there are many studies on the framework or theory used to understand and describe technology adoption drivers in different aspects. (Khalil & Belitski, 2020) The author believed IT governance had a wheel structure with three IT domains: operation, strategy, and management. Most TOE frameworks covered (Alshamaila et al., 2013) did not find enough evidence that competitive pressure was a significant determinant of cloud computing adoption. A study by (Ahuja et al., 2010) benchmarked ICT adoption for building project management by SMEs in the construction industry. This adoption helped categorise organisations into low, Medium, and high levels and identify industry trends and gaps. However, this measurement must account for SME business performance levels. The agency problem disrupts relationships and interactions between SMEs and their immediate upstream and downstream partners,

according to (T. Cragg & McNamara, 2018). However, this framework discusses integration and examines partner roles, control variables, and their effects. (Hong et al., 2014) outlined six steps for IS research context-specific theorising. (Nguyen et al., 2015) It examined information adoption in SMEs with two internal and external drivers, but it should have covered all variables in ICT integration with the value chain. (AlBar & Hoque, 2019), (Venkatesh & Bala, 2012) examined ICT adoption using a TOE framework, but the intent of use with perceived benefit needs further study. Technological infrastructure issues are crucial (Wakunuma & Masika, 2017), but the study has yet to discuss integration with technology providers and their impact on decision-making.

In the supply chain, the relationship between buyer and supplier is significant in enabling each other to drive technological advancement. Usually, SMEs are the suppliers/vendors of significant companies and the Government sector because of their Small size and primary manufacturer-specific product lines. As bulk buyers, these companies have significant influence and drive the value chain in the SME. Their decisions, directly and indirectly, affect the entire supply chain's performance. Thus, the buying organisation is one of the primary enablers for ICT adoption in the SME sector. Nevertheless, this ICT integration significantly impacts the whole value chain, which researchers need to pay more attention to in their study of ICT adoption.

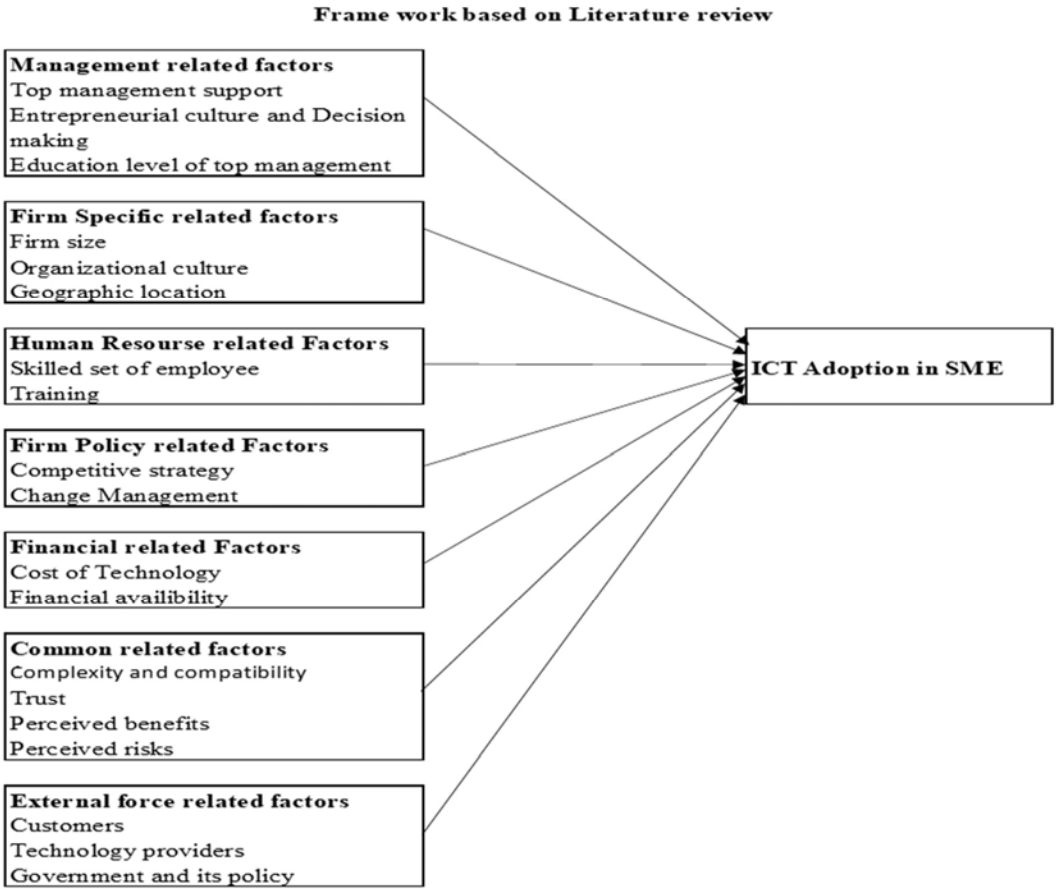


**Figure 2.5 A Framework on the drivers and Enablers of ICT adoption in SMEs.**

The study categorises critical success factors based on the literature review to understand, summarise, and demonstrate several factors influencing SME ICT adoption decisions. In the following part, this study presents a thorough conceptual framework with research issues virtually ignored by other researchers to understand ICT extent with control factors, ICT integration in the value chain, and its impact on business performance. (Yan et al., 2021) The "Continuance Intention of Online Technologies" survey matches this review study. The antecedents and consequences of SMEs adopting ICT are used to propose a conceptual model (Figure 2.5). The moderating variable affects the dependent variable (perception of public e-procurement use) with six independent variables (PEOU, PU, non-repudiation, facilitating conditions, social influences, and usage decision) in SMEs (Soong et al., 2020). In the study, the IT service partnership modifies organisational capabilities and proximities (Findikoglu & Watson-Manheim, 2015). According to (K. Zhu et al., 2003), the Firm's scope is the most critical factor. All researchers list the elements.

(Venkatesh et al., 2008) It also linked behavioural expectation and intention to system use duration, frequency, and intensity. The authors hypothesised and found that behavioural intention related more strongly to time of use and behavioural expectation to frequency and intensity. To address this issue, in the conceptual framework, there is a need to evaluate ICT integration across the value chain in MSME. Switching costs, or "excess inertia," makes technology change difficult (K. Zhu et al., 2006). In this competitive market, technological efficiency requires finance (G. Li et al., 2020). (Johnston & Wright, 2004) Enabling electronic networks outweighs the risks. (K. Lal, 2002) also identified firm absorptive capacity and country-specific organisational culture. Most organisations' use of cloud computing would increase privacy risks (Wakunuma & Masika, 2017). We have summarised the factors under various headings to describe them in detail.

### *2.4.1 Management-related factors*

ICT speeds communication, knowledge capture, and problem-solving (Marasini et al., 2008). Senior management must strategically promote change (Agostini & Nosella, 2019) (Ahuja et al., 2010). In addition to these studies, (Johnston & Wright, 2004) argued that SMEs are entrepreneur-centred, Smaller firms with little time and capability to execute this decisive management activity. (Iacovou et al., 1995) Anticipate management's recognition that perceived benefits increase adoption. Decentralised decision-making in profitable SMEs improves adoption efficiency for the young (Lytras et al., 2010). Family-run SMEs are a burden for young entrepreneurs rather than a motivation based on working and decision-making legacy (Lauto et al., 2020). (Awa et al., 2015) is examined, ICT-related top management (Goel et al., 2012) experience is second only to age in determining e-commerce adoption, and organisational mission affects ICT adoption. Collaborative development and deployment improve user and management acceptance (Benjaoran, 2009). (P. Cragg et al., 2013) found that IT management sophistication in SMEs depends on IT. SME IT leadership means many things (e.g., inspiring staff and creating an IT vision).

Technical competency enhanced innovation and absorptive capacity in traditional and managerial skills education (Gray, 2006). (Liu et al., 2020) Due to a knowledge and capability gap, SMEs could not use big data analytics to improve their products and customer service. Qualified owners are growth-oriented, while others are growth-averse

(Gray, 2006). Training facilities, affordable SME ICT capabilities, and incentive-based education programmes must improve (Ahuja et al., 2010). Education with financial support influenced ICT adoption more than economic factors (Khalil Moghaddam & Khatoon-Abadi, 2013). ICT adoption supports and transforms explicit knowledge into systematic sets of definite and more complex knowledge (Lopez-Nicolas & Soto-Acosta, 2010). However, (Awa et al., 2015) argue that top management knowledge influences ICT adoption. Each study discusses top management differently. Thus, we proposed top management's role as a vital critical variable to examine its impact on ICT uses.

### *2.4.2 Firm-specific related factors*

The organisation's context, culture, and values determine technology adoption in emerging countries (Dasgupta & Gupta, 2019) (Apulu et al., 2011) (Goel et al., 2012). (Chege et al., 2020) Found that organisational structures do not affect IT innovation and company performance. (Shirokova et al., 2013) In their paper, entrepreneurial culture is company employees who share entrepreneurial values to support exploration. Leaders in collaborative partnerships set a vision and an example to foster cooperation (Chen, 2020). Small business owners need help with customer-centric products, skilled workers, and strong company culture (Foroudi et al., 2017). According to (Abrahamse & Lotriet, 2012), technology extends business processes to site employees. (Abed, 2020) advised SMEs to provide employees with financial and technological resources, including high-speed Internet. The adopted organisational culture dimensions are mission, adaptability, consistency, and involvement (Dasgupta & Gupta, 2019). (Venkatesh & Zhang, 2010) By learning about cultural similarities, organisations can adopt a proven strategy of another country to implement technology while saving money and resources. However, country-specific culture needs study. Organisational behaviour and management have made job satisfaction a central concept in rich nomological networks (Venkatesh et al., 2007). The owner's demography significantly affects SMEs' cultures, styles, and identities (Bendell et al., 2020). SMEs need an organisational culture to adopt new technology (AlBar & Hoque, 2019). Firm Age is negatively related to technical efficiency (Charoenrat & Harvie, 2014), and in the authors' findings (Benitez, Castillo, et al., 2018), improved innovation performance. Firm Age impact on ICT differently (OECD, 2008).

Larger SMEs develop more ICT capabilities in large environments than Smaller ones (Neirotti et al., 2018), and ICT use in SMEs depends on their environment and size. In

SMEs, Firm Size directly affects technology adoption (Oliveira et al., 2014). Small organisations' core systems and services are affected by size. Thus, digital security is more critical than larger organisations (Osborn & Simpson, 2017). where (Aslesen & Harirchi, 2015) claimed that only Small firms use IT outsourcing as a critical factor in e-business. Primary business budgets heavily for IT procurement and network infrastructure to support Internet-based ICT adoption (Karjalainen & Kemppainen, 2008), especially in Small and Medium-sized Manufacturing and service firms (Tan et al., 2010). (Chen, 2020) suggested that firms with limited financial resources need management skills and a shared vision to adopt the technology. Compared to larger firms and competitors, SMEs gain a competitive advantage from innovative software (Kohn & Hüsig, 2006). (Rasel, 2016a) did not believe Firm Size-based results indicate that IT returns from larger firms are uncertain to smaller firms and cannot be generalised. Geographic proximity with partner firms can offset resource scarcity and lack of capabilities in SMEs (Aslesen & Harirchi, 2015). The service provider's proximity to other firms can moderate the Firm's new technology adoption (Sabi et al., 2016). Location factors affected feature use and individual outcomes (Venkatesh et al., 2016). Globalisation revamps and implements international knowledge linkages to promote link and network co-evolution (Guerrieri & Pietrobelli, 2004). SMEs' size and proximity to the service provider must be studied as control variables because researchers disagree on their effects on adoption decisions. In a knowledge-based economy, Medium-sized enterprises were most likely to develop ICT capability (Hua, 2007).

### *2.4.3 Human resource-related factors*

"Flexibility" in the firm (Wided, 2023) is critical and "Training" is essential to the success of technologies (Abrahamse & Lotriet, 2012). According to (Venkatesh et al., 2002), pre-training and training environment interventions play a critical role in shaping users' motivation and perceptions for forming their intentions and use of technology. Also (Charoenrat & Harvie, 2014), appropriate education and training opportunities are prerequisites to enhancing the workforce's expertise and skills, supported by peer exchange programmes for technological innovation (H. Gupta & Barua, 2016). However, (Marasini et al., 2008) believe formal training is less practical than their standard operating procedure in implementing ICT solutions. Similarly, (Lytras et al., 2010) extended their finding that the training variable negatively correlates with efficiency. (Antonioli et al., 2010) Suggests that the industrial relations (IR) system is prominent for

organisation and training; however, Small-sized SMEs may still need the IR system in place. A study by (Van Deursen & Van Dijk, 2014) argues that working with ICTs is lost due to skill insufficiencies. To address sustainability issues in SMEs, managers' awareness, knowledge, and specialised training are critical (Aboelmaged, 2018). Their job profiles in the Industry 4.0 era will explicitly state continuous learning, training, and education (Contador et al., 2020).

### *2.4.4 Firm policy-related factors*

(El-Haddadeh, 2020) found that organisational innovativeness and capabilities are critical in adopting new technologies in SMEs. (Johnston & Wright, 2004), It is crucial to consider the risks and barriers of new technology and develop business-planning skills to identify, select, and implement it. Problem assessment, impact, and redefinition need policy reforms(Sunday & Vera, 2018). SMEs' abilities to manage commercial opportunities through rapid technology innovation (Chege et al., 2020). (Hassan et al., 2020) argued that SMEs' innovativeness is the most critical capability factor in adoption decisions and that new ICT-related behavioural aspects are more important than SMEs' capabilities (Khanzode et al., 2021). (Alam & Adeyinka, 2020) It also suggested that SMEs' Internet access to business information leads to a change mindset, which affects business process changes and SME performance (Colombo et al., 2013).

To meet country-specific needs, developing countries like India need significant regional policies for innovative innovations (Aslesen & Harirchi, 2015). SME ICT adoption is slow and cautious (Cuadrado-Roura & Garcia-Tabuenca, 2004). Intelligent learning systems need extra attention in decision-making (J. Lee et al., 2015). SMEs need internal sources (Ntwoku et al., 2017). ICT integrates all stakeholders in SME value-adding (Schubert & Leimstoll, 2007) (Glavas et al., 2019). Technology's ease of use and convenience promote SMEs' collaboration and sharing, which is necessary (P. Gupta et al., 2013). Affordable, customised products based on an organisation's strengths and weaknesses increase ICT implementation in SMEs (Nousala et al., 2008). Due to technological obsolescence, SMEs rarely adopt ETAs (Subrahmanya, 2014). For all SMEs, ICT integration is a distant goal (Acar et al., 2005). Electronic uncertainty discourages SMEs from adopting new technology (Solaymani et al., 2012). (Shaltoni et al., 2018) found that SMEs prefer e-marketing when it benefits them. SME productivity remains the same with IT-enabled decentralisation (Rasel, 2016a). To meet competition

or customer demand, SMEs asked technology suppliers for new products (Subrahmanya, 2014). (El-Haddadeh, 2020) found a need for the organisation's role in innovation adoption to match the technology adoption process. While SMEs prefer improvisational technology adoption over classic change (Marasini et al., 2008). The authors suggest that IT leaders can make this change (Khalil & Belitski, 2020). CEOs develop company models, promote change, implement new IT applications and services, and manage multidisciplinary teams and stakeholders using sophisticated ICT trends.

ICT adoption is an ongoing activity (Sunday & Vera, 2018); networking, intelligence, and service in Manufacturing cause a schism in the organisation and elevate Manufacturing information (Zhang et al., 2014). Small businesses face uncertainty and threats from business and technological changes (Sunday & Vera, 2018) (Oni & Papazafeiropoulou, 2014).

### *2.4.5 Financial-related factors*

During economic downturns, SMEs struggle with working capital, credit ratings, and supply chain partner exploitation (J. Wang et al., 2021) (da Silva et al., 2022). Due to financial constraints, most SMEs wait to adopt cheaper technology (Oni & Papazafeiropoulou, 2014). This decision delay may cost more SMEs. (Madrid-Guijarro et al., 2009) Found that cost-related managers' perceptions are significant barriers, while (S. H. Kim et al., 2017) discussed that Small firms lack Investments and IT expertise. They cannot accept its performance, security, and risks. SME ICT Investment models emphasise human capacity (Rantapuska & Ihanainen, 2008), and digital marketing offerings indirectly derive digital innovation from technology and human capabilities (Nasiri et al., 2020). Authors (Lytras et al., 2010) argued that higher-technical-efficiency firms use more advanced ICT human resource practices. (Pradhan et al., 2020) The authors stated that ICT, venture capital Investment, and innovation diffusion drive long-term economic growth. The author (Gray, 2006) agreed that the sales target influences SME owners to hire more, and technology Investments significantly impact organisational Performance (Shirokova et al., 2013) (Harland et al., 2007). Despite this decision, which is a significant concern for problem-oriented decision-makers and requires immediate attention (Alam & Adeyinka, 2020), their research shows that ICT Investment boosts productivity. This paper claims that SMEs' owner-managers actively invest in IT and manage finances (Rantapuska & Ihanainen, 2008) (AlBar & Hoque,

2019). According to (Khalil & Belitski, 2020), IT managers should invest strategically in digital skills to improve digital capabilities. (Agostini & Nosella, 2019) Found that SME managers' reluctance to adopt new technologies hinders their first Investment in supplier system integration. Choices worsen the situation. Flexibility requirements in ICT options with more features and information make them more expensive and delay irreversible decisions like new Investments (Becchetti et al., 2003).

Managers' perceptions of objectives, drivers, and barriers depend on past Investments (Corrocher & Fontana, 2008). The cost of switching from old to new technology affects companies' decisions. (K. Zhu et al., 2006) Path dependency (moving from old to new), benefits, and cost-effectiveness, intangible and non-obvious, determine adoption cost. Future Investments should consider flexibility (Wided, 2023) and the long-term fiscal impact of switching costs (Yildirim & Ansal, 2011). Literature covers many technology costs and financing issues. How these factors affect ICT adoption is unknown.

### *2.4.6 Common related factors*

Established and "trusted" suppliers are the suppliers of choice for SMEs (Harland et al., 2007) (Müller et al., 2020). SMEs are reluctant to work with a new vendor (Agostini et al., 2019). (Oh et al., 2012) state that perceived business risk and information risk are "trust" factors. At the same time, partners' credibility enhances perceived net benefits (Mohd Salleh et al., 2017). Trust in information security over the Internet is also a concern (Harrigan et al., 2008), whereas (Nolan et al., 2007) discovered that various forms of trust between informers and informants are crucial. To engage in collaborative innovation efforts and be receptive to environmental shifts (Torrent-Sellens et al., 2016). The study by (Yu et al., 2018) suggested that service providers recognise the significance of dependable services, as trust in IT artefacts directly impacts transformation. In their study on how people use cloud computing (Loukis et al., 2017), the authors discovered that a company's prior experiences matter. This experience builds awareness and trust in external ICT service providers. The authors (Agostini et al., 2019) do not hold the same view. They argue that an initial environment of trust is insufficient and cannot endure the duration of the process, which varies with the time of implementation. While online, personal trust is questionable, and privacy remains susceptible (Harrigan et al., 2008). (Dwivedi et al., 2021) studied adopting AI-equipped devices and found that data quality, privacy, and security concerns are critical challenges in SMEs. Whereas (Oh et al., 2012)

found that organisational characteristics can affect the perception of risk rather than financial impact and that this risk depends on the manager's perceptions (Nasiri et al., 2020).

### *2.4.7 External force-related factors*

Information Technology has transformed business and Government (Jorgenson & Vu, 2016), (Harland et al., 2007). SMEs that want to do business with the Government need innovative Internet systems, according to (Mohd Salleh et al., 2017). Government regulations encourage Small businesses to adopt technology (Alderete, 2017) (Solaymani et al., 2012).

Government pressure and the TOE framework for technology adoption are critical (K. Zhu et al., 2003). In the scenario studied by (Pavlou & Fygenson, 2006), public policy establishes security guidelines to protect information by banning spam and other technical issues. (AlBar & Hoque, 2019) Agree that regulation helps ICT adoption. MSMEs fail due to strict Government policies (H. Gupta & Barua, 2016). (Iacovou et al., 1995) found that Government-dependent Small businesses are likelier to adopt EDI. (Flores et al., 2009) emphasise that Governments and universities encourage Small start-ups to boost economic growth. The Government and stakeholders can provide affordable technology and a regulatory framework for sustainable ICT adoption. These agents become control variables and must be studied to determine how ICT integration with the value chain affects SME ICT adoption and business performance. In Tanzania (Kabanda & Brown, 2017), they demonstrated that research institutions, information service providers, financial institutions, and universities could collaborate under the ICT policy.

"Lack of policy frameworks (Government policy)" and "lack of understanding" are the biggest obstacles to Industry 4.0, according to (Khanzode et al., 2021) (Won & Park, 2020). Government policy creates one digital market (Biagi & Falk, 2017). According to (Kaynak et al., 2005), SMEs need Government and private sector incentives to adopt technology to benefit from e-commerce over cost. (Oni & Papazafeiropoulou, 2014) stated that the Government is the main anchor for recognising and training SMEs. These programmes enable worker training, technical education, and lifelong learning by the Government (Biagi & Falk, 2017). The Government can help SMEs innovate and compete as policymakers and large spenders (H. Gupta & Barua, 2016), (Charoenrat & Harvie, 2014).

Suppliers become strategic partners due to alliances (X. Koufteros et al., 2005) (Grudinschi et al., 2014). According to (Rantapuska & Ihanainen, 2008), company-oriented decision-makers focused on ICT acquisition, particularly software delivery. Gender-sensitive marketing increased women SME entrepreneurs (Bendell et al., 2020). (T. Cragg & McNamara, 2018) examined how SMEs can mitigate agency issues through contract design and information sharing with partners and consortiums. According to (Rufaro & Dick, 2008), SMEs use ICT less than business support organisations.

The system is desirable until it meets regulatory and customer requirements (Hastig & Sodhi, 2020). Small, cost-sensitive firms benefit from a high technology supplier concentration (K. Zhu et al., 2003). There are high communication costs, a telecom service provider monopoly, and English-only online content restrictions (Rufaro & Dick, 2008). Technology providers' chances of SMEs adopting technology Supply partners prefer direct information sharing, so business conditions and information systems are unrelated (Welker et al., 2008). Relational learning and ICT implementation grow faster in telecommunications than in construction (Cegarra-Navarro et al., 2010).

## 2.5 Gaps in Existing Literature Review

The 63 million MSMEs with 30 per cent Gross domestic product (GDP) contribution and employing 111 million people are significant contributors to India's growth story. Still, only 65% of MSEs are digital, and most struggle with during-covid business pressure.

The term ICT was first used in the United Kingdom in 1997; later, ICT became popular in all areas of industries, including universities. Previously, IT was the most sought-after term in use. Since then, the uses of ICT have witnessed extensive use in various research. It was the time when the various theories were in the developing phase to understand the motivation of ICT adoption in the industry. From the literature, it has been identified that four theories are mainly responsible for understanding ICT adoption. These explained theories identified the main factors that motivate the firm to adopt technology, mainly the behavioural aspects.

In India, the MSME sector, the backbone of the economy, is tiny, primarily in size and capital Investment. The Government of India understood the importance of ICT for the Indian MSME sector. It introduced the scheme to promote ICT use in the process by providing training and Government aid in the Year 2010. This scheme is also only

extremely popular with a proper framework. Various research has been picked in the literature since 2010; however, very few have been in the Indian context.

However, ICT adoption has been around for about two decades now, considering the complexities of the field. It is only natural that many pieces still need to be found and linked together to generate a comprehensive study of ICT adoption more suitable for the Indian context in a descriptive and more accurately identified ICT Investment level.

Though the literature identified the most influential factors responsible, like Firm Size, Firm Age, and Government policies for ICT adoption in the MSME sector, most studies are conducted with a Small sample size with the questionnaire on a limited Period. There needs to be more magnitude of these factors used in the financial numbers and study of the actual mediating impact of the ICT Investment decision and these factors' impact on firm performance with the secondary data set. Hence, it is felt that it is worthwhile to study the impact of ICT adoption (through ICT Investment) in the Indian MSME sector and provide the conceptual framework to propose the most suitable technology at the desired level of ICT Investment required to firm specifically with the most suitable vital factor with the validation of results on the longitudinal study.

1. Very few studies have been conducted on measuring the impact of ICT Investment on firm financial performance parameters with the moderating impact of the Firm Size, especially in the Indian MSME Manufacturing sector context.
2. Extremely limited, almost no longitudinal studies are available on measuring the impact of ICT Investment and firm financial performance in the Indian context.
3. Many studies discuss the role of Government aid, Firm Size, Firm Age, and financial credit (through Short-term borrowing) on the decision of ICT Investment; however, how these factors affect the ICT Investment and the firm financial performance with the mediating role of ICT Investment are negligible in the Indian MSME Manufacturing sector.

We characterise the research gaps in this area with the following research questions:

RQ1.

What are the research frameworks/theories on existing ICT adoption in the MSME sector in the literature?

RQ2.

What are the different Critical successful factors (such as Firm Size, Firm Age, Short-term borrowing, and Government aid) investigated in prior literature on ICT adoption?

RQ3.

How does ICT adoption (through ICT Investment) impact Indian MSME financial performance (PBDITA) while examining the moderating role of Firm Size?

RQ4 a.

Do Firm Size and age positively influence firm financial performance (ROA)?

RQ4 b.

Do Short-term borrowing and Government aid positively influence ICT adoption?

RQ4 c.

How does the mediating role of ICT adoption (through ICT Investment) impact financial performance (ROA)?

RQ 5.

Does ICT Investment impact the Firm's financial performance (ROA) with the interaction of short-term borrowing and gross working capital for Micro, Small and Medium Firms for Pre-COVID (2015-2019) and during the Covid Period (2020-2022)?

These research questions have been sought in depth in our work.

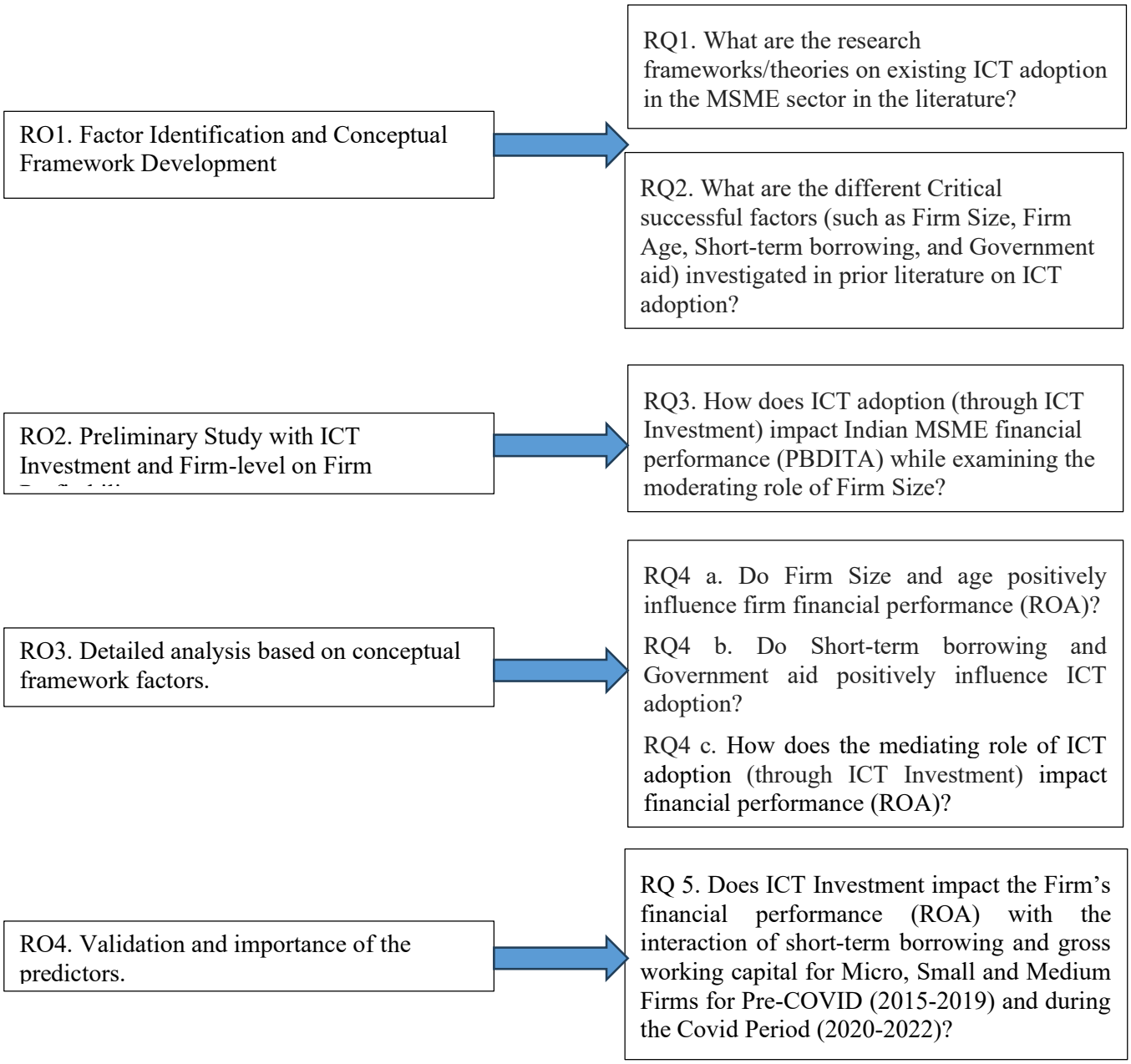


**Figure 2.6 Schematic diagram for Research Questions to Research Objectives.**

## 2.6 Conceptual Framework

This COVID-19 pandemic teaches every business entity to remain sustainable, and they need to be "resilient". To date, consumer-influenced ICT adoption needs elastic, on-demand access to unlimited computing power to help them respond to considerable

fluctuations in customer demand. The uncertainty in business affects the performance of companies, especially SMEs, which are severely affected by any turmoil in economic activities. To address these issues and for sustainable operation, this section develops a framework in Figure 2.6 for classifying studies on the extent of ICT adoption on business performance. We focus on an SME manufacturer's organisational performance on the entire value chain meditated by ICT integration with the time of ICT adoption on the different business performance metrics. This framework is unique and one of the first kind in which the literature has been reviewed and summarised, which first sees the evolution of ICT worldwide with the divergent technologies on the timeframe, next, motivating theories responsible for the adoption of new or changeover advance technology in the small businesses, especially SME.

Furthermore, when we talk about the extent of ICT, we distribute the evolution of ICT in three phases: traditional, contemporary, and Emerging. This extent of ICT adoption in SMEs will directly measure the effect on business performance. We proposed measuring the SME's business performance under financial, operational excellence, inventory turnover and productivity in terms of financial values. Since SMEs are small business units, the capital requirement is always hard for these organisations. Based on the literature, size, Firm Age, along with Government aid, financial borrowing are the most influential factors for adopting ICT. Hence, it proposed using these factors as the critical factors responsible for adopting ICT in SMEs and directly affecting business performance. Recently, technology has become modernised, and the latest technologies are widely popular and claimed by various researchers to improve the advanced computing performance. Industry 4.0 applications may enhance the performance in the SME sector as well. Note that our focus is on the type of ICT technology adoption in a different part of the Manufacturing value chain. However, we do not propose under which conditions these ICT channels will be adopted.

We consider three phases of ICT adoption: ICT as traditional, ICT technologies used in contemporary, and ICT technology as emerging for SME sector improvement in business. Further, ICT adoption is presented to see the mediating effect of ICT integration in three aspects of the value chain. Figure 2.6 has proposed the critical factors.

We have proposed ICT integration in the entire value chain in three parts. In the first part, the ICT integration impacts the various departments of the SME sector. We have

proposed to study the use of ICT to coordinate and integrate the activities in multiple sections. We are further measuring the mediating impact of ICT use and the type of ICT technologies on business performance. In part B, ICT is used in traceability, transparency, predictive analysis, and information security in the value chain. These technological parameters are crucial to the decision to adopt ICT in SMEs. Part C is proposed to measure the mediating effect of ICT integration in SMEs, which ultimately depends on the technological aspects of the technology used.

From author's point of view, physical products are more challenging to deal with than digital ones, as they require inventory, distribution, and return logistics, which is different from virtual products. Therefore, operations management methods that aim to manage tangible products prevail in the literature and are the focus of our research.

## 2.7 Discussion and Conclusion

Numerous Frameworks/theories have been developed, studied, and modified over time by eminent researchers. This study investigates and identifies the various critical success factors based on prior studies' antecedents; the answers to the research questions 'What are the various research themes and factors that have been investigated in prior literature on ICT adoption?' are compiled. Furthermore, 'What models and frameworks do scholars recommend for SME ICT adoption?' We could categorise the antecedents into seven groups by answering the earlier questions. Discuss the critical factors based on global literature in the SME sector. We have proposed a conceptual framework with research questions, limitations, and recommendations for scholars and practitioners by addressing the following question: "Which ICT technologies were utilised, along with the critical variables and the mediating effects of the value chain on business performance?" Most studies focused on a limited number of factors pertinent to adopting new technology, especially in the SME sector. Before identifying the SME sector's needs in a country, thorough research should be conducted.

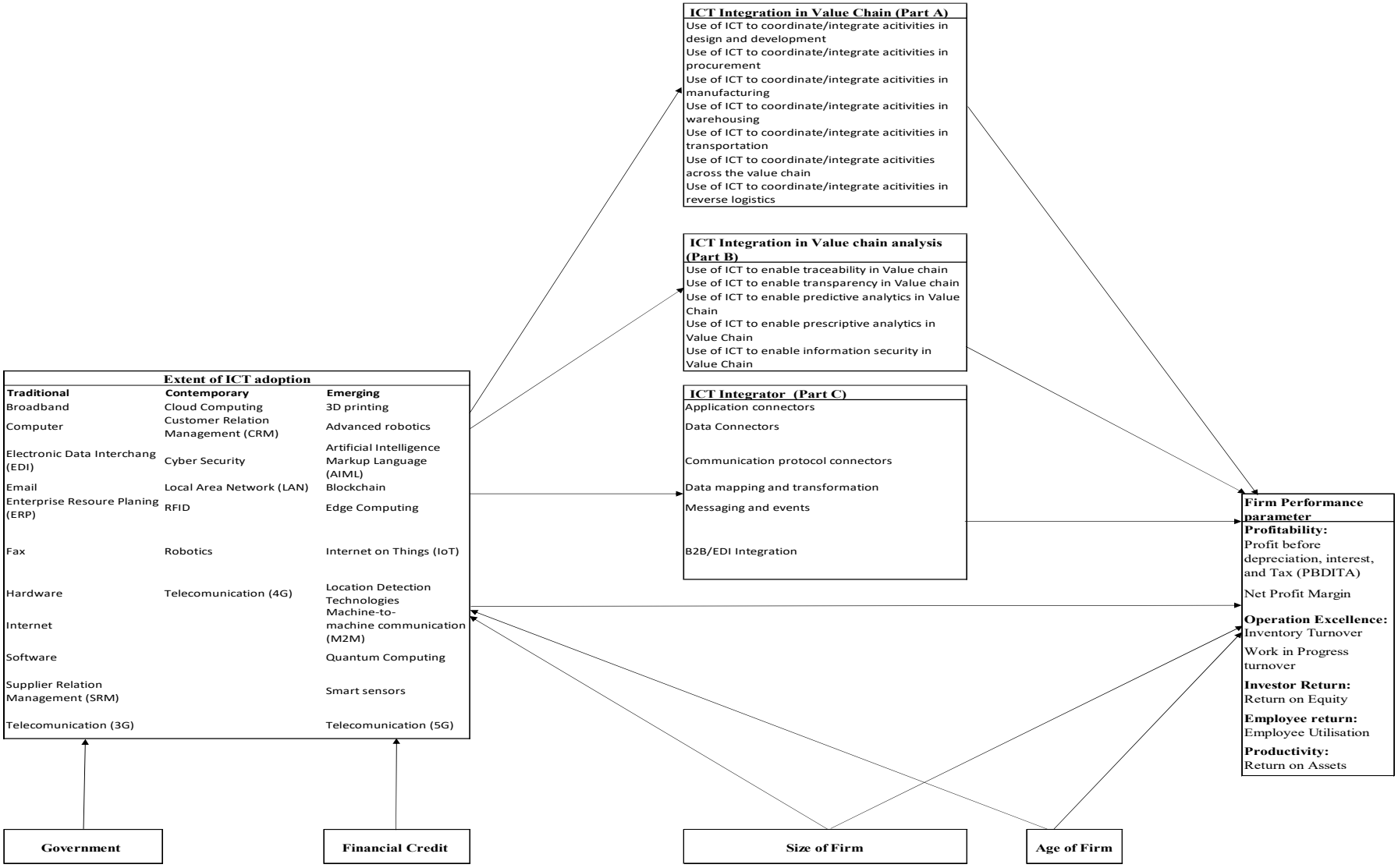


**Figure 2.7 The Conceptual Framework.**

## 2.8 Limitation

This study provides a comprehensive systematic literature review of ICT adoption in Small and Medium-sized enterprises (SMEs) worldwide and the frameworks/theories in technology adoption. Despite these contributions, this study has limitations. The factors that influence ICT adoption are classified as critical success factors. Based on the literature, these variables are conceptualised as mediators, moderators, and effects. The SLR itself carries some interference. This research has some limitations. This search is restricted to the database, which does not cover the entire global database. We restricted our search to ICT and SMEs; the database search included only academic journals and excluded sources like conference proceedings, books, and trade publications. Second, only the English language is supported for searches. Thirdly, search criteria are limited to ICT and SMEs, excluding studies conducted in larger companies. For the review examination, only highly classified journals were considered.

In addition to these limitations, this study is helpful to researchers because it provides insights for future work; by addressing these limitations, the researcher can establish their research and the potential research plan proposed in the study. Despite this, we hope that this review provides and opens exciting opportunities for future research and highlights a variety of perspectives on the sustainability and competitiveness of the SME sector with gaps in practical guidance.

# CHAPTER 3: RESEARCH METHODOLOGY

## 3.1 Chapter overview

This chapter presents the research methodology for studying Information and Communication Technology (ICT) Adoption in Indian Micro, Small and Medium Manufacturing organisations by analysing Firm performance. This study follows a multi-stage approach, as shown in Figure 3.1. In the first stage, the method provides a systematic approach to identify, analyse, and synthesise relevant literature. This stage offers the basis for further studies by mapping all the relevant studies and factors affecting the ICT adoption in the MSME sector, then providing a foundation for the conceptual framework. The second phase outlines the data collection process and the statistical techniques employed for data analysis using different statistical methods. The third and last phase delves into panel data from Eight Years to study the digitalisation of firms and the impact of COVID-19 on the firm performance by the ICT Investment level with the financing and working capital management with analysing statistical method. The chapter begins by describing the methodological approach followed in the literature review and the research questions addressed in the study. It then elaborates on the search strategy, data collection, and analysis techniques. Finally, it discusses the selection criteria for the sample and the variables considered for the design of experiments.

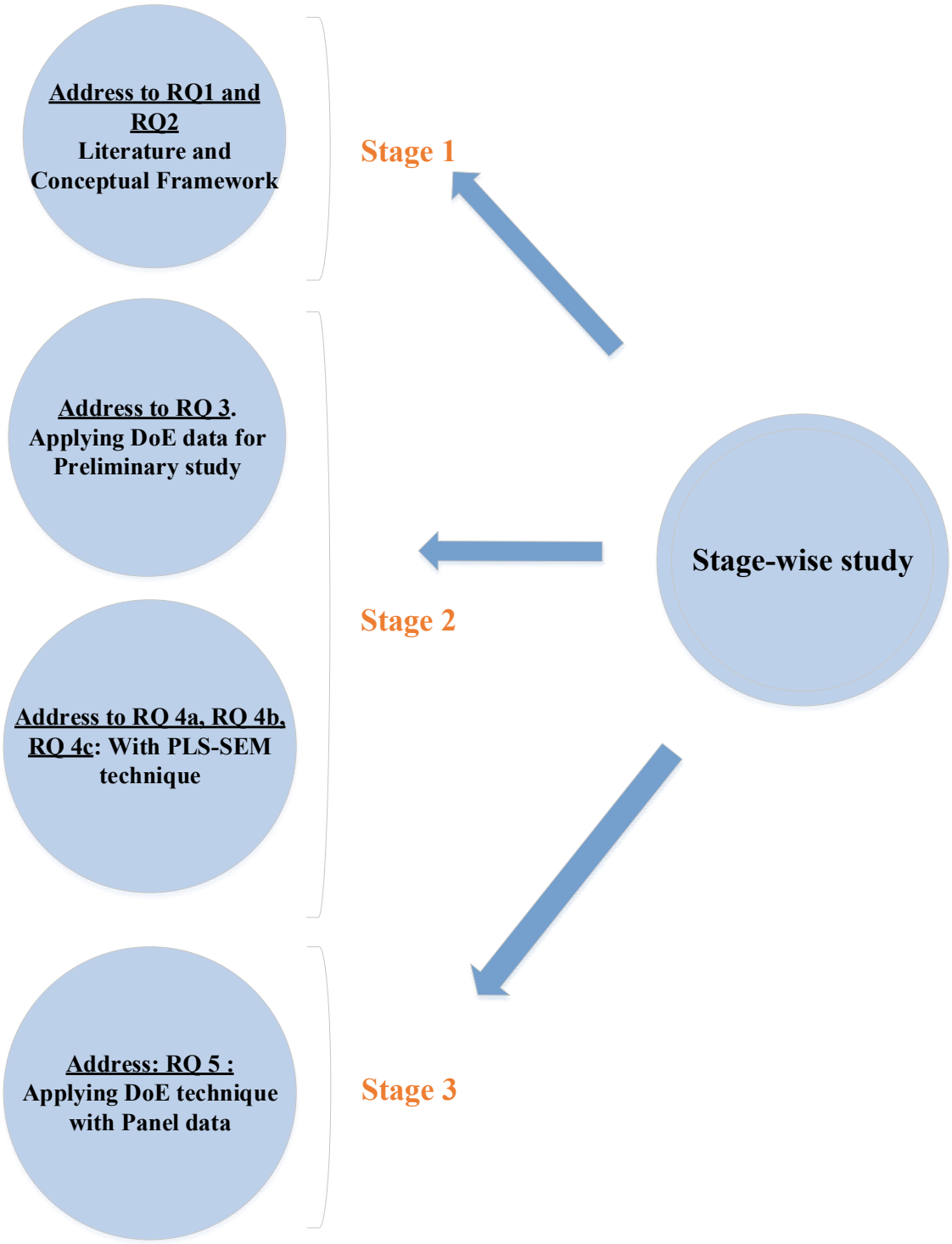


**Figure 3.1 Brief of the Stages Involved in Research.**

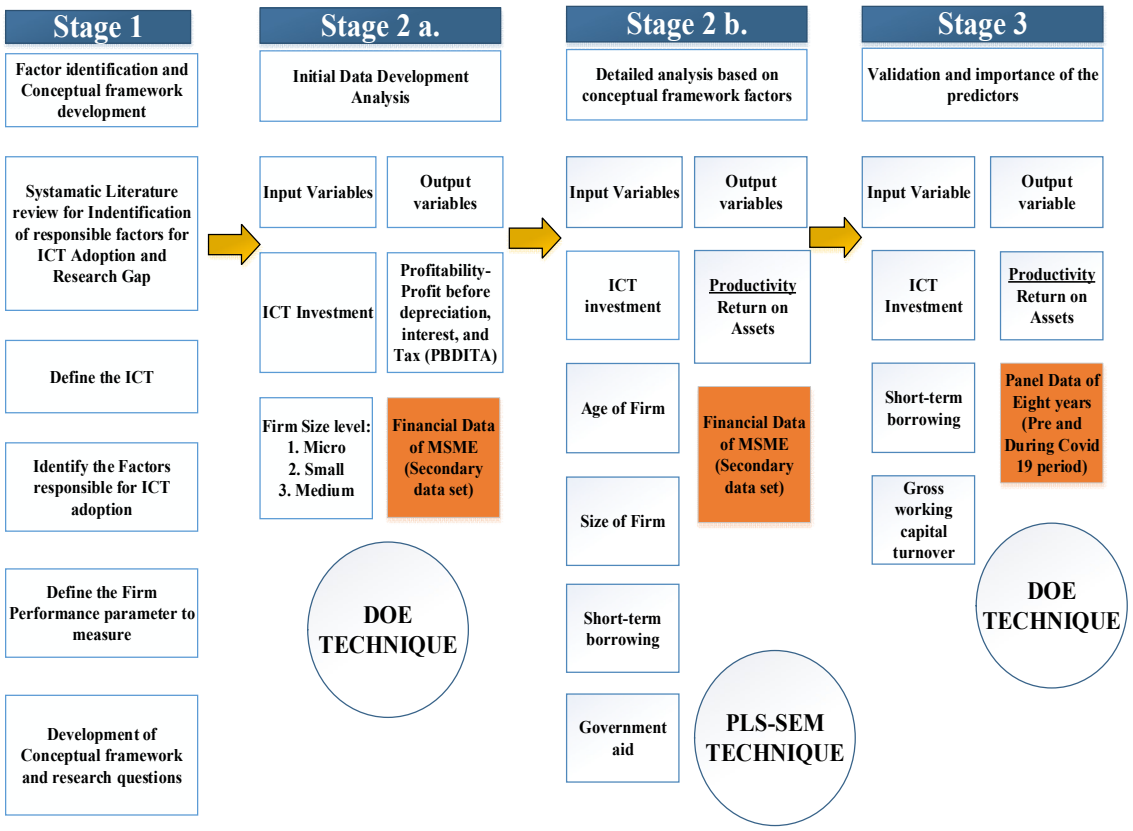


**Figure 3.2 A Comprehensive Flow of Stage-Wise Research with the Framework.**

## 3.2 Research Design

*Research design* is a framework or plan for conducting studies. It describes the procedures to collect data to structure or address research problems. This study adopted a descriptive research design to identify the relationships between ICT adoption and firm performance in Indian MSME Manufacturing firms. The primary objective of descriptive research was to describe the situation accurately. Since this study aims to investigate the characteristics of Manufacturing firms regarding ICT Investment with internal and external factors, emphasising their investment levels and assessing the significant impact of critical factors on the firm performance on financial parameters, a descriptive research design is appropriate for this study.

## 3.3 Data explanation

The study focuses on the Indian MSME Manufacturing sector, and therefore, the sample selection criteria were based on the official definition of MSMEs in India. The broad definition of MSME classification was first defined in 2006 by the MSMED Act 2006 and further

modified after the Gazette of India notification dated 01.06.2020. This notification is classified based on annual turnover and Investment in Plants and Machinery.

**Table 3.1 MSME Definition based on the Investment.**

| Sr. No | Sector | Investment in Plant & Machinery or Equipment (in ₹) | Turnover (in ₹) |
|---|---|---|---|
| **1** | Micro | 10 million | 50 million |
| **2** | Small | 100 million | 500 million |
| **3** | Medium | 500 million | 2500 million |

In the study conducted by the Organisation for Economic Cooperation and Development (OECD) to determine the effects of Investments in information and communications technology (ICT) in participating nations, the researchers argued that ICT Investments in each nation consist of Investments in information technology (IT) and software. Similarly, we have included in our investigation all business Investments, including costs associated with communication, IT/ITES services, computer and IT systems, communication apparatus, and software. According to the MSME Act, the Investment limit for Micro firms is up to 10 million INR; for Small firms, it is 100 million INR; and for Medium enterprises, it is 500 million INR. MSME is the second-greatest employment sector in India and contributes to the country's gross domestic product. This sector comprises Micro, Small, and Medium-sized enterprises categorised by their annual revenue and Investment in Plant and Machinery. The Centre for Monitoring Indian Economy (CMIE) administers the largest database of information regarding the Indian economy and the financials of numerous Indian businesses. For this research, data were extracted from the Prowess database (CMIE) for the MSME Manufacturing sector in India, which consists of approximately 17000 company records, from which 2000 company records (Micro, Small, and Medium) were randomly selected for the collection. After data purification, which included removing missing values and brief information, we discovered a dataset containing 1101 companies for this study.

## 3.4 Overview of techniques

**Stage 1.** A search strategy was employed using relevant keywords such as "ICT," "MSME," and "Manufacturing" to ensure a comprehensive review of the literature. The search was conducted in reputable databases, including EBSCO, Emerald, Science Direct, Scopus,

Springer, Taylor & Francis, Wiley Online, and ProQuest. The inclusion criteria for selecting relevant articles were based on their relevance to the research questions and the language of publication (English). One hundred thirty-five papers from reputed journals were included in the review, exceeding the suggested limits for a systematic literature review.

**Stage 2 a.** The main objective is to analyse the effects of information and communications technology (ICT) Investments on the profitability of Micro, Small, and Medium-sized enterprises (MSMEs) in India. This stage is a pilot study that introduces four levels of ICT Investment based on the amount of money invested, ranging from Level 1 to Level 4. The study focuses on the entire range of ICT Investment to understand its impact on MSME profitability. The constructs and variables used in the study, such as total Investment in ICT, Firm Size, and profitability, are presented. The **Design of Experiment** (DoE) technique used data from the Prowess data platform, consisting of a Small random sample of 300 Manufacturing companies in the MSME sector for the study.

**Stage 2 b.** This stage discusses the quantitative approach and data set used in the study. This study is a comprehensive study conducted to understand the various technologies of ICT Investment with internal and external factors and their impact on the Firm's performance with dependent variable. The data set is based on the official classification of MSMEs in India, considering Investment in Plant and Machinery and annual revenue. Data were extracted from the Prowess database maintained by the Centre for Monitoring the Indian Economy (CMIE). A random sample of 2,000 company records represents Micro, Small, and Medium-sized enterprises. After data cleansing, the final data set contains 1074 company records. Considering the complex relationship between the various factors, the **Partial Least Squares Structural Equation Modeling** (PLS-SEM) technique was used for this study.

**Stage 3.** This stage is a comprehensive study with a large panel data sample of 1101 companies over Eight Years to validate the results. Six hypotheses were proposed, focusing on the impact of ICT Investment, gross working capital cycle, and short-term borrowing on the return on assets (ROA) of MSME firms. The **Design of Experiments (DoE)** application was also used to identify significant process parameters influencing firm performance. The study is an extensive analysis with the panel data of Eight Years, divided into Pre-COVID and during-COVID phases.

## 3.5 Appropriateness of statistical methods

Descriptive statistics describe the fundamental characteristics of the study's data. They provide

straightforward summaries of the sample and measures. They form the foundation of virtually all quantitative and simple graphical data analysis. Appendices contain descriptive statistics such as mean and standard deviation for all measured variables with the data sets.
The data was finally validated by conducting a longitudinal study for the eight Years data set. DoE effectively handles multiple variables in problem-solving (Chong et al., 2021). DoE is used to see the main effect and interaction effects on the response variables. In the study of the Indian Firm, authors (Thanki & Thakkar, 2014) argued that advanced statistical tools like the DoE are required for future research. DoE is a valuable tool that can be integrated into the early stages of the development cycle (Guo et al., 2012).

Structural Equation Modelling (SEM) evaluates and validates theoretical models characterising the relationship between variables. It is appropriate to use the PLS (Partial Least Squares) and SEM (Structural Equation Modelling) are well-known data analysis techniques for examining the relationships between model variables in this research (Hair et al., 2019) (Kijkasiwat et al., 2021). First, PLS is a technique for analysing the relationship between two sets of variables, in which the predictors or independent variables are used to predict the response or dependent variables (Benitez, Castillo, et al., 2018). Second, PLS is used in the secondary data similar to this study (Benitez, Castillo, et al., 2018) (Alhassan & Adam, 2021). PLS is frequently employed when the number of predictors significantly exceeds the number of observations. In recent Periods (Benitez et al., 2020), PLS-SEM has been used in all fields and for financial ratios (Hair et al., 2019); thus, this research qualified for using PLS-SEM for study.

## 3.6 Variables Definition

The study's variables were derived from a review of the relevant literature on the extensive study of various adoption-responsible theories and frameworks of past studies. This study devised a conceptual framework based on the internal and external factors responsible for ICT adoption. These internal and external factors are derived from the TOE framework. Further, we study the impact of ICT on the firm performance. In addition, subsections 3.6.1–3.6.3 describe the 20 variables used in this study.

### *3.6.1 Factors Determining the Firm Profitability*

We construct two research objectives for this investigation into (1) the impact of ICT adoption (in the form of business Investment) on profitability and (2) the impact of firm type on profitability. In ICT, Investment is the sum of all the expenditures made in IT, software,

hardware, and communication technology. This ICT Investment directly impacts the Firm's Profitability, which is moderated by the firm type.

**Table 3.2 Variables for the Design of Experiment**

| Construct considered | Variable considered |
|---|---|
| **Total Investment in Information and Communication Technology** | ICT INVESTMENT (in Million INR) |
| **Firm Size: Micro, Small and Medium** | Industry Type |
| **Profitability** | Profit before depreciation, interest, Tax and Amortisation (PBDITA) from the Profit and loss account. |

### *3.6.2 Factors for studying the impact of individual ICT technology on Firm performance.*

The impact of ICT Investments on productivity varies between studies of large and Small businesses. The term "productivity trade-off" was coined by a few authors to describe the practice of measuring a company's productivity on one dimension while retaining or ignoring the other (Pilat, 2005). The second possible explanation is that some researchers measure ICT adoption using Likert scale survey questions to motivate adoption, but very few on the Firm's financial performance.

**Table 3.3 Variables for the PLS-SEM study**

| **Construct** | **Construct Code** | **Definition** | **Articles** |
|---|---|---|---|
| **ICT Investment in the MSME** | ICT Investment | The degree of the financial value invested in the various ICT-based technologies. The study uses the total ICT Investment by the Firm. | (Schweikl & Obermaier, 2020); (Biagi, 2013); (Modjo et al., 2022) |
| **Critical success factors** | | The variables are the impact of ICT Investment and Firm Performance and the mediating of ICT Investment on the Firm Performance. | |
| Firm Age | Age of Firm | The Firm Age is defined in Years from the current Year, i.e., 2023, to the Firm's incorporation. | (Modjo et al., 2022), (OECD, 2008), (Charoenrat & Harvie, 2014), |

| | | | |
|---|---|---|---|
| Firm Size | Size | The value of the market size of the Firm and the study | (Neirotti et al., 2018); (Hua, 2007), (Benitez et al., 2020) |
| Short-term borrowing | Short-term borrowing | The Firm's short-term loan/debt value in the study | (Shirokova et al., 2013) (Harland et al., 2007) |
| Government aid | Government aid | The value of Government subsidy or aid to the Firm | (Alderete, 2017); (Solaymani et al., 2012); (K. Zhu et al., 2003); (Oni & Papazafeiropoulou, 2014) |
| **Firm Performance** | | The degree to which a firm has superior performance in financial terms. | (Shirokova et al., 2013) (Harland et al., 2007) |
| Return on Assets | Return on Assets | The Ratio of Net Income to Total Assets of the Firm. | (Matanda & Freeman, 2009), (Miroshnychenko et al., 2017), (Benitez, Llorens, et al., 2018), (Shi & Yu, 2013), (M. Zhu et al., 2021) |

### *3.6.3 Factors for studying the impact of ICT with panel data on Firm performance.*

ICT have the potential for development and sustainability, which require Investment (UNCTAD, 2018). For Investment, MSMEs rely on Banks or other financial institutions in India. Nevertheless, banks limit their lending exposure to MSMEs due to their increased perceived risk of non-performance, low performance or credit data (Neirotti et al., 2018). ICT reduce transaction costs and saves business time (Adeniran & Johnston, 2016). SMEs need to enhance their level of services to fulfil the enterprise's targeted goals of effectively monitoring, controlling, organising and minimising production costs, inventory control levels, purchasing materials and utilising resources (AL-Shboul, 2019). Managing the working capital improves the firm performance (Altaf & Shah, 2018), which requires low inventory costs. Hence, with the ICT Investment, the financing to ICT with the operation excellence construct has been created to study the impact on the Return on Assets.

**Table 3.4 Variables for the Design of Experiment (DoE) study**

| Construct considered | Variable considered |
|---|---|
| **a. Total Investment in Information and Communication Technology** | ICT INVESTMENT in % of sales |
| **b. Firm short-term borrowing** | Short-term borrowing in % of sales |
| **c. Gross working capital turnover** | Gross working capital in days. |
| **Productivity** | Return on Assets |

## 3.7 Conclusion

This chapter presented a detailed and comprehensive research methodology for studying ICT applications in Small and Medium Manufacturing organizations and tiny businesses worldwide. The systematic literature review methodology was adopted to identify, analyse, and synthesize relevant studies. The research questions guided the review process and employed a comprehensive search strategy. Data collection involved the selection of relevant articles from reputable databases, while data analysis techniques included the use of statistical methods. The sample selection criteria and variables for the design of experiments were also discussed. It is essential to consider the limitations of the research methodology to ensure a nuanced interpretation of the findings. Overall, the research methodology was employed.

# CHAPTER 4: MEASURING THE IMPACT OF INFORMATION AND COMMUNICATION TECHNOLOGY ON THE PROFITABILITY OF MICRO, SMALL, AND MEDIUM ENTERPRISES: A DESIGN OF EXPERIMENT APPROACH

## 4.1 Introduction

Under the banner of globalisation, the global economy has entered the 21st century. Globalisation, defined as the internationalisation of production, capital, markets, and information systems worldwide, fundamentally alters economic activity conditions, the criteria, and goals of economic development for individual nations, regions, and the entire world. India would be the engine of the global economy. Niti Aayog of India (NITI Aayong, 2020) elucidated that India's vision of becoming a $5 trillion economy is tied to an innovation-focused approach to economic growth. Micro, Small, and Medium-Sized Enterprises (MSME) play an essential role in economic development and can generate income by employing low-income groups (Amir et al., 2013). According to a June 2020 report by the Global Alliance for Mass Entrepreneurship (GAME) Task Force, approximately 110 million people, or over 40% of India's non-agricultural workforce, are employed in this sector (Mastercard & NITIAayog, 2021). As MSMEs and start-ups drive the economic growth engine, establishing more incubators and common facility centres can propel them to greater heights (NITI Aayong, 2020) (Apulu et al., 2011). Most MSMEs view themselves as the backbone of the economy, anticipating sales growth soon and recognising that technology can make work more enjoyable (Amir et al., 2013).

The rise of collaboration in the global economy and the digitisation of business have created multiple avenues for expanding individual firms. However, it has also presented them with significant challenges and competition from domestic and international competitors. Sustainability is an urgent requirement and an engineering challenge in the contemporary world (Kavathatzopoulos, 2015). Developing intelligent technologies is essential for ensuring the sustainability of future Manufacturing, and a competitive enterprise that has learned the lessons of global competition can compete with other companies in the home economy (Mathur et al., 2012). Information exchange and cooperation across industry segments become incredibly relevant when digitising value processes in the industry. When supply chain partners work together and share data (T. Cragg & McNamara, 2018), the competitiveness of a supply chain can be enhanced (Müller et al., 2020). Small and Medium-sized enterprises (SMEs) use

information and communications technologies (ICT) to improve their competitiveness in global business environments (Ghobakhloo et al., 2011). As the strategic decisions of SMEs are commonly based on flexibility, reactivity, and customer proximity, ICT may help SMEs achieve these objectives (Moeuf et al., 2018) (Pickernell et al., 2013).

Compared to large companies, Small and Medium-sized enterprises (SMEs) have lower productivity, higher costs, and poorer on-time delivery performance (Moeuf et al., 2018). The timely decision in the Manufacturing strategy may provide a competitive advantage to MSMEs if these strategies are aligned with large-scale production systems (Kharub et al., 2019) (Johnston & Wright, 2004). This ICT Investment is a critical and complex decision for MSMEs (Rantapuska & Ihanainen, 2008). Cost reduction, quality enhancement, and on-time delivery have emerged as significant obstacles for the MSME sector in India. At the same time, ICT adoption enables flexible production: just-in-time inventory management, sales integration, and production planning (Spiezia, 2011). Electronic procurement, for example, improves inventory control and reduces the cost of supplier coordination. Due to rising prices, however, it is difficult for Small and Medium-sized enterprises to select and implement a suitable competitive strategy (Kharub et al., 2019). Even before COVID, the sector needed to be more competitive in cost. Many Small businesses are trapped in a negative cycle of informality, low productivity, and stunted growth. Ninety-five per cent of all companies in India employ fewer than five people, and 98% employ fewer than ten. Only 20,000 companies have paid-up capital of over ten crores INR (Force, 2020).

For decades, ICT has facilitated business activities. It enhances competitiveness, product and service delivery, effectiveness, and management information systems (MIS). In some instances, ICT has transformed business models. Any global enterprise requires ICT applications (Commissioner & India, 2014).

In India, affordable and effective communication access to its citizens and companies can make a knowledge-based society. In this context, the Government project empowers citizens and the Government. The Government focused on achieving “Broadband on Demand” by 2015, with 175 million connections targeted by 2017 and 600 million by 2020 (Choudhury et al., 2020). This type of initiative enables businesses and households to access cheap ICT technology. The available econometric evidence at the Firm-level indicates that combining Investment in ICTs and changes in organisations and work practises made possible by these technologies contribute to the growth of firm’s productivity (Spiezia, 2011) (Beynon et al., 2021). Small and Medium-sized enterprises (SMEs) have limited technical capabilities and rely on Smaller

groups of IT professionals or contract IT staff for their IT needs (Oliveira et al., 2014). Productivity measurement is a valuable tool to gauge business performance (Martínez-Caro & Cegarra-Navarro, 2010). The finance role is critical for any Small firm (Apulu et al., 2011).

There are two research objectives for this investigation into the impact of ICT adoption in the form of business Investment. First, the assessment of the effect of ICT Investment on the Profitability of the MSMEs. Second, to determine the financial ramifications of each Firm's size, such as Micro, Small, and Medium-sized businesses, based on the economic parameter. Using the pertinent literature as a guide, we studied data from a representative sample of three hundred firms, 100 of each type.

The literature review and research methodology are presented and discussed in sections 2 and 3 to outline the conceptual framework. Section 4 presents the results and analysis. Section 5 discusses the managerial implications of results, and finally, in section 6, Conclusions and future research directions are presented.

We must conduct such studies when India must play a pivotal role in global trade in the future. The MSME Policy and its connection to the Digital India initiative will benefit significantly from implementing structural changes in MSME. These considerations provide the chapter's underlying motivation.

## 4.2 Literature review

A strict lockdown prevented India and the rest of the world from conducting business during COVID-19. They have impacted the entire supply chain. During this time, there were substantial communication gaps between upstream companies, resulting in a deterioration of the business relationship. The Niti Aayog provided that Increasing productivity and decreasing production costs through technological interventions are effective means of expanding business in any industry (Mastercard & NITIAayog, 2021). From upstream to downstream firms, however, problems arise due to uninformed decision-making. There is either a need for more information or an abundance of information from which a business cannot select. The Organisation for Economic Cooperation and Development (OECD) study reveals that an important finding of the Growth Project was that productivity in the ICT sector could increase an economy's overall productivity (DEVELOPMENT, 2004). However, successful economies were more likely to have rapid diffusion of ICT, especially in the service industries, different from having the freedom to access ICT benefits in Manufacturing industries. Thus, this research examines the impact of ICT Investment on the productivity of Manufacturing firms in

MSME at the Firm-level. Firm-level evidence also suggests that the adoption and impact of ICT vary across firms, depending on Firm Size, age, and activity (OECD, 2008). Millions of users still need to be digital adopters, even though digital adoption is increasing rapidly (Hajro et al., 2022).

The Micro, Small, and Medium-sized enterprises (MSME) sector typically manufacture specialised products for large corporations. This sector has also been a critical enabler of distribution and supply chains for more giant corporations, contributing nearly 25% to India's services GDP and 33% to Manufacturing output (Mastercard & NITIAayog, 2021). This sector has limited access to information and financial credit compared to larger businesses. A recent study found that MSMEs face a loss in domestic and global demand (the WTO predicts that international trade in goods will decline by 13 to 32%), as well as disruptions in the supply of raw materials and non-payment of debts. This reduction in profit could result in a significant profit contraction of approximately Rs 0.8–1.2 lakh crore by FY21 for companies with revenues between Rs 75–250 crore (Force, 2020). In the FICCI survey, 60% of respondents from MSMEs felt that their business partner and customer relationships had improved due to using ICT tools (Industry, 2012). Collaborative development and deployment improve user and management acceptance (Benjaoran, 2009). The United Nations proposed as the core indicator of the Use of ICT by Businesses the number of sales made via the Internet during the Period (United Nations, 2007). However, only sales data has not provided the Firm's overall position since the goal of the Firm is to maximise the profit. Thus, in this chapter, we propose to measure the impact of ICT Investment on profit increment in MSMEs using the Design of experiments method.

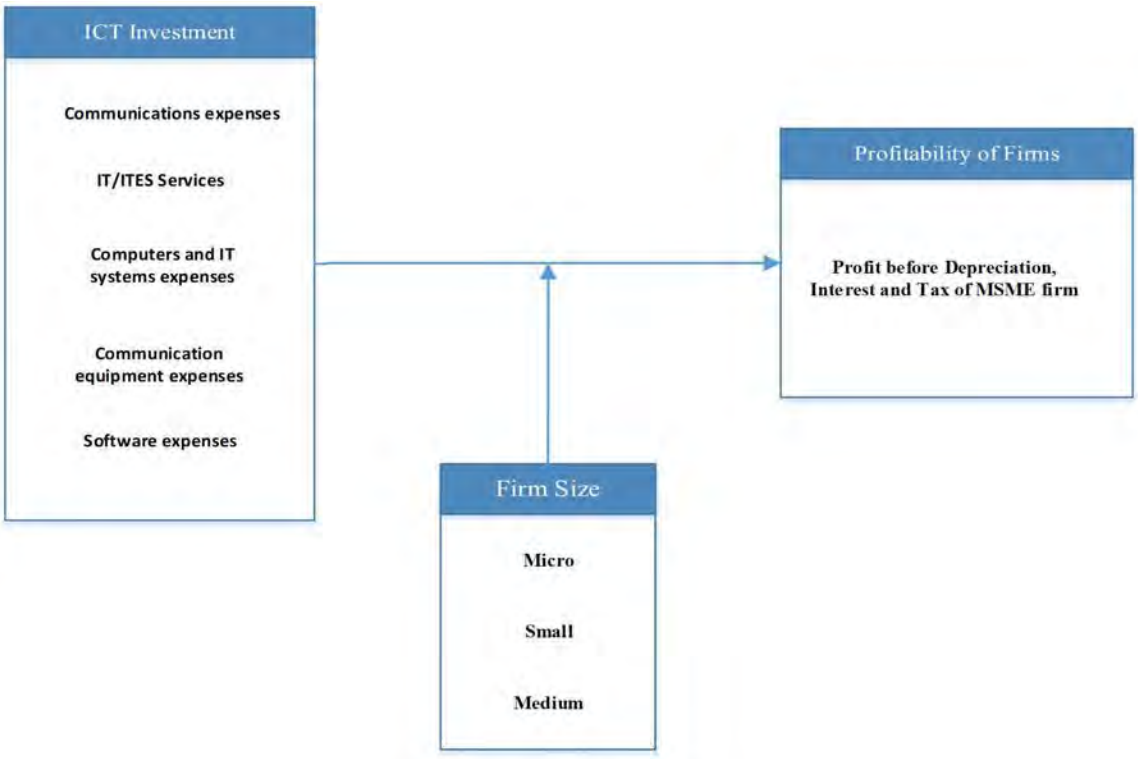


**Figure 4.1 Framework for the study.**

Based on the literature, we developed the framework in Figure 4.1. We construct two research objectives for this investigation into (1) the impact of ICT adoption (in the form of business Investment) on profitability and (2) the impact of firm type on profitability. In ICT, Investment is the sum of all the expenditures made in IT, software, hardware, and communication technology. This ICT Investment directly impacts the Firm's Profitability, which is moderated by the firm type. This firm type is based on the Investment in Plant and Machinery derived from the official definition of MSME in India. Various studies are related to the interview-based (Gäre & Melin, 2011) to validate these outcomes and decisions based on the actual results are very few and rarely explored in the Indian MSME context.

## 4.3 Research Methodology

With their inadequate financial knowledge, the leaders of SMEs could not determine the optimal level of Investment in ICT (Okundaye et al., 2019).

The broad definition of MSME classification was first defined in 2006 by the MSMED Act 2006 and further modified after the Gazette of India notification dated 01.06.2020. This notification is classified based on annual turnover and Investment in Plants and Machinery.

**Table 4.1 MSME Definition based on the Investment.**

| Sr. No | Sector | Investment in Plant & Machinery or Equipment (in ₹) | Turnover (in ₹) |
|---|---|---|---|
| **1** | Micro | 10 million | 50 million |
| **2** | Small | 100 million | 500 million |
| **3** | Medium | 500 million | 2500 million |

In the study that the OECD conducted to determine the effects of Investments in information and communications technology (ICT) in the countries that took part, the researchers argued that ICT Investments consist of Investments in information technology (IT) and software in each nation. Equivalently, in our research, we have included all the Investments businesses have made, including costs associated with communication, IT/ITES services, computer and IT systems, communication equipment, and software costs. According to the official definition of MSME, the Investment in Plant and Machinery of firms in the MSME sector is modest. According to Table 4.1, a Micro firm has an Investment limit of less than 10 million INR, 100 MN and 500 MN, respectively, for the remaining two categories, namely Small and Medium.

In literature, ICT is related to sustainability in both positive and negative ways (Kavathatzopoulos, 2015); however, what level of ICT has yet to be studied? In addition, the ICT Investment level has yet to be studied in the literature. Therefore, we propose and exercise the entire range of ICT Investment is divided into four levels according to the amount of money invested: Level 1 (ICT Investments of less than one million INR), Level 2 (ICT Investments of between 1.1 and 5 million INR), Level 3 (ICT Investments in between 5.1 to 10 million INR), and Level 4 (ICT Investments above 10 million INR). The premise of our assumption is that we define the level of ICT Investment, keeping 10% of the threshold value of the total Investment bracket of Plant and Machinery. On the contrary, if we take 10% of the 100 million (Small firm cap), the value is quite significant for the Investment in ICT; hence, we introduce level 1 between the value range from 01 MN to 10 MN.

In Table 4.2, we have created three constructs: Total Investment in ICT, Firm Size, and profitability. These three constructs are each represented by a variable, with the Profitability variable serving as our response variable. This response variable is measured in terms of profit

before depreciation, interest, and tax to determine a company's actual profit from sales minus expenses.

**Table 4.2 Variables for the Design of Experiment**

| Construct considered | Variable considered |
|---|---|
| **Total Investment in Information and Communication Technology** | ICT INVESTMENT (in Million INR) |
| **Firm Size: Micro, Small and Medium** | Industry Type |
| **Profitability** | Profit before depreciation, interest, Tax and Amortisation (PBDITA) from the Profit and loss account. |

The MSME definition determines the Firm-level in India, typically based on the turnover and Investment in Plant and Machinery. This definition is used to derive the Firm-level. Therefore, to conduct this analysis, we accessed the data for the current fiscal Year from the Prowess data platform, which was based on a random sample size of 300 Manufacturing companies in the MSME sector. These 300 firms consist of 100 numbers of Micro, Small, and Medium-sized enterprises. To serve as a model for analysing the impact that the adoption of information and communications technology has had on the profitability of Micro, Small, and Medium-sized enterprises (MSME), an essential concern for any organisation concerning their ongoing accounting principle.

Table 4.3 showcases a sample of data collected from the Prowess database for the study, as appended in Annexure A.

**Table 4.3 Sample of Data of Study**

| Investment in Plant & Machinery (In MN INR) | Firm type | Investment in ICT (In MN INR) | ICT Level based on investment | PBDITA (In MN INR) |
|---|---|---|---|---|
| 3.6 | Micro | 0.8 | Level 1 | 29.6 |
| 4.1 | Micro | 1.5 | Level 2 | 5.9 |
| 7.7 | Micro | 1.9 | Level 2 | 52.1 |
| 9.3 | Micro | 19.3 | Level 4 | 324.78 |
| 84.1 | Small | 32.3 | Level 4 | 268.9 |
| 25.2 | Small | 9.8 | Level 3 | 36.8 |
| 269 | Medium | 29.6 | Level 4 | 350.4 |
| 232.3 | Medium | 1.3 | Level 2 | -16.9 |

In the study of the Indian Firm, authors (Thanki & Thakkar, 2014) recommended that advanced statistical tools like the design of Experiments are required for future research. Thus, DoE is used for this preliminary study. Design of Experiments (DOE) is a valuable tool that can be integrated into the early stages of the development cycle (Guo et al., 2012). The Design of Experiments (DOE) method is currently being considered to acquire a deeper comprehension of the significance of the influencing variables ICT Investment and Firm Size as factors). Furthermore, the degree (levels) they contribute to the company's profitability (response factor).

## 4.4 Data Analysis

Data are analysed on the aim of our study and the empirical outcome of the study. The data analysis process was a step-by-step approach that unveiled how data were analysed and reported (dependability check) (Eze et al., 2019). SMEs' Investment in information systems (IS) is a function of their strategy (cost reduction versus value-added) (Molinillo & Japutra, 2017).

Design of Experiments (DoE) for ICT Investment levels in the Micro, Small and Medium are applied with identified significant input variables (factors) and factors set at historical Minimum and Maximum levels. Below, Figure 4.2 summarises the effects summary of the DOE run.

**Effect Summary**

| Source | Logworth | PValue |
|---|---|---|
| Industry type | 3.460 | 0.00035 |
| ICT INVESTMENT | 3.112 | 0.00077 |
| Industry type*ICT INVESTMENT | 0.701 | 0.19887 |

**Figure 4.2 Effects Summary-Design of Experiments.**

In the case of MSME, Industry type (Micro, Small and Medium) and Different level of ICT Investment is observed to influence the Firm's Profitability. In addition, the interaction between Industry type and ICT Investment is not a significant influencer on profitability.

Figure 4.3 depicts the whole model by predicted plot, in which profitability is very well explained by the input variables, i.e., ICT Investment and the industry type.

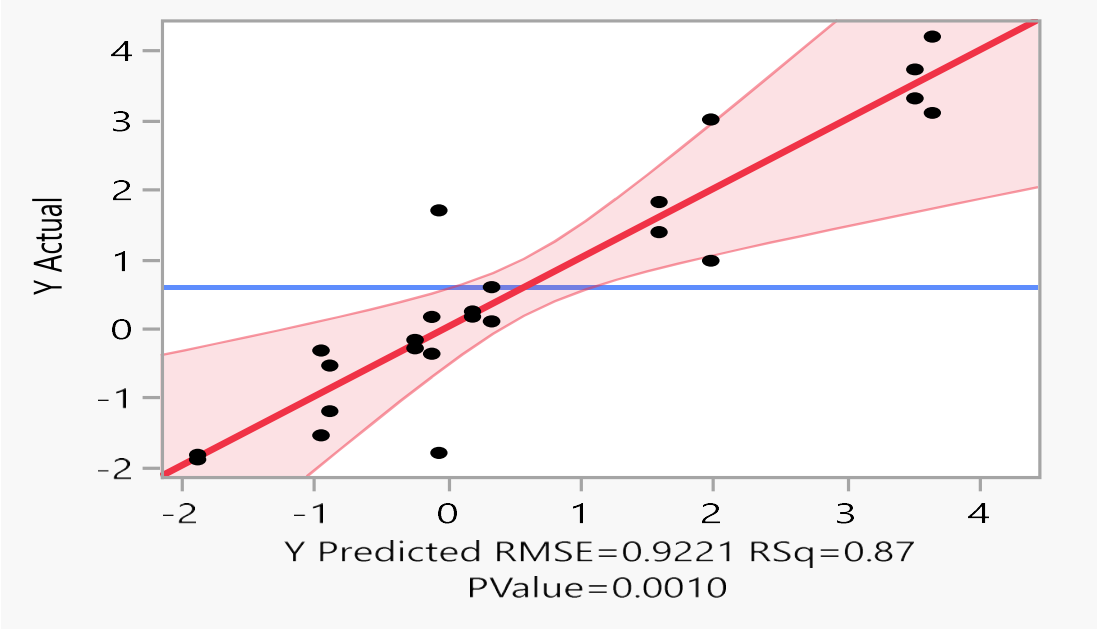


**Figure 4.3 Whole Model Actual by Predicted Plot.**

**Analysis of Variance**

| Source | DF | Sum of Squares | Mean Square | F Ratio |
|---|---|---|---|---|
| Model | 11 | 66.348184 | 6.03165 | 7.0938 |
| Error | 12 | 10.203218 | 0.85027 | Prob > F |
| C. Total | 23 | 76.551403 | | [illegible] |

**Parameter Estimates**

| Term | Estimate | Std Error | t Ratio | Prob>\|t\| |
|---|---|---|---|---|
| Intercept | 0.6006833 | 0.188223 | 3.19 | [illegible] |
| Industry type[0-10] | 1.1180311 | 0.266187 | 4.20 | [illegible] |
| Industry type[10.1-500] | -1.470619 | 0.266187 | -5.52 | [illegible] |
| ICT INVESTMENT[<1] | 1.2988794 | 0.326012 | 3.98 | [illegible] |
| ICT INVESTMENT[1.1-5] | -1.336524 | 0.326012 | -4.10 | [illegible] |
| ICT INVESTMENT[5.1-10] | 0.856345 | 0.326012 | 2.63 | [illegible] |
| Industry type[0-10]*ICT INVESTMENT[<1] | 0.4986694 | 0.46105 | 1.08 | 0.3007 |
| Industry type[0-10]*ICT INVESTMENT[1.1-5] | -0.615848 | 0.46105 | -1.34 | 0.2064 |
| Industry type[0-10]*ICT INVESTMENT[5.1-10] | 1.0724626 | 0.46105 | 2.33 | [illegible] |
| Industry type[10.1-500]*ICT INVESTMENT[<1] | -0.23129 | 0.46105 | -0.50 | 0.6250 |
| Industry type[10.1-500]*ICT INVESTMENT[1.1-5] | 0.3411495 | 0.46105 | 0.74 | 0.4736 |
| Industry type[10.1-500]*ICT INVESTMENT[5.1-10] | -0.859149 | 0.46105 | -1.86 | 0.0870 |

**Figure 4.4 Analysis of Variance (ANOVA) and Parameter Estimates.**

Figure 4.4 summarises the ANOVA and Parameter estimates of the DoE run for the three types of firms.

For all kinds of firms

- The model can explain a substantial portion of the variation (Higher value of Model Sum of Squares)
- F ratio is a significantly high value
- The p-value is less than 0.05.

The above observations indicate that the remarks about the factors and the inference about their influence on PBDITA are statistically significant.

ICT infrastructure (Gäre & Melin, 2011), competitive advantage (Maguire et al., 2007) and Financial decisions are supplementary to each other (Chibelushi & Costello, 2009). Below Figure 4.5 is the summary of the prediction profiler for MSME. This profiler has predicted that a Profit before depreciation, tax, and interest of 3.51 million INR can be achieved by managing the ICT Investment of less than 1 million INR and Plant and Machinery Investment of less than 10 million INR. These findings enable to Firm owner to become the ICT-enabled leader (Okundaye et al., 2019).

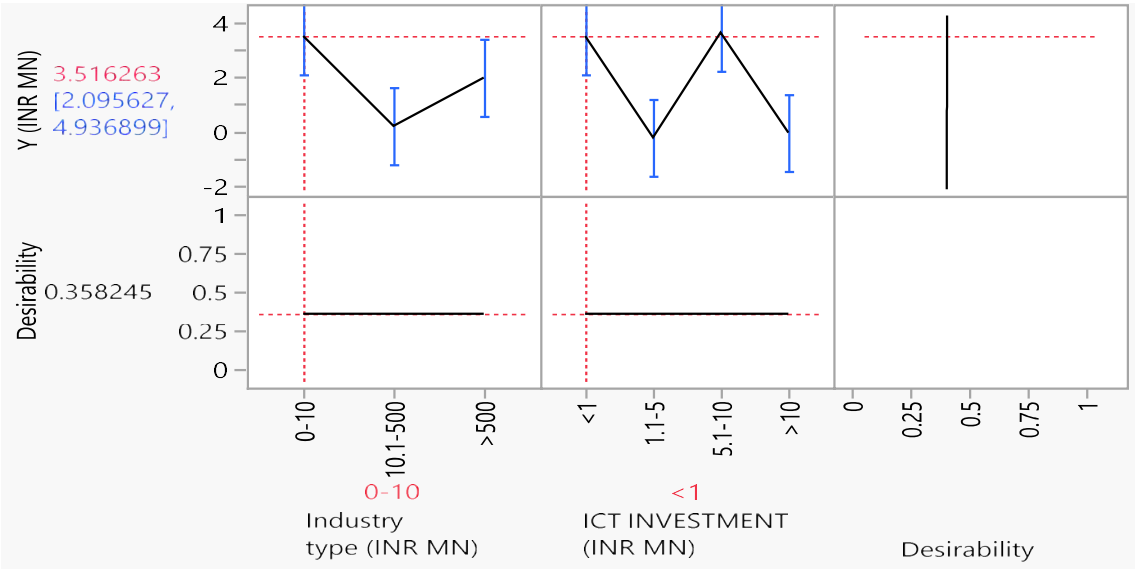


**Figure 4.5 Prediction Profiler for ICT Investment.**

## 4.5 Managerial Implication and Finding

Based on the results of the current study, the influential Investment levels of ICT in Indian MSMEs were identified. SMEs are always cautious about Investment decisions (Ghobakhloo et al., 2011). These Investment levels were categorised into four levels, and their impact on profitability was determined through DOE, as discussed above. According to the data analysis and present study results, the Investment of ICT and Firm Size factors strongly and positively explain the increment in firm's profits.

Our findings are based on the argument that top management should adopt ICT by first recognising its value. To validate our discovery, we have collected the financial data of the companies. We extracted from the Prowess database all information about Manufacturing companies. After filtering a large data set, the sample size for each firm type (Micro, Small, and Medium) was 100 based on the 2022 data. The research presented uncovers that the status of Investment in ICT in Indian MSMEs is not so encouraging. The reason is that how much the Investment should be made in ICT has yet to be analysed before.

Our findings are highly congruent and support our contention that the Investment in ICT has positively impacted the Firm's profitability. These results suggest that the top management can no longer consider the Investment in ICT a cost centre, as it is now reaping the benefits of this Investment and has become a revenue centre. (Beynon et al., 2021) Survey-based findings support and validate our findings. ICT capabilities need to be established (Martínez-Caro &

Cegarra-Navarro, 2010), and these ICT capabilities require firm Investment and priority concern for the organisation (Saffu et al., 2008), which require sophisticated tools that are not usually available with SME (Molinillo & Japutra, 2017). This challenge is SMEs' inability to predict technological advancement (Eze et al., 2019) (Eze et al., 2018). Our findings are the answer to these drawbacks to providing a clear view.

Moreover, this study's findings indicate that the Investment in ICT is low. According to the results, the level of Investment ranges from 1 million to 5 million INR, which is a reasonable Investment range for boosting profitability. Consequently, this study confirms that the level of Investment in ICT, in conjunction with the Firm's size, provides top management with the information necessary to decide whether to adopt ICT and how much to invest in ICT. From Figure 4.5, it has further inferred that Investment level 3 also maximises the output, i.e., profitability at the Medium firms. The challenge for top management is to find a way to change the mindset towards technology adoption.

Compatibility of the Firm's profitability with ICT Investment at an optimal level was the decisive factor in adoption. This finding is consistent with earlier research showing that the Firm's maximising the profit is the primary concern, and the business decision always depends on this primary premise. Perceived benefits in adopting the technology to ICT Investment (Chibelushi & Costello, 2009) (Saxena, 2017) are always an area of challenge along with the IS strategy (Molinillo & Japutra, 2017) (Khalil & Belitski, 2020). In our findings, the way out to this concern of MSME.

## 4.6 Conclusions and Future Research Directions

This study is a unique and candid approach to see the impact of ICT Investment yield the desired results in the Firm performance. Since a family business or Small entrepreneur typically runs the MSMEs, for them, the cost of technology is a significant concern to adopt. COVID-19 has affected the business performance of each Firm. In addition, these financial data are being taken for FY 2022; we observe that even the firms are making negative Profits due to various other factors. Profitability has a strong relationship with ICT Investment. These results encourage the policymakers, Government and even the financial institutions to invest in ICT and enhance the adoption of the technology in their business operation. This approach is the holistic approach, which relies more on secondary data.

The minimum and maximum performance levels for each operating metric are used as levels for the respective factors in the experiments. The relevance and the degree of influence of each

operational metric (aspect) on the profitability (response) of the individual Firm are determined, and the degree of interactions among the variables is significant. This study helps provide a straightforward framework but effective way to implement to maximise the Profit of the Firm. This study sees the different ICT Investment levels to predict the Investment strategy and fine-tune profit targets.

The observations could not be generalised as the experiments' analysis; the design was limited to a few vital metrics, only three hundred firms were considered, and the database of registered MSMEs in India is quite large. As a future research agenda, this study needs to be validated with an extensive set of operating variables and extended to a broader group of firms. (Kazakov et al., 2020) The authors studied job satisfaction and employee loyalty, and this finding can be verified by employee utilisation in the MSME sector. Based on such studies, the findings can be generalised, and in future, these results can be compared with the large Firm to prepare the model. Future research also needs to examine the impact of financial credit due to a lack of financial resources in the MSME sector and their access to cheap credit from the market.

# CHAPTER 5: THE INFORMATION AND COMMUNICATION TECHNOLOGY INVESTMENT AND INDIAN MSME MANUFACTURING FIRM PERFORMANCE PARADOX-A PLS-SEM APPROACH INVESTIGATION

## 5.1 Introduction

Man, machine, and materials are the fundamental pillars of any organisation. These are necessary for business to flourish overall. The definition of MSME is integrated and based on the number of employees and Investment in Plant and Machinery in India. These three pillars in MSMEs are struggling in one way or another. The conditions of MSMEs on these basic units are areas of concern, and the MSMEs need experienced and well-trained staff, technologically advanced machines, and not very well-managed materials. The "cost", "knowledge", "training", "technology access", and "financial credit" are easily accessible to the MSMEs (R. K. Singh, 2011). Information asymmetry is one of the biggest reasons in business operations for incurring more cost, less efficiency, and low agility. Information technology Investments increase and constitute many total expenditures (Renkema & Berghout, 1997). Production in the company uses different resources, such as labour and different forms of physical and human capital (UNCTAD, 2019).

MSMEs help resolve some of the labour problems in the country by employing more people per capita than the value invested in business compared to large firms (Kaushalesh Lal, 2011). MSMEs are known to be labour-intensive (Apulu et al., 2011); (Whah & Lim, 2018). The growth of the business depends on the employee (Allan & Lawless, 2005) only; however, MSMEs need to do more technologically skilled (Khanna & Sharma, 2022). A management structure of prime managerial concern is whether full-time employees have the appropriate skills needed to exploit new ICT trends (Khalil & Belitski, 2020). The growth of conventional enterprises generally depends on increased Investment in capital, labour, land and technology (Ng & Li, 2003).

Authors (Charoenrat & Harvie, 2014) indicate that Firm Size, Firm Age, experienced personnel, location, type of firm ownership, Government assistance, Foreign Investment, and export activity are significant firm-specific factors contributing to MSMEs' technical efficiency. However, the authors must establish a correlation between these parameters and a company's financial performance following ICT Investment. ICT technology includes a portion of a company's hardware and Software Investment (Rasel, 2016b), and prior research indicates

that ICT enhances productivity. (Brynjolfsson & Hitt, 1998) Authors argued that what occurs within a company's factors significantly impacts I.T. Investment returns, and this relation needs study to validate.

The rapid penetration of communication and information technology (Vu & Asongu, 2020) in the form of cloud, 5G, and essential technologies offers valuable insights into the vitality of Small businesses to embrace the ICT revolution in order to overcome the obstacles that have prevented them from maximising their backwardness advantage, in Indian MSME are still striving for essential ICT technologies. E-leadership facilitates business and digital strategy alignment (W. Li et al., 2016). However, this alignment is an ongoing concern of the MSME in India. The digitalisation of a Firm is the process of making information and transforming the process through I.T. and Internet-based technology (Ekman et al., 2020). Digital MSME is a need at the current time in India.

(Ilavarasan, 2019) argued that low-cost ICTs enhance Small enterprises' potential; however, there needs to be evidence that the impact reaches the bottom line. (Melville et al., 2004) suggest that organisational performance measurement includes profitability, productivity, and efficiency. Authors (Brocke et al., 2021) pointed out that most studies are qualitative in this field of study, while validation of results requires study with actual firm financial data.

The study aims to answer these four primary research questions based on the concerns raised by various researchers. The first is the impact of ICT Investment on the MSME financial parameter (Binuyo & Aregbeshola, 2014), (Bharadwaj, 2000), (Mukhopadhyay et al., 1995) (Seth & Gupta, 2005); second, external anchors like Government aid and financial credit (Short-term borrowing) affect directly(Control) to the ICT Investment and the mediating role of ICT Investment on Firm Performance. Third, the internal factors of Firm Size and Firm Age directly affect the Firm’s financial performance and ICT Investment with the mediating role of ICT Investment on Firm Performance.

(RQ 1): Does ICT adoption (through ICT Investment) positively influence a Firm financial performance?

(RQ 2): Do external factors like Government aid and Short-term borrowing positively influence ICT Investment?

(RQ 3): Do internal factors like Firm Age and Firm Size positively influence the ICT Investment and firm financial performance?

(RQ 4): Does ICT Investment (through ICT Investment) mediate the Firm's Financial Performance?

It is evident from this review that there are few studies available on the topic. The first research query relates to the influence of ICT Investments on the Firm's Performance. The second and third research questions concern measures of critical success factor variables on the Firm's Performance, which are external factors that directly influence the analysis of the MSME's Performance and internal factors that indirectly affect the MSME performance. We develop and implement a model that suggests the critical relationship between the Firm's Performance and the factors influencing the parameters. This study is the answer to these research questions. A detailed analysis was undertaken with the extensive data set to identify which ICT Investment factors are influenced by internal and external factors for firm performance.

The chapter is organised as follows. First, we discuss the ICT Investment and different firm performance factors relevant to the study. Second, we present four research questions based on literature to understand the underlying topic, represented in a framework using an essential firm Performance measuring unit. Third, we address the critical issues of this study, the impact of ICT and the role played by internal and external variables that influence the ICT Investment-firm performance relationship. We then discuss three significant considerations that the owner/Government and the financial institution need to address when using the decision related to ICT in the Indian MSME Manufacturing sector.

## 5.2 Literature review

Their efficacy is affected by the "digital divide" between large and Small businesses. The impact of ICT Investments on productivity varies between studies of large and Small businesses. The term "productivity trade-off" was coined by a few authors to describe the practice of measuring a company's productivity on one dimension while retaining or ignoring the other (Pilat, 2005). The second possible explanation is that some researchers measure ICT adoption using Likert scale survey questions to motivate adoption, but very few on the Firm's financial performance. Numerous studies begin quantifying the productivity trade-off on the ground but exclude the nature of ICT Investment and firm financing. I.T. is not just a tool for automating extant processes; it also facilitates technological pursuits and organisational changes that can result in productivity gains (Khanna & Sharma, 2022). Numerous studies in this field indicate a negligible or non-existent impact of ICT Investment on MSME firm Performance in the Indian context. (Ng & Li, 2003) The relationship between an organisation's ICT Investment and productivity could have been more linear.

**Purpose of ICT Investment:**

There are distinct reasons for Investment decisions in ICT. In the paper, authors (Renkema & Berghout, 1997) argued that mandatory Investments rely primarily on enhancing performance and that competitive advantage Investments are required to evaluate the Investment's purpose. The ICT resource and Investment impact firm performance (Rai et al., 2006), which includes how and why I.T. influences higher-order process capabilities, resulting in business performance gains (Rai et al., 2006). The Investment strategy varies by ICT Investment level (Sabherwal & Chan, 2001). This ICT Investment is required to assess the Firm's performance, especially on the financial Performance of the MSME.

**External Factors:**

a. **Short-term borrowing:**

ICT Investment needs finance for the technology in the MSME sector. MSMEs struggle with working capital, credit ratings, and supply chain partner exploitation (J. Wang et al., 2021) (da Silva et al., 2022). Low credit rating hurdle Short-term borrowing for MSME. Due to financial constraints, most MSMEs wait to adopt cheaper technology (Oni & Papazafeiropoulou, 2014). This decision delay may cost more MSMEs (Madrid-Guijarro et al., 2009). Future Investments should consider flexibility in financing ICT technology (Wided, 2023) and the long-term fiscal impact of switching costs (Yildirim & Ansal, 2011). Literature covers many technology costs and financing issues. How this factor affects ICT adoption is unknown.

b. **Government aid:**

Government pressure for technology adoption is critical (K. Zhu et al., 2003). (Iacovou et al., 1995) found that Government-dependent Small businesses are likelier to adopt EDI. The Government and stakeholders can provide affordable technology and a regulatory framework for sustainable ICT adoption. The Government can help SMEs innovate and compete as policymakers and large spenders (H. Gupta & Barua, 2016), (Charoenrat & Harvie, 2014). However, MSMEs need Government and private sector incentives to adopt technology to benefit from e-commerce over cost (Oni & Papazafeiropoulou, 2014). This aspect needs to be studied for ICT Investment decisions by Government aid.

**Internal Factors:**

a. **Firm Size:**

Larger SMEs develop more ICT capabilities in large environments than Smaller ones (Neirotti et al., 2018), and ICT use in MSMEs depends on their environment and size. In MSMEs, Firm Size directly affects technology adoption (Oliveira et al., 2014). Small organisations' core

systems and services are affected by Size (Osborn & Simpson, 2017); nevertheless, how the Firm Size impacts the firm financial performance with the mediating impact of ICT Investment is still unknown.

b. **Firm Age**:

Firm Age negatively relates to technical efficiency (Charoenrat & Harvie, 2014), and the authors' findings (Benitez, Castillo, et al., 2018) improved the innovation performance. Firm Age impact on ICT differently (OECD, 2008). In the literature, contradicting results in the studies of Firm Age on the ICT Investment with the mediating impact on the Firm Performance.

**Firm Performance:**

Researchers consider firm Performance one of the essential dependent variables (Naala et al., 2017). Most studies focus on labour productivity rather than business performance (Pilat, 2005). The Productivity paradox is a trade-off between investing in ICT and the Firm's Performance. (Binuyo & Aregbeshola, 2014) The increase in productivity is always the driving force behind a firm decision to invest in ICT. Productivity is an easy concept to grasp. It refers to the ratio of output to input (Brynjolfsson & Hitt, 1998). Investing in human capital and technology causes a transition from low to high growth levels, accompanied by increased productivity and returns (Voghouei et al., 2021). In this instance, labour is directly substituted for the relatively more productive input factor of I.T. capital, leading to increased capital intensity and, ultimately, a rise in labour productivity and firm Performance (Schweikl & Obermaier, 2020) (Brynjolfsson & Hitt, 1998). Return on Assets is a significant measure of productivity (Benitez, Llorens, et al., 2018), which covers maximising profit (Miroshnychenko et al., 2017). Many researchers use the ROA as a crucial measuring parameter for firm Performance (Matanda & Freeman, 2009), (Miroshnychenko et al., 2017), (Benitez, Llorens, et al., 2018), (Shi & Yu, 2013), (M. Zhu et al., 2021).

In the production chain, ICT accelerates the production cycle, improves product quality, increases labour productivity, reduces production costs, efficiently monitors and controls the production process, and shortens production and distribution times (Voghouei et al., 2021), while increment in the ICT Investment decreases the bottom line of the Firm. This trade-off needs to be addressed and validated. Therefore, there is no concrete way to measure the Firm performance parameter; hence, this chapter has attempted to measure performance on financial parameters.

**Table 5.1 Construct Definition**

| Construct | Construct Code | Definition | Articles |
|---|---|---|---|
| **ICT Investment in the MSME** | ICT Investment | The degree of the financial value invested in the various ICT-based technologies. The study uses the total ICT Investment by the Firm. | (Schweikl & Obermaier, 2020); (Biagi, 2013); (Modjo et al., 2022) |
| **Critical success factors** | | The variables are the impact of ICT Investment and Firm Performance and the mediating of ICT Investment on the Firm Performance. | |
| Firm Age | Age of Firm | The Firm Age is defined in Years from the current Year, i.e., 2023, to the Firm's incorporation. | (Modjo et al., 2022), (OECD, 2008), (Charoenrat & Harvie, 2014), |
| Firm Size | Size | The value of the market size of the Firm and the study | (Neirotti et al., 2018); (Hua, 2007), (Benitez et al., 2020) |
| Short-term borrowing | Short-term borrowing | The Firm's short-term loan/debt value in the study | (Shirokova et al., 2013) (Harland et al., 2007) |
| Government aid | Government aid | The value of Government subsidy or aid to the Firm | (Alderete, 2017); (Solaymani et al., 2012); (K. Zhu et al., 2003); (Oni & Papazafeiropoulou, 2014) |
| **Firm Performance** | | The degree to which a firm has superior performance in financial terms. | (Shirokova et al., 2013) (Harland et al., 2007) |
| Return on Assets | Return on Assets | The Ratio of Net Income to Total Assets of the Firm. | (Matanda & Freeman, 2009), (Miroshnychenko et al., 2017), (Benitez, Llorens, et al., 2018), (Shi & Yu, 2013), (M. Zhu et al., 2021) |

The following hypotheses are based on the literature review related to the research questions.

(RQ 1) Does ICT adoption (through ICT Investment) positively influence firm financial performance?

**H1: There is a positive relationship between ICT and the Firm's financial performance.**

(RQ 2) Do external factors like Government aid and Short-term borrowing positively influence ICT Investment?

**H2: Government aid positively impacts the ICT Investment in the MSME.**

**H3: Government aid positively impacts the Firm's financial performance through ICT Investment.**

**H4: Short-term borrowing positively impacts the ICT Investment in the MSME.**

**H5: Short-term borrowing positively impacts the Firm's financial performance through ICT Investment.**

(RQ 3) Do internal factors like Firm Age and Firm Size positively influence the ICT Investment and Firm financial performance?

**H6: Firm Age positively impacts the ICT Investment in the MSME.**

**H7: Firm Age positively impacts the Firm's financial performance.**

**H8: Firm Size positively impacts the ICT Investment in the MSME.**

**H9: Firm Size positively impacts the Firm's financial performance.**

(RQ 4) Does ICT Investment (through ICT Investment) mediate the Firm's financial performance?

**H10: ICT Investment positively mediates the impact of Firm Age on the Firm's financial performance.**

**H11: ICT Investment positively mediates the Firm Size's impact on the Firm's financial performance.**

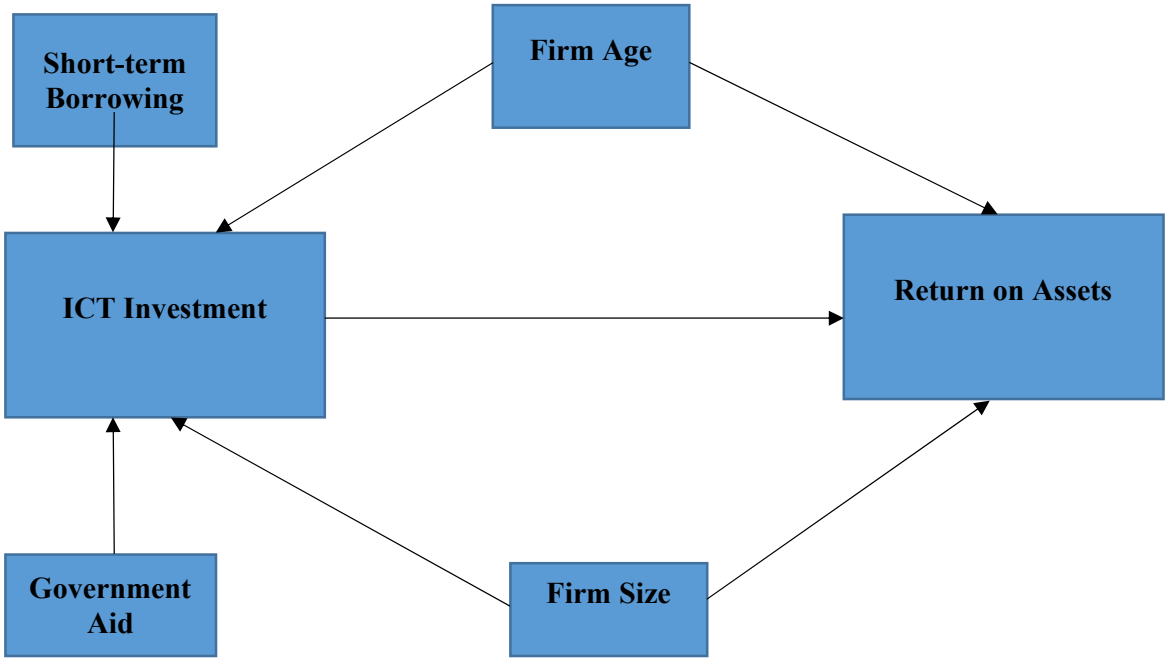


**Figure 5.1 Framework for the Study.**

Based on the literature and Conceptual framework, the framework is derived and presented in Figure 5.1. The framework is unique wherein it aims to study the direct impact of ICT Investment on ROA, where internal factors directly influence decision-making of ICT Investment and ROA by mediating the impact of ICT Investment. The external factors are directly affected by the input factor of ICT Investment.

## 5.3 Methodology

This study adopted a quantitative approach research technique, applied to the secondary data source related to the Indian MSME Manufacturing sector. The MSME is defined based on the official definition of the Indian MSME Act.

### *5.3.1 Data Set*

The MSME sector in India is the second largest employment sector and contributes to the Indian gross domestic product. This sector consists of Micro, Small, and Medium-sized businesses, categorised according to their Investment in Plant and Machinery and annual revenue. The Centre for Monitoring the Indian Economy (CMIE) maintains the most extensive data repository about the Indian economy and the financials of various Indian businesses. Therefore, for this study, the extracted data from the Prowess database (CMIE) for the Indian MSME Manufacturing sector. Which consists of approximately 17000 company records, from which we randomly sampled two thousand company records (Micro, Small, and Medium) for collection. After data cleansing, such as removing missing values and short information, we discovered a data set containing 1074 companies for this research (CMIE, n.d.) with sample data presented in Annexure B.

### *5.3.2 Firm's selection criteria*

The aim of the study is for the MSME Manufacturing sector in India. Hence, the Data set is based on the official definition of the MSME in India. In India, Micro firm has an Investment capacity of up to 10 M INR, Small firms have an Investment capacity of 100 M INR, and Medium enterprises have a 500 M INR capacity (Ministry of MSME(GOI), n.d.).

### *5.3.3 Descriptive statistics*

In this study, 1074 observations have been conducted in the SmartPLS4.0 software. Table 5.2 presents the descriptive statistics used to clean the data and presented.

**Table 5.2 Descriptive Analysis**

| | ICT Investment **(in MN INR)** | Firm Age **(in Year)** | Firm Size **(in MN INR)** | Government aid **(in MN INR)** | Short-term borrowings **(in MN INR)** | Return on Assets **(in %)** |
|---|---|---|---|---|---|---|
| Mean | 3.22 | 30.50 | 1373.41 | 0.52 | 199.22 | 0.06 |
| Standard Error | 0.26 | 0.52 | 38.77 | 0.19 | 9.49 | 0.00 |
| Median | 1.20 | 28.00 | 976.00 | 0.00 | 88.65 | 0.05 |
| Mode | 0.30 | 27.00 | 879.80 | 0.00 | 1.00 | 0.00 |
| Standard Deviation | 8.42 | 16.93 | 1270.73 | 6.08 | 310.94 | 0.06 |
| Sample Variance | 70.84 | 286.76 | 1614750.03 | 36.92 | 96685.66 | 0.00 |
| Kurtosis | 150.83 | 4.90 | 2.78 | 714.34 | 22.90 | 42.11 |
| Skewness | 10.34 | 1.71 | 1.62 | 25.04 | 3.94 | 3.82 |
| Range | 159.40 | 121.00 | 8250.30 | 179.70 | 3319.90 | 0.93 |
| Minimum | 0.10 | 1.00 | 0.00 | 0.00 | 0.10 | 0.00 |
| Maximum | 159.50 | 122.00 | 8250.30 | 179.70 | 3320.00 | 0.93 |
| Sum | 3455.60 | 32762.00 | 1475041.40 | 559.00 | 213958.20 | 66.43 |
| Count | 1074 | 1074 | 1074 | 1074 | 1074 | 1074 |

The two most popular ways of evaluating model fit involve the X2 goodness-of-fit statistics and fit indexes (Hu & Bentler, 1999).

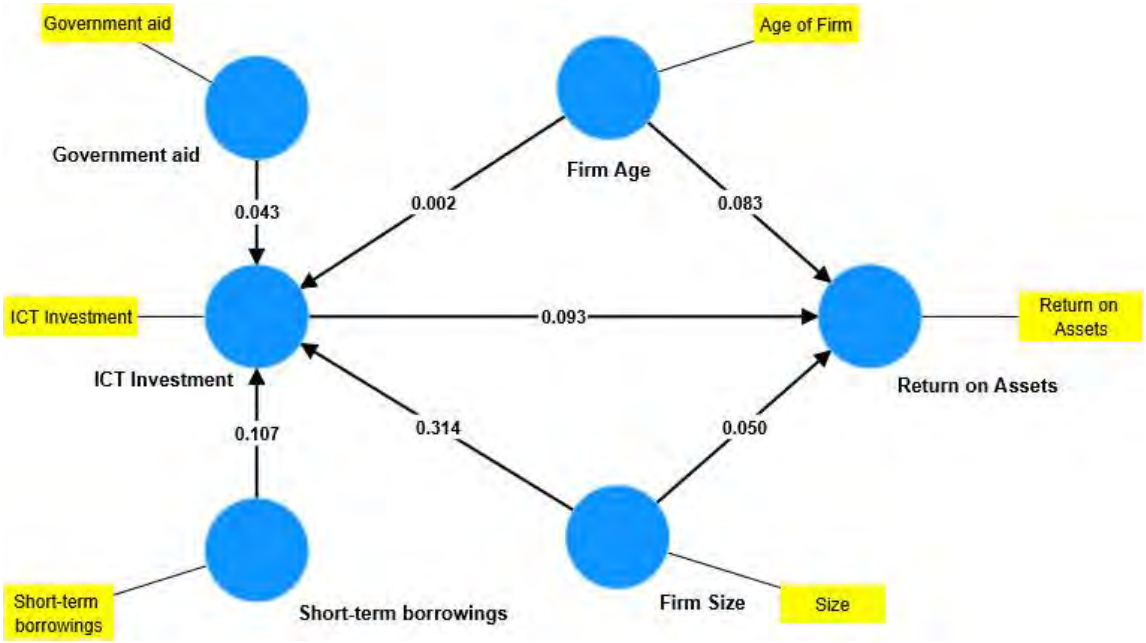


**Figure 5.2 SEM Path Diagram.**

## 5.4 Data analysis

Structural Equation Modelling (SEM) evaluates and validates theoretical models characterising the relationship between variables. It is appropriate to use the PLS (Partial Least Squares) and SEM (Structural Equation Modelling) are well-known data analysis techniques for examining the relationships between model variables in this research (Hair et al., 2019) (Kijkasiwat et al., 2021). First, PLS is a technique for analysing the relationship between two sets of variables (Valaei et al., 2017), in which the predictors or independent variables are used to predict the response or dependent variables (Benitez, Castillo, et al., 2018). Second, PLS is used in the secondary data similar to this study (Benitez, Castillo, et al., 2018) (Alhassan & Adam, 2021). PLS is frequently employed when the number of predictors significantly exceeds the number of observations. In recent Periods (Benitez et al., 2020), PLS-SEM has been used in all fields and for financial ratios (Hair et al., 2019); thus, this chapter qualified for using PLS-SEM for study.

(Hair et al., 2019), (Shmueli et al., 2019) (Dirsehan & Henseler, 2022) explained in their paper that PLS-SEM is most suitable when the relationship is complex and has a large sample size. Hence, our study confirms both the conditions for this type of study. The SmartPLS 4.0 software (Bayonne et al., 2020) uses PLS-SEM to analyse the research data in two phases: assessing the measurement model and testing the structural model (Alhassan & Adam, 2021). (Aboelmaged, 2018) indicated that PLS-SEM is less sensitive to sample data and is suitable for large data sets like this study, which consists of 1074 firms.

### *5.4.1 Assessment of measurement model*

In the PLS-SEM results assessment, the author (Hair et al., 2019) suggested that the Variance Inflation Factor (VIF), Bayesian information criterion (BIC), and f2 value of the endogenous construct(s) are critical to the analysis. A bootstrapping analysis is used to test the statistical significance of the PLS-SEM (Svensson et al., 2018), (Hair et al., 2019).

**Variance Inflation Factor (VIF):**

As the author (Hair et al., 2019) suggested and based on the Variance Inflation Factor (VIF) values in Table 4, the data does not possess any multi-collinearity considering the values less than 3 (Shmueli et al., 2019), which shows no concern for any variables. Consequently, there is no significant redundancy or collinearity between these variables, and they can all be included in a regression or modelling analysis without concern of multi-collinearity influencing the results.

**Table 5.3 Collinearity Statistics (VIF)**

**Outer model**

| | VIF |
|---|---|
| Age of Firm | 1.000 |
| Government aid | 1.000 |
| ICT Investment =A+B+C+D+E | 1.000 |
| Return on Assets | 1.000 |
| Short-term borrowings | 1.000 |
| Size | 1.000 |

**Inner model**

| | VIF |
|---|---|
| Age of Firm -> ICT Investment | 1.013 |
| Age of Firm -> Return on Assets | 1.009 |
| Government aid -> ICT Investment | 1.007 |
| ICT Investment -> Return on Assets | 1.110 |
| Short-term borrowings -> ICT Investment | 1.593 |
| Size -> ICT Investment | 1.609 |
| Size -> Return on Assets | 1.119 |

### *5.4.2 Structural model estimation*

The provided model fit indices compare the fit of the "Saturated Model" (a hypothetical model that precisely reproduces the observed data) to the fit of the "Estimated Model" (the actual model). We follow a similar approach to (Heredia et al., 2022) to test the model fit and evaluate the Standardised Root Mean Residual (SRMR) values.

**Table 5.4 Model Fit Summary**

| | **Saturated model** | **Estimated model** | **Results of assessment** | **Conclusion** |
|---|---|---|---|---|
| SRMR | 0.000 | 0.032 | SRMR < 0.08 | Supported |
| d_ULS | 0.000 | 0.021 | d_ULS < 0.3 | Supported |
| d_G | - 0.000 | 0.007 | d_ULS < 0.3 | Supported |
| Chi-square | 0.000 | 37.599 | This higher value for the estimated model is a significant difference between the model and the data. | |
| Normed Fit Index (NFI) | 1.000 | 0.946 | NFI>0.9 | Supported |

In particular, as per the authors (Hu & Bentler, 1999), the model usually does not fit if SRMR>0.08. The SRMR value in Table 5.4 is 0.032, indicating the model is well-fitting, as values below 0.08 are considered satisfactory. The d_ULS and d_G values of 0.021 and 0.007, respectively, indicate that the model has an acceptable fit, as values less than 0.3 are typically considered acceptable. The Normed Fit Index (NFI) value of 0.946 is marginally above the NFI>0.9 (Hu & Bentler, 1999), which means the model is a good fit.

**Bayesian information criterion (BIC)**, which achieves a good trade-off between model fit and predictive power in the estimation of the PLS-SEM (Cheah et al., 2021) (Bollen, 2011). (Hair et al., 2019) suggest that the Smaller BIC value is in better equilibrium, based on that criterion and Table 5.5 below values are fit for equilibrium between model complexity and fit quality. The above values signify that the models are equilibrium more for ICT Investment than Return on Assets.

**Table 5.5 BIC (Bayesian Information Criterion)**

| | BIC (Bayesian information criterion) |
|---|---|
| **Firm performance** | -2009.368 |
| **ICT** | -65.429 |

## 5.5 Discussion with Managerial impact

***5.5.1*** Discussion on the Model:

The paper (Kazakov et al., 2020) explained that the structural model could be evaluated based on the following criteria: the significance of the structural path coefficients and the effect size ($f^2$).

In this study from Table 5.3, collinearity is not an issue, and the next step is examining the $f^2$ value of the endogenous construct(s) (Hair et al., 2019). As shown in Table 5.6, the $f^2$ effect sizes of the exogenous latent variables in the PLS-SEM and PLS-SEM models have Small to Medium effects (Cheah et al., 2021) (Kazakov et al., 2020).

**Table 5.6 f-Square Value**

| | f-square |
|---|---|
| Age of Firm -> ICT Investment | 0.001 |
| Age of Firm -> Return on Assets | 0.007 |
| Government aid -> ICT Investment | 0.001 |
| ICT Investment -> Return on Assets | 0.007 |
| Short-term borrowings -> ICT Investment | 0.013 |
| Size -> ICT Investment | 0.111 |
| Size -> Return on Assets | 0.000 |

The f-square evaluates the effect size of each independent variable on the dependent variable, maintaining the effects of all other predictor variables in the model. A value of 0.02 for f-square denotes a minor effect, 0.15 a moderate influence, and 0.35 a substantial impact (Cohen, 1988). The f-square values in Table 5.6 show that size significantly influences ICT Investment (f-square = 0.111), indicating a very substantial effect. The remaining variables are moderate and minor effects on the ICT Investment and Firm performance.

The correlation matrix in the PLS-SEM analysis provides a fundamental role in accessing the relationship between variables and diagnosing collinearity. However, the VIF is considering checking collinearity more predominately.

Table 5.7 shows that most variables are positively correlated except the Government aid with Firm Age and Short-term borrowing to ROA. Despite this relationship in the PLS-SEM, the Path analysis has more explanation.

**Table 5.7 Correlation Matrix**

| | **Age of Firm** | **Government aid** | **ICT Investment** | **Return on Assets** | **Short-term borrowings** | **Size** |
|---|---|---|---|---|---|---|
| **Age of Firm** | 1.000 | -0.039 | 0.002 | 0.083 | 0.012 | 0.090 |
| **Government aid** | -0.039 | 1.000 | 0.043 | 0.013 | 0.059 | 0.070 |
| **ICT Investment** | 0.002 | 0.043 | 1.000 | 0.093 | 0.107 | 0.314 |
| **Return on Assets** | 0.083 | 0.013 | 0.093 | 1.000 | -0.125 | 0.050 |
| **Short-term borrowings** | 0.012 | 0.059 | 0.107 | -0.125 | 1.000 | 0.608 |
| **Size** | 0.090 | 0.070 | 0.314 | 0.050 | 0.608 | 0.000 |

## 5.6 Theoretical contribution

The current study is unique and contributes to the novel significant theoretical implication. First, this study is one of the first kinds in the Indian MSME sector, which is a novel approach. These findings provide an in-depth new perspective for the owner, external agencies like Government, Financial institutions, and other stakeholders. Previous studies, especially in the Indian context for ICT adoption in MSME, are limited to the adoption theories, or some researchers extend their research with a survey-based approach. The framework is designed based on the extensive literature review to summarise all the business aspects that attract everybody's interest.

The researchers have applied the bootstrapping technique along with PLS-SEM path analysis to understand the results with hypothesis testing, which are deliberated below.

**Table 5.8 Path Analysis**

| | **Path coefficients** |
|---|---|
| Firm Age -> ICT Investment | -0.032 |
| Firm Age -> Return on Assets | 0.082 |
| Firm Size -> ICT Investment | 0.398 |
| Firm Size -> Return on Assets | 0.015 |
| Government aid -> ICT Investment | 0.022 |
| ICT Investment -> Return on Assets | 0.088 |
| Short-term borrowings -> ICT Investment | -0.137 |

The table displays the path coefficients model relationships between variables.

**Path Analysis**

The negative path coefficient for "Age -> ICT Investment" indicates a slight decline in ICT Investment with increasing Age. The positive path coefficient for "Age -> ROA" indicates ROA increments for old firms. The positive path coefficient for "Government -> ICT" suggests that Government aid influences the use of ICT in the MSME. The high positive path coefficient "Firm Size -> ICT Investment" explains the importance of the Firm Size in the ICT Investment. The moderately positive path coefficient for "ICT -> Firm performance" indicates that the relationship between ICT use and firm Performance is weakly positive, which is supported by (Voghouei et al., 2021), (ENOMATE & AUDU, 2021) found the same finding ICT has a positive impact on Firm performance likewise these chapter findings.

A significantly negative path coefficient for "Short-term borrowing -> ICT Investment" indicates a negative relationship between short-term borrowing and ICT Investment.

**Inter-dependent impact**

The indirect effects that result from multiplying the path coefficients of two independent trajectories are the effect of an independent variable on the dependent variable via an intermediate variable. In this instance, Firm Age, Short-term borrowing, Firm Size, Government, and ICT are the intermediate variable, and firm performance is the dependent variables.

**Table 5.9 Specific Indirect Effects**

| | Specific indirect effects |
|---|---|
| Firm Age -> ICT Investment -> Return on Assets | -0.003 |
| Short-term borrowings -> ICT Investment -> Return on Assets | -0.012 |
| Government aid -> ICT Investment -> Return on Assets | 0.002 |
| Firm Size -> ICT Investment -> Return on Assets | 0.035 |

These values represent the strength and direction of the relationship between each independent and dependent variable, as mediated by the intermediate variable. Since the specific indirect effects are negligible or zero, they are unlikely to significantly impact the overall relationship between the independent and dependent variables.

### *5.6.1 Bootstrapping analysis*

(Hair et al., 2019) recommended evaluating the significance of path coefficients and their indirect effect on a specific target construct via one or more intervening constructs. PLS-SEM is a nonparametric method; therefore, bootstrapping is used to determine statistical significance (Svensson et al., 2018), (Hair et al., 2019). This finding is a vital analysis in the comparison of the PLS-SEM analysis (Jayeola et al., 2022) (Kazakov et al., 2020), (Bayonne et al., 2020) suggested running with 3000 samples; in our analysis, we also performed with 3000 samples. The outcome is below.

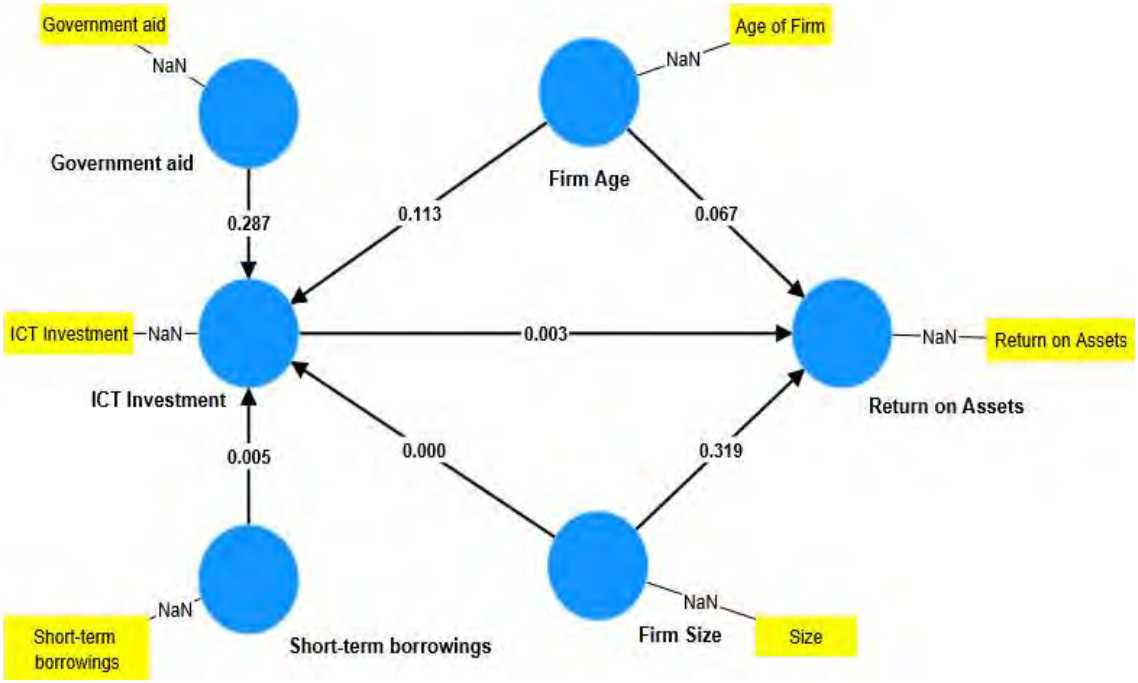


**Figure 5.3 Bootstrapping SEM Path diagram with P-Values.**

In comparison with Figure 5.2 and Figure 5.3, we can analyse that the independent variables have explained the dependent variables. The ICT impact on the Firm's performance has the same positive impact. There are significant findings, age and size improved the firm performance and have impacted the more than ICT.

**Table 5.10 Bootstrapping Results**

a. Direct impact analysis

| | Original sample (O) | Sample mean (M) | Standard deviation (STDEV) | T statistics (\|O/STDEV\|) | P values | Hypothesis testing and conclusion |
|---|---|---|---|---|---|---|
| Firm Age -> ICT Investment | -0.032 | -0.032 | 0.026 | 1.210 | 0.113 | H6: Not Statistically significant, and Firm Age negatively impact ICT as well. |
| Firm Age -> Return on Assets | 0.082 | 0.078 | 0.054 | 1.501 | 0.067 | H7: Not Statistically significant, and positive impact on ROA. |
| Firm Size -> ICT Investment | 0.398 | 0.415 | 0.083 | 4.784 | 0.000 | H8: Statistically significant, and Firm Size positively impacts ICT Investment. |
| Firm Size -> Return on Assets | 0.015 | 0.016 | 0.033 | 0.471 | 0.319 | H9: Not Statistically significant, and Firm |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | Size positively impacts ROA. |
| Government aid -> ICT Investment | 0.022 | 0.011 | 0.039 | 0.563 | 0.287 | H2: Not Statistically significant, and Government aid positively impacts ICT. |
| ICT Investment -> Return on Assets | 0.088 | 0.090 | 0.032 | 2.756 | 0.003 | H1: Statistically significant, and ICT have a positive impact on ROA. |
| Short-term borrowings -> ICT Investment | -0.137 | -0.139 | 0.052 | 2.605 | 0.005 | H4: Statistically significant; however, Short-term borrowing negatively impacts ICT. |

b. Indirect impact analysis

| | **Original sample (O)** | **Sample mean (M)** | **Standard deviation (STDEV)** | **T statistics (\|O/STDEV\|)** | **P values** | **Hypothesis testing and conclusion** |
|---|---|---|---|---|---|---|
| Firm Age -> ICT Investment -> Return on Assets | -0.003 | -0.003 | 0.003 | 1.113 | 0.133 | H10: Not Statistically significant, ICT Investment is not mediating with Firm Age on ROA. |
| Short-term borrowings -> ICT Investment -> Return on Assets | -0.012 | -0.013 | 0.007 | 1.677 | 0.047 | H5: Statistically significant, Short-term borrowing indirectly impacts Firm performance. |
| Government aid -> ICT Investment -> Return on Assets | 0.002 | 0.001 | 0.004 | 0.524 | 0.300 | H3: Not Statistically significant; Government aid does not indirectly impact ROA. |
| Firm Size -> ICT Investment -> Return on Assets | 0.035 | 0.037 | 0.016 | 2.261 | 0.012 | H11: Statistically significant, ICT Investment has a mediating impact with Firm Size on ROA. |

Table 5.10a and Table 5.10b summarise the outcomes of the bootstrapping PLS-SEM analysis. With these above outcomes, there is a significant relationship between ICT Investment and Firm performance, which has been justified by various researchers in the past as well. There are new findings as the Firm Age does not statistically impact the ICT adoption and resultant the Firm Performance. However, Firm Age has a favourable path relationship with ROA while a negative relationship with ICT. It is the opposite in the case of Firm Size having a positive

significance with ICT Investment, and ICT Investment has a significant mediating relationship with ROA.

At the same time, Short-term borrowing has a negative relationship with ICT Investment, which means an increment with the borrowing less in the ICT Investment; however, it signifies the ICT Investment and Firm performance. In contrast, Government aid influences ICT Investment with the significance of the results.

## 5.7 Practical Managerial Contribution

The model is a good fit, with all the selected variables firmly explaining the dependent variables. This research has exciting practical outcomes. First, we try to form the hypothesis based on the premise that the ICT Investment always has a Productivity paradox, explained by various researchers in their papers.

In practice, this chapter has also proved that ICT Investment has a positive and significant relationship with Firm financial performance. The possible explanation is that ICT Investment needs funding, which is also a finding of this study. Short-term borrowing has a negative relationship with ICT Investment but is a significant relationship. This finding provides practical managerial guidance that the manager can improve the ICT Investment with the lower value of borrowing.

The Government have various promotional schemes to promote technology adoption; the findings of this study support that Government aid has a positive relationship with ICT Investment, which means improved ICT Investment; however, these schemes are not sufficient as Government aid is not statistically significant with ICT and ROA indirectly. This study's results provide guiding parameters for Policymakers that the Government should provide more grants and form the policy in such a way as to improve the ICT adoption in the form of ICT Investment, which may directly and significantly improve the Firm's financial performance.

Age and Firm Size have different impacts on performance. A more aged firm does not mean less performance, whereas Age with ICT turned positive. The inference is that the more newly aged firms are not willing to take ICT, resulting in negative improvement in performance. The Firm Size factor explained significantly for both ICT Investment and ROA. These results signify and support our old analysis as well.

The significant finding is the first time we have explained in the Indian context that Firm Size is an essential external factor compared to Firm Age. In contrast, Short-term borrowing is a significant internal factor with a negative relationship with ICT Investment and, indirectly,

Firm Performance. This finding is a torch bearer to decide on financing ICT in MSME from top management and financial credit firm's views.

## 5.8 Conclusion and final remarks

Productivity growth determines our living standards and the wealth of nations. This analogy also applies to business, and the Firm's performance depends on its ability to deliver more accurate value for consumers without using more labour, capital or other inputs (Brynjolfsson & Hitt, 1998). Our study premise on these values only the path analysis uncovered several significant findings concerning the relationships between model variables. According to the findings, short-term financing substantially affects firm Performance and ICT. Other variables, however, have either minor or moderate effects. Nonetheless, it is crucial to account for some relationships' relatively low statistical power, which may compromise the precision of the estimates.

The negative effect of Age on firm Performance and ICT is a noteworthy finding. The path coefficients indicate that as a Firm's Age increases, its efficacy and ICT usage decrease marginally. This finding highlights the potential difficulties organisations may have adapting to new technologies as their workforces age. Strategies aimed at bridging the generational gap and encouraging technology adoption among senior employees could be advantageous for enhancing firm Performance and ICT usage.

The positive effect of Government influence on firm Performance and ICT utilisation suggests that Performance and ICT utilisation increase as Government involvement increases. This finding suggests that excessive Government regulations or bureaucracy need more alignment with organisations' requirements and ICT adoption. The collaboration of policymakers and organisations is required to foster an environment conducive to innovation, administrative burden reduction, and ICT adoption.

The results demonstrate a positive correlation between ICT and business performance. Even though the path coefficient is modest, it suggests that ICT utilisation contributes to improved firm performance. Consider investing in and leveraging ICT to enhance the overall performance of an organisation.

The discovery is essential that short-term financing substantially negatively impacts ICT. This finding suggests that even though short-term financing may provide immediate financial resources for ICT Investment, it may improve the company's overall performance. Organisations should carefully manage their financing strategies to balance the short-term

benefits of ICT Investment and the organisation's long-term financial viability and performance.

The effect of Firm Size on firm Performance and ICT is significant. Larger enterprises perform marginally better with an ICT adoption rate. This study suggests that organisations may have more capabilities and resources contributing to their efficacy.

In conclusion, the results indicate that short-term financing significantly affects firm Performance and ICT. In addition, the results emphasise the importance of effective communication, the potential challenges of Government influence, and the role of ICT in enhancing firm performance. This result is supported by (Bollen, 2011) that in many SEMs with large samples, there is considerable statistical power to detect even minor mistakes in the model specification. In practice, there will be ambiguity in assessing the overall model fit. Additional research with larger sample sizes and higher statistical power is required to confirm and expand upon these findings.

The present study focused on specific ICT-related variables and external and internal factors within a study of ICT on firm performance. This study provides a broader perspective on the findings, and future research could examine additional factors like the motivation of adoption, perceived use of technology and behavioural aspects of the adoption with the relationships in various industries or regions.

This study provides insights into the complex interplay between various factors and their impact on firm Performance and ICT. The findings have practical implications for businesses attempting to improve performance and effectively leverage ICT. By addressing the identified relationships and considering the study's limitations, organisations can develop strategies to enhance their performance and navigate the challenges and opportunities they face.

# CHAPTER 6: IMPACT OF INFORMATION AND COMMUNICATION TECHNOLOGY (ICT), GROSS WORKING CAPITAL AND SHORT-TERM BORROWING ON INDIAN MSME PERFORMANCE: A DOE APPROACH FOR MICRO, SMALL AND MEDIUM FIRMS FOR PRE-COVID (2015-2019) AND DURING COVID (2020-2022)

## 6.1 Introduction

The COVID-19 pandemic put unprecedented pressure on firm's financial health globally. Firms need to be resilient and financially sound to survive overall; during-COVID-19 makes a new way of thinking for firms to explore and exploit business opportunities in a cutting-edge technological world. As technology evolves, digital interventions can help mitigate financial risks. Information and Communication Technology (ICT) transforms business approaches in processing information, evolving strategic visions, selecting the optimal process strategy, and streamlining collaborative teamwork (Y. C. Lee et al., 2011), (S. Singh et al., 2021). Over the last three decades, intensive innovations in ICT have resulted in the proliferation of new user-friendly ICT tools and software (Pradhan et al., 2020). Manufacturing is transforming into "Smart Manufacturing". This Smart Manufacturing refers to incorporating IT and data into Manufacturing methods and tools (Mittal et al., 2020). Technology brings innovation or vice-versa, facilitating the firm's efficiency (Díaz-Chao et al., 2021). ICT's role substantially impacts the efficiency, competitiveness, and sustainability of all stakeholders in the business (Al-Busaidi & Al-Muharrami, 2021) (ENOMATE & AUDU, 2021). Companies create ways to determine the specific effects of various kinds of ICT on their efficiency in productivity (Bayo-Moriones et al., 2013). Investment in ICT in Supply Chain improves collaboration and reduces coordination costs by boosting visibility and transparency (Shi & Yu, 2013). The market abandons ICT resources, yet the cost is an important commercial factor, especially for Small firms. Priority number one for any business is determining the Return on Investment of its information and communication technologies Investments. The financial decisions affect the Firm's growth through a favourable or unfavourable technology selection (Eldomiaty et al., 2019). Companies that emphasise total digitalisation and integration of all digital ecosystems, processes, and communication (S. Singh et al., 2021) require considerable Investment for transformation. Investing in ICT increases ICT capability. Thus, increment in organisations'

productivity and market share provide other benefits, including assistance in competitively introducing new products and services (Chege et al., 2020).

MSMEs' Manufacturing sector is essential to the Indian and worldwide economy, and it is one of the most promising industries. The ineptitude to access proper credit is prevalent in India's diverse MSME ecosystem ('CREATING A ROADMAP FOR A DIGITALLY INCLUSIVE BHARAT', 2021). Management is now concerned with Information and Communication Technologies (ICT). Greater diffusion of ICT will raise firm's productivity, especially SMEs (Pradhan et al., 2020). The exponential rise of ICT offers enormous potential to improve the performance of businesses. Nevertheless, the significant Investment in IT increases the management demand to justify the spending by quantifying ICT's commercial value (Mukhopadhyay et al., 1995).

Given the extent of ICT Investments, a financial study of the benefits and costs of ICT is crucial for continuing to invest in ICT and for strategic and operational ICT planning decisions (Al-Busaidi & Al-Muharrami, 2021). In the literature review, the authors (Shi & Yu, 2013) (Al-Busaidi & Al-Muharrami, 2021) provide the Return on Assets (ROA) and return on Equity (ROE) as significant measures to evaluate the impact of Information technology. ICT Investments influence revenue growth as a company's most crucial performance measure (Voghouei et al., 2021). Profitability in terms of profits or losses is defined as the accounting registration of yields and costs (Renkema & Berghout, 1997). (Bharadwaj, 2000) has observed no relationship between IT Investments and any measure of firm profitability, including return on assets, equity, and economic value added.

Despite its importance in the economy, recent studies of ICT adoption in the Indian MSME Manufacturing sector show that ICT business values are, at best, inconclusive. While some researchers found the adoption agents, others found negative results or no impacts. At least two limitations are present in past studies: 1. There needs to be more evidence of ICT investment in the performance of India's Manufacturing MSMEs. 2. Some of the studies are for short Periods or survey-based, which makes it challenging to track all the Investment levels at the process level. Thus, the primary aim of this study is to see the impact of ICT Investment in the MSME Manufacturing sector financially and operationally. Investing in ICT by a firm is vital in improving financial stability and supply chain resilience. (1) ICT can enable firms to improve profitability, which results in the better Return on Assets (ROA) of MSME and provides the firm with business flexibility in improving the working capital, and (2) ICT improved working capital management can facilitate firm's resilience of operational

competence, this resultant into again improves the profitability. Thus, we have developed three research questions to study:

RQ1. Does ICT adoption positively impact Firm Performance?

RQ2. Does ICT Investment impact the Firm's financial performance with the interaction of short-term borrowing and Gross working capital?

RQ3.Does the COVID-19 pandemic change the impact of ICT adoption on Firm Performance?

Two significant additions to the prior research come from this study. First, the study adds to the literature. It provides a set of critical financial parameters for the digital firm by focusing on digital transformation (finding the optimal level of ICT Investment) in MSME Manufacturing firms. In addition, we add credibility to the link between digital transformation and improved financial outcomes for businesses by providing empirical evidence of the link.

As a result, we examine three fundamental mechanisms (business experimentation, financial flexibility, and operational competence) through which ICT Investment may influence ROA, the Working capital cycle. We evaluate the proposed theory using a secondary data set from Prowess, a sample of 2000 Micro, Small and Medium Manufacturing firms in India. The study has the potential to provide top management and managers with practical advice on how to establish and maintain a presence in the digital economy and gain a competitive advantage (CMIE, n.d.).

The chapter is categorised as follows. Section 2 overviews the pertinent literature concerning ICT's impact on firm performance. Section 3 discusses the conceptual framework, research hypotheses, and Methodology; Section 4 dedicates and discusses data results and practical implications in detail. Section 5 examines interpreting the results for Practical managerial implications. Furthermore, the final section draws the central conclusions and discusses further research agenda.

## 6.2 Literature review

Investment in and usage of information and communication technologies (ICT) boosts overall productivity after organisations demonstrate the connection between the two. The co-innovative aspects of SMEs consist of particular techniques primarily geared towards boosting revenue and optimising expenses or production variables (Torrent-Sellens et al., 2016). Due to the COVID-19 financial crisis and the high cost of loans, MSMEs need more money and other resources. Figure 6.1 depicts that lending rates in India are always higher compared to the USA,

China and in line with Indonesia. Therefore, short-term borrowing is the costliest for firms in emerging countries like India and Indonesia. Today, the most critical question for Micro, Small, and Medium-sized enterprise owners is not "Does ICT pay off?" but "How can we best utilise ICT?" Companies gain a competitive advantage by combining resources that collaborate to produce organisational capabilities. (Bharadwaj, 2000). This organisation's capabilities are in the form of tangible and intangible assets. IT capital broadly defined includes the stock of hardware, software, telecommunications and IT-related services (Schweikl & Obermaier, 2020) (Brynjolfsson & Hitt, 1998). In his paper (Bharadwaj, 2000) discusses the resource-based IT system; for this chapter, we have expanded the IT to ICT, since in the present time, technological advancement has opened new avenues the enhance the definition of IT to submerge the communication technology. So, to see the impact, the term derives it as an ICT resource.

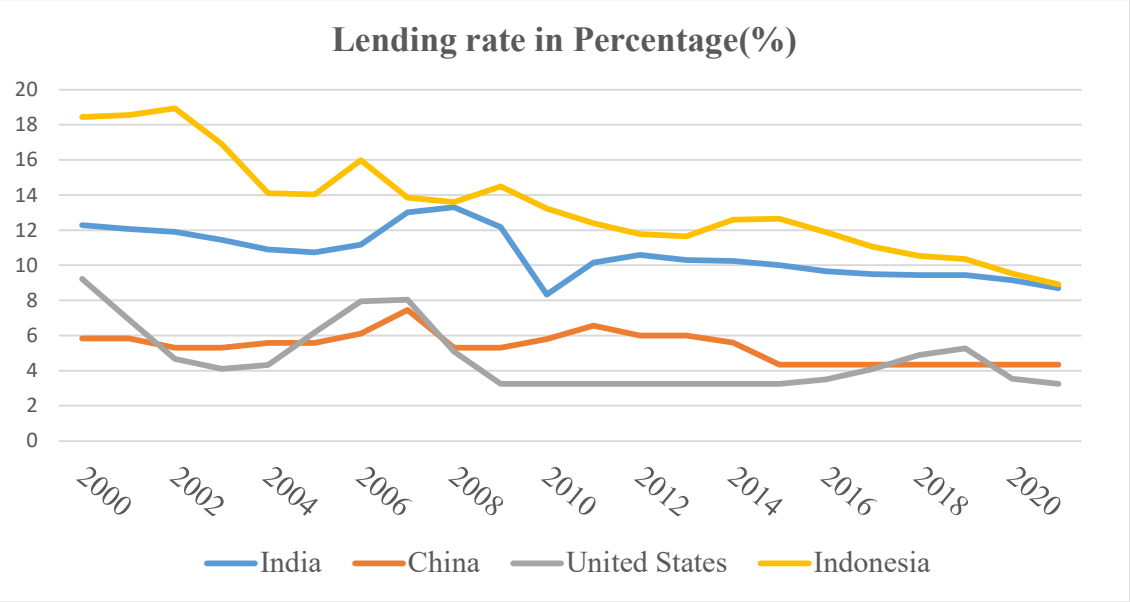


**Figure 6.1 Lending Rate Comparison (Reference:** (Worldbank, n.d.)**.**

In the literature, ICT performance studies can be broadly categorised as stemming from two perspectives:

***Firm ICT Capabilities***

Companies gain a competitive advantage by combining resources that collaborate to produce organisational capabilities (Bharadwaj, 2000). IT capabilities result from the synergistic integration of IT resources and other organisational competencies (Lyver & Lu, 2018) (Sunday & Vera, 2018) (Neirotti et al., 2018). These competencies become a competitive advantage (X.

A. Koufteros et al., 2002). Using information and communication technologies to bolster the link between resource transformation capabilities (Onyinyi & Kaberuka, 2019) improve productivity, communication, and functionalities (Ajibade & Mutula, 2020). ICT capabilities are enhanced by ICT budget allocation (Khalil & Belitski, 2020) and Investment in ICT technologies (Bharadwaj, 2000) (El-Haddadeh, 2020). ICT capabilities are intangible assets for the firm (Binuyo & Aregbeshola, 2014) that improve the technology and indirectly affect financial performance.

***Firm borrowing***

ICT have the potential for development and sustainability, which require Investment (UNCTAD, 2018). For Investment, MSMEs rely on Banks or other financial institutions in India. Nevertheless, banks limit their lending exposure to MSMEs due to their increased perceived risk of non-performance, low performance or credit data (Neirotti et al., 2018). Most Indian Small business owners rely only on expensive and unreliable informal finance sources because they need certified financial accounts or appropriate collateral to present with their loan applications ('CREATING A ROADMAP FOR A DIGITALLY INCLUSIVE BHARAT', 2021). There may be difficulties in raising finance to invest in e-Business (Harland et al., 2007). Firm borrowing is a critical factor for ICT adoption, and the result directly impacts firm's ICT capabilities.

***Gross working capital turnover***

ICT reduce transaction costs and saves business time (Adeniran & Johnston, 2016). SMEs need to enhance their level of services to fulfil the enterprise's targeted goals of effectively monitoring, controlling, organising and minimising production costs, inventory control levels, purchasing materials and utilising resources (AL-Shboul, 2019). Managing the working capital improves the firm performance (Altaf & Shah, 2018), which requires low inventory costs. In addition, the ICT reduces asymmetric information in "Just-in-time inventory management" (Biagi, 2013), directly impacting operational overheads. In Indian Manufacturing, poor performance is due to a lack of supporting technologies (Shrimali et al., 2019). ICT integration in the firm's value chain improves the shared information in the supply chain (Piplani & Viswanathan, 2003), resulting in reduced inventory or improved working capital turnover. Manufacturers seek external financing for their working capital needs (W. M. Ho, 2021).

***Productivity (Return on Assets)***

The success of a business generally depends on its ability to deliver more tangible value for consumers without using more labour, capital, or other inputs. Productivity is a simple concept. It is the output per input unit (Brynjolfsson & Hitt, 1998). Therefore, at the Firm-level, productivity depends on the value of ICT Investment is associated with a substantial increase in revenue each Year (Brynjolfsson & Hitt, 1998). In order to analyse the contribution of IT Investments to productivity, it is necessary to understand the functional relationship between inputs and output (Schweikl & Obermaier, 2020). Return on Asset is a significant measure the productivity (Benitez, Llorens, et al., 2018), which covers maximising profit (Miroshnychenko et al., 2017). Many researchers use the ROA as a crucial measuring parameter for firm performance (Matanda & Freeman, 2009), (Miroshnychenko et al., 2017), (Benitez, Llorens, et al., 2018), (Shi & Yu, 2013), (M. Zhu et al., 2021).

Concerning financial consequences, a further distinction between profitability and return (Renkema & Berghout, 1997) is required. Financial Economic: Accounting measures capture only historical aspects of firm performance (ENOMATE & AUDU, 2021).

Several researchers have tried to define ICT productivity. (Y. C. Lee et al., 2011) in balanced scorecard approach through survey-based argue that BPR significantly positively impacts corporate financial performance. The motivation for the decision on ICT investment often needs to be addressed. (Agostini & Nosella, 2019) Argued that introduces the difference between the probability of adopting I4.0 technologies and the intensity of adoption, which could tell us more as far as antecedents of I4.0 are concerned.

## 6.3 Methodology

Firms that are successful in creating superior ICT capability, in turn, enjoy superior financial performance by blistering firm revenue and decreasing firm costs. Firms incurring Investment in ICT is a disadvantage for the firm. The firm operation flexibility and performance are directly impacted by ICT Investment. To fund the ICT Investment, MSMEs do not have in-house liquidity. Hence, short-term borrowing has a direct impact on productivity. The trade-off between the burden on the financial health of MSME and the enhancement of the firm's capacity to invest in the new technology. This Investment may affect productivity. The paper (Becchetti et al., 2003) found that improved telecommunications technology increases the inflow of available information, thereby generating a flexibility option. Indian MSMEs strive to improve working capital (Khanzode et al., 2021). Increased Investment in ICT will reduce

asymmetric information on the operational overhead, thus enabling MSME to improve the working capital cycle to gauge the Firm's productivity more accurately. This literature review leads us to six hypotheses based on our three research questions.

H1: ICT Investment has positively impacted the Return on Assets of MSME firms.

H2: Gross working capital cycle positively impacts the Return on Assets of MSME firms.

H3: Short-term borrowing positively impacts the Return on Assets of MSME firms.

H4: ICT Investment with improvement in Gross working capital cycle positively impacts the Return on Assets of MSME firms.

H5: ICT Investment with Short-term borrowings positively impacts the Return on Assets of MSME firms.

H6: Working capital financed by Short-term borrowings positively impacts the Return on Assets of MSME firms.

H7: ICT Investment with interaction with Gross working capital positively impacts the Return on Assets of MSME Firms.

H8: ICT Investment positively impacts the Return on Assets similarly to all the Micro, Small and Medium firms after the COVID-19 pandemic.

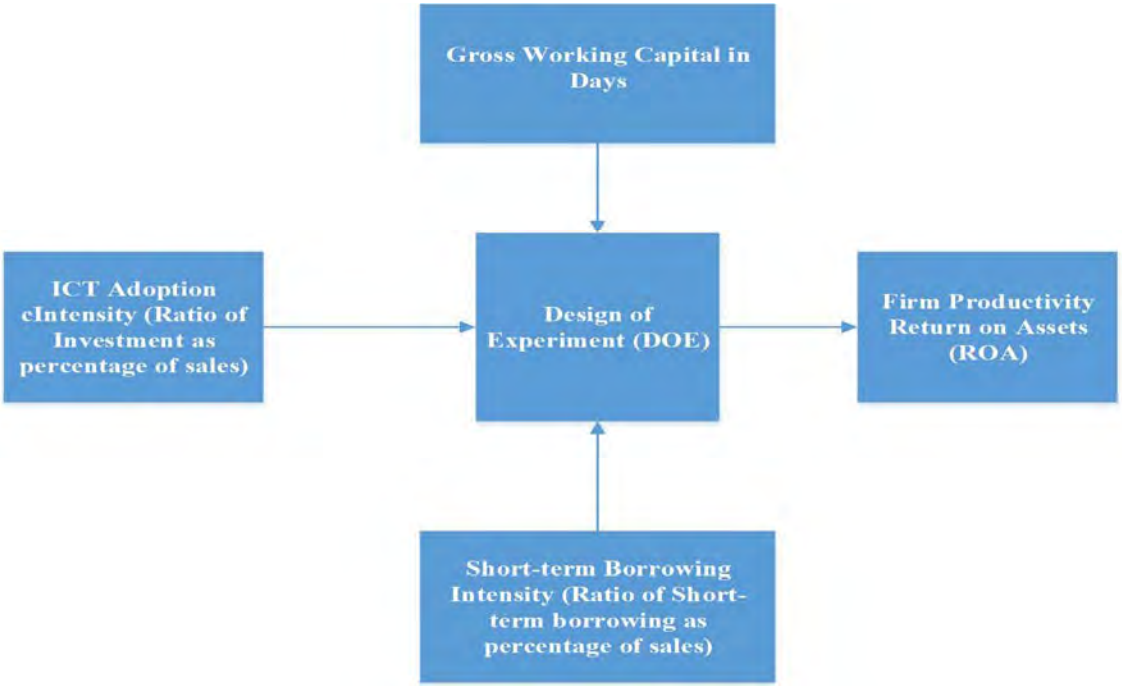


**Figure 6.2 Framework for the Study.**

### *6.3.1 Design of Experiment*

During the analysis phase, the authors conducted a controlled experiment (Kumar et al., 2006) to identify the significant process parameters influencing the firm performance, i.e. ROA. Design of Experiment (DoE) to strengthen the exploratory process (Prashar, 2018) (Szczepanski et al., 2020), (Thomas et al., 2009) explained that the technique provides a compelling and economical method for determining significant factors and factor interactions that affect variability within a product. DoE is a powerful statistical technique that successfully provides more accurate predictions (Chong et al., 2021) (MYERS et al., 2009).

This chapter develops a DOE-based ICT Investment impact on firm performance by conducting experiments to identify the influencing variables and ICT Investment decisions that impact the Return on Assets (ROA) problem faced by most MSMEs. The DOE techniques were conducted using the customised design method in JMP 17 software (Christaki et al., 2017) (B. Jones, 2021) (Chong et al., 2021), and the results are explained in the following sections.

COVID-19 has divided the world into two distinct phases: Pre-COVID and during COVID-19. This pandemic provided a significant boost and pushed technology adoption in all lines of activity, from households to education to industry. Technology helps to call firms to come together to collaborate and co-create. The company can withstand business hardships with a resilient and adaptable ICT system. Considering this effect, we used panel data spanning eight Years, from 2015 to 2019 (Pre-COVID) and 2020 to 2022 (During-COVID), to examine the impact and need for ICT adoption in Small businesses, which are the economic pillars of India. Any technology Investment decision is a decision that will impact the Firm's bottom line. Furthermore, companies with sacred financial health, such as MSMEs, have always derived such financing decisions for this type of Investment.

### *6.3.2 Data Set*

This study comprises panel data on the Indian MSME Manufacturing sector from 2015 to 2022. The data set is based on the official definition in India, i.e., Investment in Plant and Machinery. The MSME sector, the backbone of the Indian economy, provides the second highest employment. This sector suffers from covid19 pandemic at large. Hence, to understand the impact Covid19 on technology adoption in MSME, we took data from The Centre for Monitoring Indian Economy (CMIE) database. CMIE provides the online database from their Prowess and administers the largest repository of information regarding the Indian economy and the finances of numerous Indian enterprises.

For in-depth analysis, we divided the randomly selected database into three categories, namely Micro, Small and Medium firms. Then further, this database was divided into two categories for the Pre-COVID and during covid Periods. The COVID-19 pandemic started at the end of 2019 to ended in 2020. Hence, we divided the data set into these Periods, i.e., Pre-COVID 2015 to 2019 and 2020 to 2022 for the During-covid.

Which consists of approximately 17000 company records, from which we randomly selected 1981 [Micro (307), Small (855), and Medium (819)] for collection, a sample data presented in Annexure C. After data purification, which included removing missing values and brief information, we discovered a data set containing 1101 companies for this study.

## 6.4 Data Analysis

Table 6.1 explains the Design of Experiments (DoE) with three factors and their corresponding levels. This study comprises three levels of underlying factors, called a levels study (Montgomery, 2017). These three factors are responsible for the response variable: ICT Investment in the percentage of sales, short-term borrowing in the percentage of sales, and Gross working capital cycle in days. Later in this study, these levels will represent numbers without the units. Experiments run on different factor values, called the level (Goos, 2016), as summarised in Table 6.1.

**Table 6.1 Factors and their Levels**

| Factors | Level 1 | Level 2 | Level 3 |
|---|---|---|---|
| **ICT Investment as % of sales (%)** | <50 | 50-100 | >100 |
| **Short-term borrowings as % of sales (%)** | <100 | 100-500 | >500 |
| **Gross working capital cycle (Days)** | <500 | 500-1000 | >1000 |

For this study, three factors were undertaken for the study. Revenue (Sales) is essential to a company's economic viability. Thus, we have employed the weighted sales percentage average to avoid the score disparity. In this study, we have run this experiment six times (two times for

each firm type, Micro, Small and Medium). Following Table 6.1, three levels of each investigated factor have been considered for each of the 27 experiments conducted in one-time analysis; this means that each experiment involves a unique combination of the investigated factors and is considered a treatment. Hence, for the complete study, we ran a total of 162 experiments (27*6), which reflects a high standard, and this is the first time such depth experiment runs under the subject taken for study.

## 6.5 Data interpretation and theoretical implication:

### *6.5.1 Micro Firms:*

In most developed nations, the definition of a Micro firm is not defined; however, for emerging economies such as India, the company Micro is vital to the economy. With the official definition of the Indian MSME Act, the Micro firm is a company that has invested up to 10 million INR in Plant and equipment. This amount is substantial for a Small company. In the DOE results for Pre-COVID and During-Covid, Figure 6.3 and Figure 6.4 show that all detailed factors are statistically significant, as their P-Values are less than 0.05. In the Pre-COVID era, the Gross working capital cycle was the most influential factor. However, in the during-covid era, it was the interaction between short-term borrowing and the Gross working capital cycle. Micro firms rely more on credit firms to finance their working capital and pressure on their top line due to the cessation of economic activity.

| Source | Logworth | PValue |
|---|---|---|
| Gross working capital cycle | 25.336 | 0.00000 |
| ICT Investment as % of sales*Short-term borrowings as % of sales | 24.461 | 0.00000 |
| Short-term borrowings as % of sales*Gross working capital cycle | 18.503 | 0.00000 |
| ICT Investment as % of sales*Gross working capital cycle | 17.593 | 0.00000 |
| Short-term borrowings as % of sales | 13.077 | 0.00000 |
| ICT Investment as % of sales | 11.993 | 0.00000 |

**Figure 6.3 Effect Summary - Design of Experiments- for Micro Firms [Pre-COVID Period (2015-2019)].**

| Source | Logworth | PValue |
|---|---|---|
| Short-term borrowings as % of Sales*Gross working capital cycle | 23.474 | 0.00000 |
| ICT Investment as % of Sales*Gross working capital cycle | 22.230 | 0.00000 |
| ICT Investment as % of Sales*Short-term borrowings as % of Sales | 19.399 | 0.00000 |
| Gross working capital cycle | 13.352 | 0.00000 |
| ICT Investment as % of Sales | 12.333 | 0.00000 |
| Short-term borrowings as % of Sales | 10.260 | 0.00000 |

**Figure 6.4 Effect Summary - Design of Experiments-for Micro Firms [During-COVID Period (2020-2022)].**

The Prediction Profiler is a standard Design of Experiments (DoE) instrument used to comprehend and visualise the relationship between the input and desired response variables (B. Jones, 2021), (Christaki et al., 2017). It allows researchers and practitioners to obtain insight into the effects of various factors on the response variable and to predict novel factor combinations (Goos, 2016). Figures 6.5 and 6.7 present the prediction profiler for Micro firm. For the study, maximising the return on assets (ROA) in desirability can be achieved by preserving the status quo. The desirability function is rated on a scale from 0 to 1, with one denoting the most desirable outcome. From comparing these two figures, it is clear that the Micro Firm's during-Covid behaviour changed at an almost identical level of desirability (Goos, 2016). The Investment in ICT maximises the ROA at less than 50%. The maximum value of ROA is 5.83%, as observed in Figure 6.5, with the red line intersecting at the level of ICT at less than 50%, Short-term borrowing at less than 100% and Gross Working Capital at less than five hundred days in the Pre-COVID Period. In Figure 6.7, of the During-COVID Period, the Maximise ROA is 6.14% at a similar level of ICT Investment at less than 50%, Short-term borrowing at less than 100% and Gross Working Capital at less than five hundred days. This result is persistent in both Periods for Micro firms.


**Figure 6.5 Prediction Profiler for Micro Firms [Pre-COVID Period (2015-2019)].**

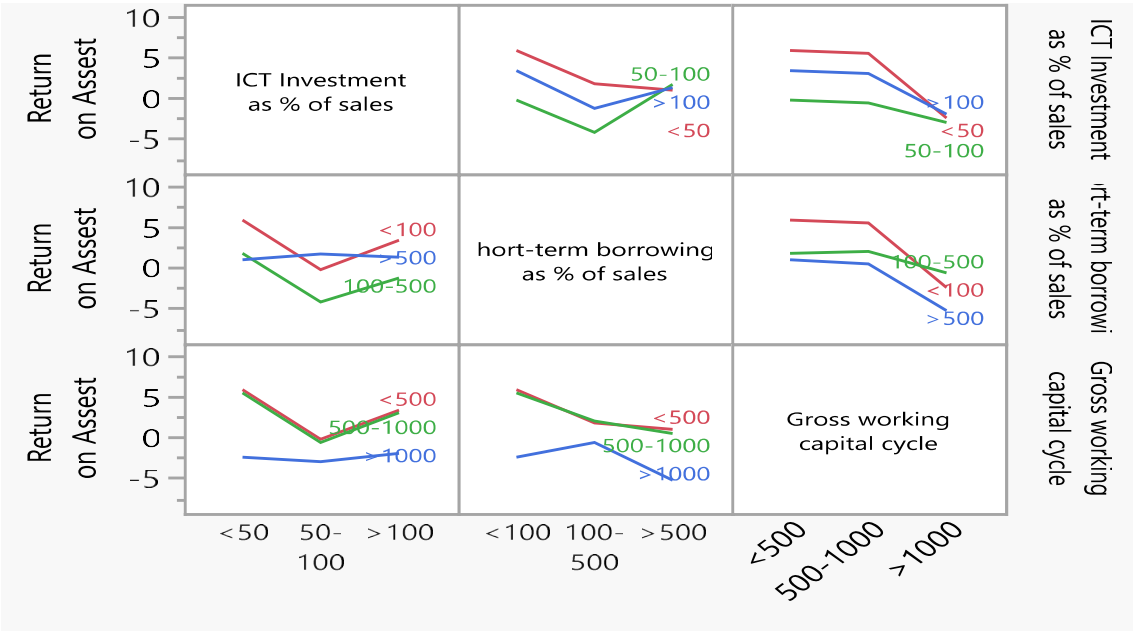


**Figure 6.6 Interaction Profiles for Micro Firms [Pre-COVID Period (2015-2019)].**

Interaction Profiles in the Design of Experiments (DoE) are graphical representations (Christaki et al., 2017) that help visualise and comprehend the interactions between input variables (factors) and response variables (Chong et al., 2021). These profiles reveal that the effects of one aspect depend on the levels of other factors, and these interactions influence the response variable.


**Figure 6.7 Prediction Profiler for Micro Firms [During-COVID Period (2020-2022)].**


**Figure 6.8 Interaction Profiles for Micro Firms [During-COVID Period (2020-2022)].**

**Table 6.2 Interaction Profiles Summary for Micro Firm for Pre-COVID and During-COVID Period**

6.2.a. ICT Investment interaction with Short-term borrowing and Gross Working Capital

| | **Pre-COVID Period** ICT Investment as % of Sales | | | **During-COVID Period** ICT Investment as % of Sales | | |
|---|---|---|---|---|---|---|
| | <50% | 50-100% | >100% | <50% | 50-100% | >100% |
| Short-term borrowing as % of Sales | <100% | <100% | <100% | <100% | <100% | 100-500 |
| Gross working capital cycle in days | <500 days | <500 days | <500 days | <500 days | <500 days | No interaction |
| **Maximise ROA value (Approx.)** | 6% | 0% | 5% | 7% | 5% | 1% |

6.2.b. Short-term borrowing interaction with ICT Investment interaction and Gross Working Capital

| | **Pre-COVID Period** Short-term borrowing as % of Sales | | | **During-COVID Period** Short-term borrowing as % of Sales | | |
|---|---|---|---|---|---|---|
| | <100% | 100-500 % | >500% | <100% | 100-500 % | >500% |
| ICT Investment as % of Sales | <50% | <50% | 50-100% | <50% | <50% | <50% |
| Gross working capital cycle in days | <500 days | 500-1000 days | <500 days | <500 days | <500 days | <500 days |
| **Maximise ROA value (Approx.)** | 6% | 2% | 2% | 7% | 3% | 1% |

6.2.c. Gross Working Capital interaction with Short-term borrowing and ICT Investment

| | Pre-COVID Period<br>Gross working capital cycle in days | | | During-COVID Period<br>Gross working capital cycle in days | | |
|---|---|---|---|---|---|---|
| | <500 days | 500-1000 days | >1000 days | <500 days | 500-1000 days | >1000 days |
| ICT Investment as % of Sales | <50% | <50% | >100% | <50% | <50% | <50% |
| Short-term borrowing as % of Sales | <100% | <100% | 100-500% | <100% | >500% | <100% |
| **Maximise ROA value (Approx.)** | 6% | 6% | 0% | 7% | 0% | 3% |

In Figure 6.6 and Figure 6.8, the interaction profile for Micro Firm for the Pre-COVID and During-COVID Periods. The top graph represents the ICT Investment interaction with the other two factors, and it does not have a parallel line, which means there is an interaction among all the factors.

Table 6.2 is the summarised interpretation of the results for the interaction profiles for Micro firm:

1. ICT Investment Interaction with Short-term borrowing and Gross Working Capital:
    - In the Pre-COVID Period, when ICT Investment is below 50% of sales, and short-term borrowing is below 100% of sales, the firm achieves the highest approximate ROA value of 6% with Gross working capital below 500 days.
    - In the During-COVID Period, when ICT Investment is below 50% of sales, short-term borrowing remains below 100% of sales, and Gross working below 500 days, the Micro firms show an increase in approximate ROA value of 7%.
    - This interaction profile provides that ROA is maximised in the During-COVID Period as above, while for the ICT level at 50-100%, ROA becomes 0% in the Pre-COVID Period; however, the pattern does not follow in the During-COVID Period.
2. Short-term borrowing interaction with ICT Investment and Gross Working Capital:
    - Across both the Pre-COVID and During-COVID Periods, maintaining short-term borrowing below 100% of sales leads to a better ROA outcome, with an approximate value of 6% during the During-COVID Period, context to During-COVID the ROA

rose to 7% with interaction value of ICT at50% and Gross working capital at less than 500 days.

- In the During-COVID Period, when short-term borrowing exceeds 500% of sales, the ROA value decreases to 1%, negatively impacting profitability.

3. Gross Working Capital interaction with Short-term borrowing and ICT Investment:

- Throughout both the Pre-COVID and During-COVID Periods, maintaining a gross working capital cycle below 500 days consistently leads to a higher ROA value of approximately 6% and 7%, respectively.
- In the During-COVID Period, when the gross working capital cycle ranges from 500-1000 days, and ICT Investment is below 50% of sales, the ROA value drops to 0%.

Overall, the findings suggest that maintaining lower levels of ICT Investment, short-term borrowing, and an efficient gross working capital cycle for Micro firms can contribute to higher ROA values. Additionally, the interactions between these factors indicate the importance of considering their combined effects on profitability, especially during the During-COVID Period.

### *6.5.2 Small Firm:*

Similarly, the influencing factors are below for Small firm's effect summary in Figure 6.9 and Figure 6.10.

In Pre-COVID time:

- Gross working capital is the most influential factor for the response variable in Pre-COVID time.
- The relationship between Short-term borrowing and Gross working capital is also significant.
- In the next three rows, it is interesting that ICT Investment with interaction with the other two variables is more important than direct impact.

In the During-COVID era:

- The Small company has demonstrated the same results as in the Pre-COVID era, but the log value has shifted slightly.

With the information presented above, we can infer that Small firms behave differently than Micro firms regarding their response to ROA.

| Source | Logworth | PValue |
|---|---|---|
| Gross working capital | 30.402 | 0.00000 |
| Short-term borrowings as % of sales*Gross working capital | 22.407 | 0.00000 |
| ICT Investment as % of sales*Short-term borrowings as % of sales | 19.621 | 0.00000 |
| ICT Investment as % of sales*Gross working capital | 19.620 | 0.00000 |
| ICT Investment as % of sales | 13.139 | 0.00000 |
| Short-term borrowings as % of sales | 10.664 | 0.00000 |

**Figure 6.9 Effect Summary- Design of Experiments- for Small Firms [Pre-COVID Period (2015-2019)].**

| Source | Logworth | PValue |
|---|---|---|
| Gross working capital cycle | 30.215 | 0.00000 |
| Short-term borrowings as % of Sales*Gross working capital cycle | 22.802 | 0.00000 |
| ICT Investment as % of Sales*Gross working capital cycle | 19.753 | 0.00000 |
| ICT Investment as % of Sales*Short-term borrowings as % of Sales | 16.266 | 0.00000 |
| ICT Investment as % of Sales | 12.426 | 0.00000 ^ |
| Short-term borrowings as % of Sales | 12.095 | 0.00000 ^ |

**Figure 6.10 Effect Summary- Design of Experiments- for Small Firms [During- COVID Period (2020-2022)].**

Figures 6.11 and 6.13 represent the prediction profiler for Small firms. For the study, we keep the same parameters as Micro firms, maximising the return on assets (ROA). The desirability function is rated on a scale from 0 to 1, with 1 denoting the most desirable outcome (B. Jones, 2021). From comparing these two figures, the Small Firm's results are different to the Micro and Medium firms. Figure 6.11 shows the red intersection line at the desired level of 0.16 in Pre-COVID; the ROA is a maximum value of 6.13% at ICT Investment <50%, Short-term borrowing <100%, and Gross working capital at 500-1000 days. Whereas, during COVID-19, the ROA maximum value of 5.95% at a level of 0.5 with the level of factors ICT Investment <50%, Short-term borrowing <100%, and Gross working capital at less than 500 days. The ROA saw a sharp decline in the Pre-COVID and During-COVID Periods as the ICT Investment level increased; however, it shows a V-shape recovery at 50-100%.

The movement of ROA follows the same pattern for short-term borrowing like ICT Investment. The Gross working capital factor, which was the most influential factor for Small firms, remains flat for the first two levels, then next, the slope of the curve is negative at a level of 500-1000 days.

The above outcome is not persistent for the response variable since all independent factors have different patterns in behaviour. ICT Investment and Gross Working capital factors follow the same path for both Periods under study, while short-term borrowing becomes flat in the During-COVID Period.

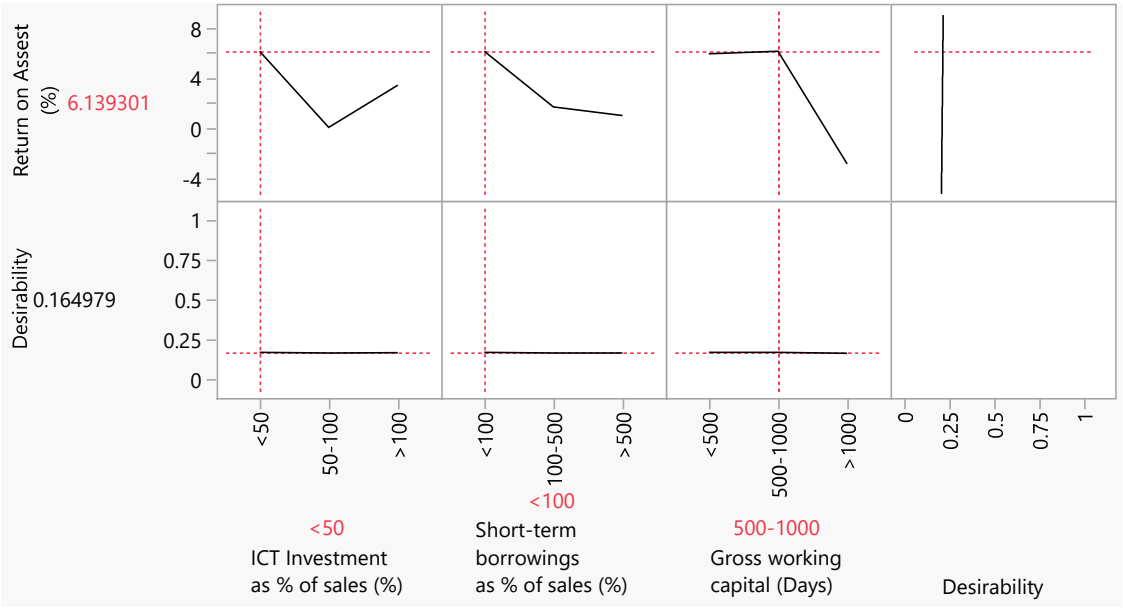


**Figure 6.11 Prediction Profiler for Small Firms [Pre-COVID Period (2015-2019)].**

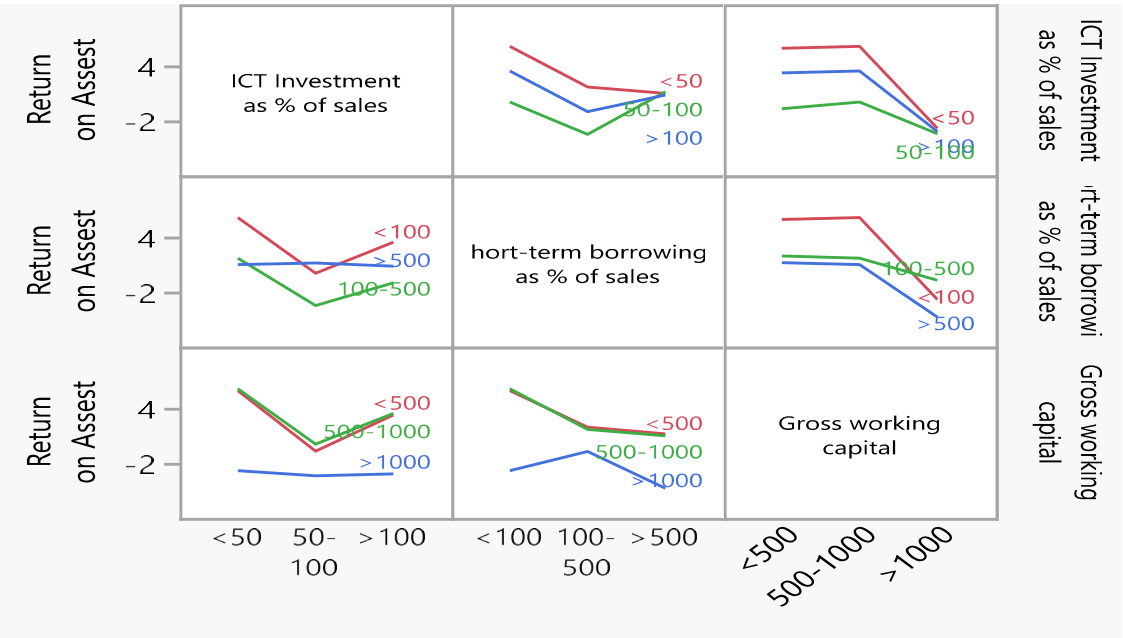


**Figure 6.12 Interaction Profiles for Small Firms [Pre-COVID Period (2015-2019)].**

Figure 6.12 and Figure 6.14 show the interaction profile for Small sized-firm for the Pre-COVID and During-COVID Periods. The top graph represents the ICT Investment interaction with the other two factors, and it does not have a parallel line, which means there is an interaction among all the factors.

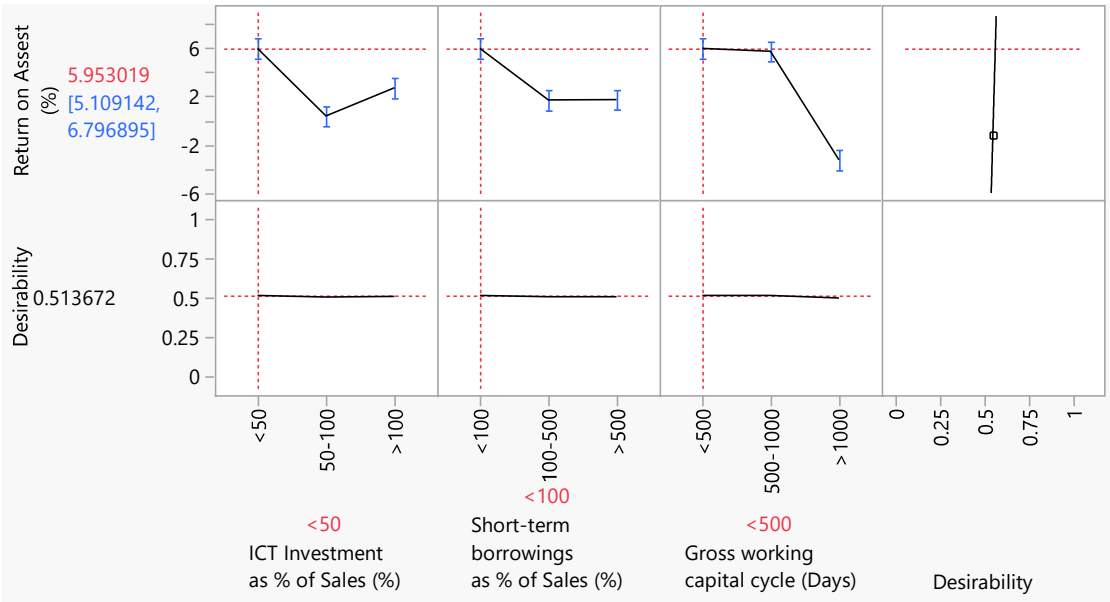


**Figure 6.13 Prediction Profiler for Small Firms [During- COVID Period (2020-2022)].**


**Figure 6.14 Interaction Profiles for Small Firms [During- COVID Period (2020-2022)].**

**Table 6.3 Interaction Profiles Summary for Small Firms for Pre-COVID and During-COVID Period**

6.3.a. ICT Investment interaction with Short-term borrowing and Gross Working Capital

| | **Pre-COVID Period** | | | **During-COVID Period** | | |
|---|---|---|---|---|---|---|
| | ICT Investment as % of Sales | | | ICT Investment as % of Sales | | |
| | <50% | 50-100% | >100% | <50% | 50-100% | >100% |
| Short-term borrowing as % of Sales | <100% | >500% | <100% | <100% | <100% | >500% |
| Gross working capital cycle in days | <500 days | <500 days | <500 days | <500 days | <500 days | 500 - 1000 days |
| **Maximise ROA value (Approx.)** | 5% | 3% | 4% | 5% | 3% | 3% |

6.3.b. Short-term borrowing interaction with ICT Investment interaction and Gross Working

Capital

| | **Pre-COVID Period** Short-term borrowing as % of Sales | | | **During-COVID Period** Short-term borrowing as % of Sales | | |
|---|---|---|---|---|---|---|
| | <100% | 100-500 % | >500% | <100% | 100-500 % | >500% |
| ICT Investment as % of Sales | <50% | <50% | No interaction | <50% | <50% | <50% |
| Gross working capital cycle in days | <500 days | <500 days | <500 days | <500 days | 500 - 1000 days | <500 days |
| **Maximise ROA value (Approx.)** | 5% | 3% | 1% | 5% | 3% | 3% |

6.3.c. Gross Working Capital interaction with Short-term borrowing and ICT Investment

| | **Pre-COVID Period** Gross working capital cycle in days | | | **During-COVID Period** Gross working capital cycle in days | | |
|---|---|---|---|---|---|---|
| | <500 days | 500-1000 days | >1000 days | <500 days | 500-1000 days | >1000 days |
| ICT Investment as % of Sales | <50% | <50% | <50% | <50% | <50% | 50-100% |
| Short-term borrowing as % of Sales | <100% | <100% | 100-500% | <100% | <100% | 100-500% |
| **Maximise ROA value (Approx.)** | 5% | 5% | 2% | 5% | 5% | 1% |

Table 6.3 is the summarised interpretation of the results for the interaction profiles summary table:

a. ICT Investment interaction with Short-term borrowing and Gross Working Capital:

- In the Pre-COVID Period, when ICT Investment is below 50% of sales and short-term borrowing is below 100% of sales, the firm achieves the highest approximate ROA value of 5%.

- In the During-COVID Period, when ICT Investment is below 50% of sales and short-term borrowing remains below 100% of sales, the firm maintains the same approximate ROA value of 5%.
- There is an interaction between ICT Investment, short-term borrowing, and the gross working capital cycle in both Periods, indicating that the impact of ICT Investment on ROA depends on the levels of short-term borrowing and gross working capital cycle.

b. Short-term borrowing interaction with ICT Investment and Gross Working Capital:

- Across both the Pre-COVID and During-COVID Periods, maintaining short-term borrowing below 100% of sales leads to a better ROA outcome, with an approximate value of 5%.
- In the During-COVID Period, when short-term borrowing exceeds 500% of sales, the ROA value decreases to 1%, negatively impacting profitability.

c. Gross Working Capital interaction with Short-term borrowing and ICT Investment:

- Throughout both the Pre-COVID and During-COVID Periods, maintaining a gross working capital cycle below 500 days consistently leads to a higher ROA value of approximately 5%.
- In the During-COVID Period, when the gross working capital cycle ranges from 500-1000 days, and ICT Investment is between 50-100% of sales, the ROA value drops to 2%.

Overall, the findings suggest that for a Small firm, maintaining lower levels of ICT Investment, short-term borrowing, and an efficient gross working capital cycle can contribute to higher ROA values. Additionally, the interactions between these factors indicate the importance of considering their combined effects on profitability, especially during the During-COVID Period.

### *6.5.3 Medium Firm*

Similarly, the influencing factors are below for Medium firm's effect summary in Figure 6.15 and Figure 6.16.

In Pre-COVID time:

- ICT Investment in interaction with other factors influences the response variable in Pre-

COVID time.

- Short-term borrowing with interaction Gross working capital is an almost similar value to the above.

In the During-COVID era:

- The Medium company demonstrated differently from the Micro and Small firms in the During-COVID Period, where the Gross Working capital was the most influential factor.
- Then, the interaction of ICT Investment works for Medium firms.

| Source | Logworth | PValue |
|---|---|---|
| ICT Investment as % of sales*Gross working capital cycle (days) | 20.645 | 0.00000 |
| Short-term borrowings as % of sales*Gross working capital cycle (days) | 20.275 | 0.00000 |
| ICT Investment as % of sales*Short-term borrowings as % of sales | 18.545 | 0.00000 |
| Gross working capital cycle (days) | 10.993 | 0.00000 ^ |
| Short-term borrowings as % of sales | 10.593 | 0.00000 ^ |
| ICT Investment as % of sales | 10.388 | 0.00000 ^ |

**Figure 6.15 Effect Summary- Design of Experiments- for Medium Firms [Pre COVID-Period (2015-2019)].**

| Source | Logworth | PValue |
|---|---|---|
| Gross working capital cycle | 29.619 | 0.00000 |
| ICT Investment as % of Sales*Gross working capital cycle | 22.546 | 0.00000 |
| Short-term borrowings as % of Sales*Gross working capital cycle | 21.664 | 0.00000 |
| ICT Investment as % of Sales*Short-term borrowings as % of Sales | 19.778 | 0.00000 |
| Short-term borrowings as % of Sales | 15.339 | 0.00000 |
| ICT Investment as % of Sales | 13.605 | 0.00000 |

**Figure 6.16 Effect Summary- Design of Experiments- for Medium Firms [During-COVID Period (2020-2022)].**

Figures 6.17 and 6.19 represent the prediction profiler for Medium-sized firms. For the study, we keep the same parameters as Micro and Small firms, maximising the return on assets (ROA) in desirability by preserving the status quo. The desirability function is rated on a scale from 0

to 1, with 1 denoting the most desirable outcome. Figures 6.17 and 6.19 show that Medium firm's desirability level remains unchanged for both Periods. The response variable graph does not follow the same patterns for Micro and Small firms. Figure 6.17 shows the red intersection line at the desired level of 0.5 in Pre-COVID; the ROA is a maximum value of 5.67% at ICT Investment <50%, Short-term borrowing <100%, and Gross working capital at less than 500 days. Whereas, in During-COVID Figure 6.19, the ROA maximum value of 6.42% at a level of 0.61 with the level of factors ICT Investment <50%, Short-term borrowing <100%, and Gross working capital at 500-1000 days.

a. ICT Investment: In the Pre-COVID Period, the ROA was maximum after a sharp decline. In contrast, in the During-COVID Period, the response variable takes a V-shaped recovery at 50-100%.

b. Short-term borrowing: From comparing these two figures, the Medium Firm's results are the same pattern for both Periods.

c. Gross-working capital: This underlying factor shows maximum changes in the time scale and at different pattern outcomes. In Pre-COVID, the pattern shape is V-shaped; in contrast, During-COVID, the ROA value is maximum at 500-1000 days at the same desired level.

This result depicts the change in behaviour after the Covid pandemic. In comparison to Small firms, Medium firms follow the same desired levels. However, they are affected most; hence, the pattern is not persistent.


**Figure 6.17 Prediction Profiler for Medium Firm [Pre COVID-Period (2015-2019)].**

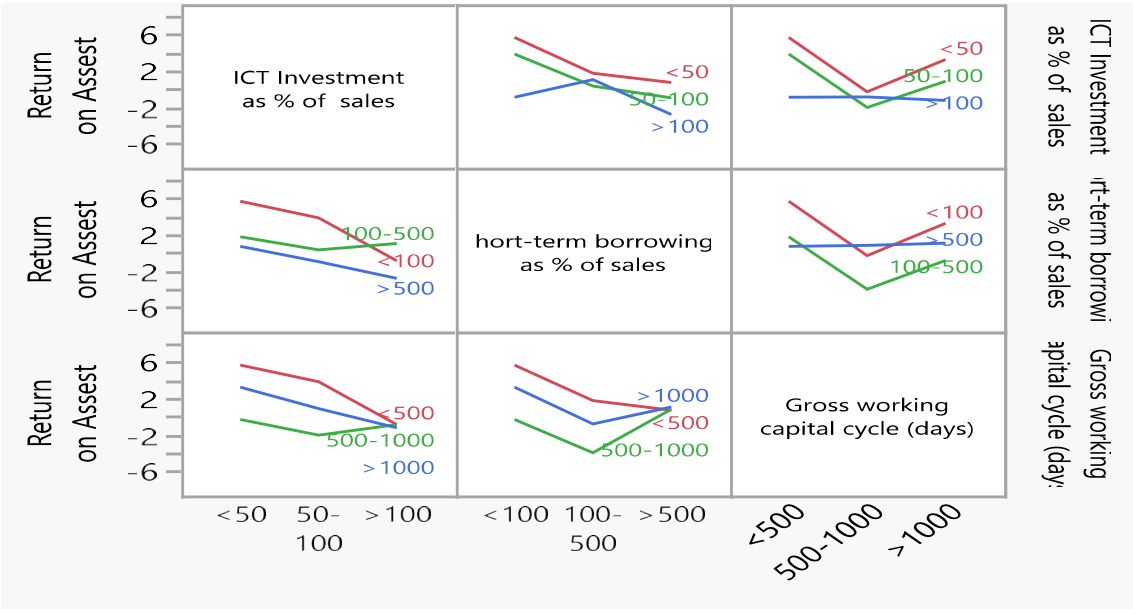


**Figure 6.18 Interaction Profiles for Medium Firm [Pre COVID-Period (2015-2019)].**

Figure 6.18 and Figure 6.20 show the interaction profile for Medium-sized firms for the Pre-COVID and During-COVID Periods. The top graph represents the ICT Investment interaction with the other two factors, and it does not have a parallel line, which means there is an interaction among all the factors.


**Figure 6.19 Prediction Profiler for Medium Firm [During-COVID Period (2020-2022)].**


**Figure 6.20 Interaction Profiles Medium Firm [During- COVID Period (2020-2022)].**

**Table 6.4 Interaction Profiles Summary for Medium Firm for Pre-COVID and During-COVID Period**

6.4.a. ICT Investment interaction with Short-term borrowing and Gross Working Capital

| | **Pre-COVID Period** | | | **During-COVID Period** | | |
|---|---|---|---|---|---|---|
| | ICT Investment as % of Sales | | | ICT Investment as % of Sales | | |
| | <50% | 50-100% | >100% | <50% | 50-100% | >100% |
| Short-term borrowing as % of Sales | <100% | <100% | 100-500% | <100% | >500% | <100% |
| Gross working capital cycle in days | <500 days | <500 days | 500-1000 days | 500-1000 days | 500-1000 days | <500 days |
| **Maximise ROA value (Approx.)** | 6% | 4% | 2% | 6% | 3% | 5% |

6.4.b. Short-term borrowing interaction with ICT Investment interaction and Gross Working Capital

| **Pre-COVID Period** | **During-COVID Period** |
|---|---|

| | Short-term borrowing as % of Sales | | | Short-term borrowing as % of Sales | | |
|---|---|---|---|---|---|---|
| | <100% | 100-500 % | >500% | <100% | 100-500 % | >500% |
| ICT Investment as % of Sales | <50% | <50% | <50% | <50% | <50% | >100% |
| Gross working capital cycle in days | <500 days | <500 days | No interaction | 500-1000 days | <500 days | <500 days |
| **Maximise ROA value (Approx.)** | 6% | 2% | 1% | 6% | 2% | 2% |

6.4.c. Gross Working Capital interaction with Short-term borrowing and ICT Investment

| | **Pre-COVID Period** | | | **During-COVID Period** | | |
|---|---|---|---|---|---|---|
| | Gross working capital cycle in days | | | Gross working capital cycle in days | | |
| | <500 days | 500-1000 days | >1000 days | <500 days | 500-1000 days | >1000 days |
| ICT Investment as % of Sales | <50% | >100% | <50% | <50% | <50% | >100% |
| Short-term borrowing as % of Sales | <100% | >500% | <100% | <100% | <100% | 100-500% |
| **Maximise ROA value (Approx.)** | 6% | 2% | 4% | 6% | 6% | -2% |

Table 6.4 is the summarised interpretation of the results for the interaction profiles for Medium firms:

1. ICT Investment Interaction with Short-term borrowing and Gross Working Capital:

    - In the Pre-COVID Period, when ICT Investment is below 50% of sales and short-term borrowing is below 100% of sales, the firm achieves the highest approximate ROA value of 6% with Gross working capital below 500 days.
    - In the During-COVID Period, when ICT Investment is below 50% of sales, short-term borrowing remains below 100%, and the Medium firms maintain the same approximate ROA value of 6%. However, the Gross working capital Period has increased to 500-1000 days.

This interaction profile provides ROA in the During-COVID Period for the ICT level at 50-100%, and ROA becomes 3%, which sees a V-shaped recovery in the Pre-COVID Period in the context of the Pre-COVID declining phase. The possible argument is that During-COVID, ICT use has increased with the capital cycle Period.

2. Short-term borrowing interaction with ICT Investment and Gross Working Capital:

    - Across both the Pre-COVID and During-COVID Periods, maintaining short-term borrowing below 100% of sales leads to a better ROA outcome, with an approximate value of 6% and an interaction value of ICT at 50%. Nevertheless, Gross working capital changes from less than 500 days to 500-1000 days.
    - In the During-COVID Period, when short-term borrowing exceeds 500% of sales, the ROA value decreases to 2%, but the Gross working capital cycle comes to less than 500 days, consistent with Micro and Small firms.

3. Gross Working Capital interaction with Short-term borrowing and ICT Investment:

    - Throughout both the Pre-COVID and During-COVID Periods, maintaining a gross working capital cycle below 500 days consistently leads to a higher ROA value of approximately 6%; however, in During-COVID, the ROA is maximum at 500-1000 days.
    - In the During-COVID Period, when the gross working capital cycle is more than 1000 days, and ICT investment is more than 100% of sales, the ROA value drops to negative, which means for the medium firm, if the ICT investment is more than 100 sales. The gross working capital cycle is very high, so firms' productivity may go negative, which is a unique

## 6.6 Managerial implication

The ROA value above 5% is considered good; more ROA means the company maximises profit (Forbes, n.d.). From the above study, MSMEs generate ROA from -2% to 7% at different interaction levels of factors. Apart from the value, this study supports that ICT Investment with identified factors is critical in determining the specific level of their value. Micro firms generate a maximum ROA of 7%, Small firms at least 5%, and Medium firms at 6%.

### *6.6.1 Micro Firm*

With the official definition, Micro firms have a low Investment capacity in Plant and Machinery. Table 6.2 for Micro firms shows the Short-term borrowings as a percentage of Sales and Gross working capital cycle interaction, and these firms heavily rely on credit firms to finance their working capital, especially during the Covid era. The interaction profile (Figure 6.8) and Prediction profile (Figure 6.7) indicate that at a level of ICT Investment less than 50%, Short-term borrowing is less than 100%, and Gross working capital is less than 500 days maximise the Micro firm Return on Assets (ROA). Then, the ROA started diminishing.

**Invest in ICT technology:** These findings provide insights for the Manager to be more agile and adaptable. Further, the above data are within the limit of Micro firm. Hence, the top management can decide on adopting technology with better working capital management to improve productivity.

**Table 6.5 Result Summary**

| Sr No | Type of Firm | Pre- Covid | | | During- Covid | | | Maximum ROA value |
|---|---|---|---|---|---|---|---|---|
| | | **Most Influencing Factor** | **Maximise ROA on predicted values of input variables (ICT Investment and Short-term borrowing in %of Sales, Gross working capital in days)** | | **Most Influencing Factor** | **Maximise ROA interaction values of input variables (ICT Investment and Short-term borrowing in %of Sales, Gross working capital in days)** | | |
| 1 | Micro | Gross working capital cycle | a. ICT Investment | <50% | Short-term borrowings as % of Sales and Gross working | a. ICT Investment | <50% | During-COVID: 7% |
| | | | b. Short-term borrowing | <100% | | b. Short-term borrowing | <100% | Pre-COVID: 6% |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | c. Gross working capital | <500 days | capital cycle interaction | c. Gross working capital | <500 days | |
| 2 | Small | Gross working capital cycle | a. ICT Investment | <50% | Gross working capital cycle | a. ICT Investment | <50% | During-COVID: 5% |
| | | | b. Short-term borrowing | <100% | | b. Short-term borrowing | <100% | Pre-COVID: 5% |
| | | | c. Gross working capital | 500-1000 days | | c. Gross working capital | <500 days | |
| 3 | Medium | ICT Investment as % of sales and Gross working capital cycle (days) | a.ICT Investment | <50% | Gross working capital cycle | a.ICT Investment | <50% | During-COVID: 6% |
| | | | b. Short-term borrowing | <100% | | b. Short-term borrowing | <100% | Pre-COVID: 6% |
| | | | c. Gross working capital | <500 days | | c. Gross working capital | 500-1000 days | |

### *6.6.2 Small Firm*

**Working capital management:** Given the importance of gross working capital in influencing the response variable for Small firms, managers may pay close attention to working capital management. This activity requires reducing the working capital cycle, improving inventory management, and implementing effective cash flow management practices to enhance financial performance.

**ICT Investment:** The analysis suggests that Small firms experienced a decline in return on assets (ROA) as ICT Investment levels increased, followed by a V-shaped recovery. Thus, Managers carefully evaluate ICT Investment's potential benefits (the level at less than 50%) and costs to ensure that it aligns with the Firm's specific needs and improves productivity and profitability.

### *6.6.3 Medium Firm*

**Invest in ICT technologies:** The interaction profile for Medium firms suggests that investing in ICT technologies can improve productivity and ROA by less than 50%. This level is significant and low, considering a Medium Firm's Investment capacity. Managers consider

allocating resources to enhance their ICT capabilities and adopting technologies that streamline processes, improve collaboration, and boost operational efficiency.

**Strengthen gross working capital management:** The analysis highlights the importance of gross working capital as the most influential factor for Medium firms, particularly during the Covid era. Managers optimise working capital levels, improve inventory turnover, and manage receivables and payables efficiently to enhance their financial performance.

### *6.6.4 Decision guide*

During COVID-19, firms with more resilient and flexible needs perform more productively in tough times. Maximising ROA in the During-COVID era requires prudent management of the gross working capital cycle, short-term borrowing, and ICT Investment. Micro, Small, and Medium firms may view the thresholds and adjust their business decision parameters to achieve the desired outcomes. By implementing these recommendations, firms can effectively enhance their financial performance and adapt to the changing business landscape.

**Table 6.6 Summary Table for Decision Guide**

| Sr No | Firm type | Optimum values of factors for maximising ROA (ICT Investment and Short-term borrowing in %of Sales, Gross working capital in days) | | Decision guide |
|---|---|---|---|---|
| 1 | Micro | a. ICT Investment<br>b. Short-term borrowing<br>c. Gross working capital | <50%<br><100%<br><500 days | Low ICT Investment with controlled borrowing and Working capital management. |
| 2 | Small | a. ICT Investment<br>b. Short-term borrowing<br>c. Gross working capital | <50%<br><100%<br><500 days | Low ICT Investment with controlled borrowing and Working capital management. |
| 3 | Medium | a. ICT Investment<br>b. Short-term borrowing<br>c. Gross working capital | <50%<br><100%<br>500-1000 days | Low ICT Investment with controlled borrowing. |

## 6.7 Conclusion and Limitation

The present analysis substantially contributes to the academic understanding of ICT for MSME sector development. This study comprehensively analyses how Micro, Small, and Medium enterprises can effectively use ICT tools to improve their financial performance. Additionally, it aims to establish a clear correlation between ICT adoption and these enterprises' financial outcomes by managing the strategic Investment decision, contributing to the theory of ICT adoption. The study's identification of optimal Investment thresholds in information and communication technology (ICT) and its emphasis on managing working capital make significant contributions to the field of ICT for the development of MSMEs in India. These findings enhance our comprehension of how the adoption of technology influences the performance of firms and, consequently, contributes to broader economic progress and human and social development with employment.

The study examined the factors influencing the return on assets (ROA) for Micro, Small, and Medium firms in both the Pre-COVID and During-COVID Periods. The Design of Experiments (DoE) approach was used to analyse the data, including Effect Summary, Prediction Profiler, and Interaction Profiles.

The Gross working capital cycle was the most influential factor for Micro firms in the Pre-COVID era. However, during the Covid era, the interaction between short-term borrowing and the Gross working capital cycle became more significant. These findings suggest that Micro firms relied more on credit firms to finance their working capital during the economic downturn caused by the pandemic. Still, the Micro firm is reluctant to invest in ICT to improve productivity.

The results showed a different behaviour for Small firms compared to Micro firms. The ICT Investment and Gross working capital are the most influential factors in both the Pre-COVID and During-COVID Periods. However, there are slight shifts in the significance of the factors in the COVID-19 era.

For Medium firms, the results also differed from Micro and Small firms. In the Pre-COVID Period, the ICT Investment with interaction with other factors was influential, while in the During-COVID Period, the Gross working capital became the most influential factor.

The Prediction Profiler graphs provide insights into the relationship between the factors and ROA for each Firm Size category. The desirability of maximising ROA varied for each Period and Firm Size. The findings suggest that the optimal levels of factors for maximising ROA

differed between the Pre-COVID and During-COVID Periods, indicating changes in the behaviour and priorities of firms during and after the pandemic. The novel findings provide insights for all the stakeholders, owners, financial institutions, and external agencies to see the impact of ICT and other factors separately at the Micro, Small and Medium Firm-levels. This study is the first kind of study in this field for the Indian context, providing detailed and in-depth expertise.

### *6.7.1 Limitations:*

Generalizability: The findings are specific to the context of India's Micro, Small, and Medium firms. The results may not directly apply to firms in other countries or economies with different characteristics.

Timeframe: The study focused on the Pre-COVID Period from 2015 to 2019 and the During-COVID Period from 2020 to 2022. The findings may not capture longer-term trends or the full impact of the COVID-19 pandemic.

Data limitations: The study relied on available data for the selected firms, which may have limitations such as missing or incomplete data. The findings should be interpreted cautiously, considering the data's quality and reliability.

Causal relationships: The study used an observational design, and the identified relationships between factors and ROA are correlational. Causal conclusions cannot be drawn solely based on this study, and other factors not considered in the analysis could contribute to changes in ROA.

Factors not considered: The study focused on specific working capital and Investment factors. Other factors, such as market conditions, industry-specific variables, and management practices, may influence ROA and were not included in the analysis.

Interpretation of profiles: The interpretation of the Prediction Profiler and Interaction Profiles relies on visual analysis and may be subjective to some extent. Robust statistical techniques or additional analyses could provide further validation of the findings.

It is essential to acknowledge these limitations to ensure a comprehensive understanding of the study's scope and potential implications. Future research could consider addressing these limitations and expanding the analysis to include a broader range of factors and a more extended Period to enhance the generalizability of the findings.

# CHAPTER 7: CONCLUSION, RECOMMENDATIONS, LIMITATIONS AND FUTURE DIRECTION

## 7.1 Conclusion

The Micro, Small and Medium-sized enterprises (MSMEs) Manufacturing sector in India is a driving force for solid development and fulfils a significant part of GDP. For India to remain a pioneer economic power in the digital world, the role of digitally driven Indian MSME sectors is indispensable. With this aim, the thesis investigates the factors influencing the adoption and impact of Information and Communication Technology (ICT) in the MSMEs Manufacturing sector using a large pool of data of approximately 2000 firms on eight-Year data. A systematic literature review identified critical success factors and proposed a comprehensive conceptual framework for ICT adoption in MSMEs. It also examined the Investment levels of ICT suitable with official definition of Indian MSMEs. This study is unique in the way it does a preliminary study, comprehensive study and validating study with various influencing factors and their impact on firm profitability and firm productivity. Furthermore, the study provided practical managerial contributions and a decision guide for firms to enhance their performance through ICT adoption. Furthermore, the study provided practical managerial contributions and a decision guide for firms to enhance their performance through ICT adoption. Further, these findings are not limited to the guiding principles but also add to the existing literature with new insights on the firm-specific responsible factors and external factors and their impact on ICT adoption. As well as on the mediating impact of ICT investments with the internal factors on the firm performance. These results provide a more informed MSME, sustainable with practical levels of investment. Thus, the strong MSME resultant in job creation and strong social and economic India is created.

The literature review highlighted the various research themes and factors investigated in prior studies on ICT adoption. The findings revealed that most studies focused on a limited number of factors, emphasising the need for comprehensive research to identify the specific needs of the MSME sector in each country. The study also identified limitations, such as database restrictions and language limitations, which may have affected the comprehensiveness of the literature review.

MSMEs are always cautious about Investment decisions (Ghobakhloo et al., 2011). The empirical analysis of Indian MSMEs' ICT Investment levels and their impact on profitability provided valuable insights. The study found a strong positive relationship between ICT

Investment and firm profitability, emphasising the need for top management to recognise the value of ICT adoption. (P. Jones et al., 2011) Survey-based findings support and validate our findings. The research also indicated that technology enhanced firm performance, particularly integrated technological Investment. These findings have practical implications for MSME owners and managers, suggesting that investing in ICT technology can significantly improve their business operations and profitability (M. K. Sharma et al., 2005).

Various researchers expressed the TOE theory for technology adoption with several factors. In contrast, many studies delve into the impact of TOE factors on ICT adoption decisions. At the same time, this study examined the impact of factors such as Firm Size, age, and Government influence on ICT adoption while mediating the impact of ICT Investment on the firm financial performance. This thesis contributes to the existing literature by providing insights into the results of this study. Researchers (Charoenrat & Harvie, 2014) argued that these factors are essential firm-specific factors contributing to the technical efficiency of MSMEs. The results indicated that Firm Size significantly affected ICT adoption, with larger firms performing slightly better. Age harmed both firm performance and ICT adoption, suggesting the challenges organisations face in adapting to new technologies as their age similar findings to those (Charoenrat & Harvie, 2014), contrary to the findings (Santhosh, 2019).

Additionally, Government aid influences ICT adoption, but not significantly, highlighting the need for collaboration between policymakers and organisations to create an innovation-friendly environment and firm-specific Government aid (Wonglimpiyarat, 2016), (Rasiah & Thangiah, 2017). These findings are applicable in the Indian context and support the study conducted in developed countries (Spurge & Roberts, 2005). Firm Size is critical for determining the ICT need since the requirement of technology differs from firm to firm basis, and the firm growth depends on Firm Size (Bentzen et al., 2012). The study of Firm Size impact (Bordonaba-Juste et al., 2012) found that e-business adoption has varied with size, supported by our findings. We have provided more detailed findings with the level of ICT Investment in connection to the size of the firm to maximise the profitability and productivity of the firms.

The practical managerial contributions of this study lie in guiding MSME owners and managers in adopting and leveraging ICT effectively. The findings emphasise the importance of effective communication, software adoption, and careful management of financing strategies to balance short-term benefits and long-term financial viability, and these findings are supported by (Mushtaq et al., 2022). The decision guide provided in the thesis offers recommendations for

firms to enhance their financial performance and adapt to the changing business landscape, particularly during the COVID-19 era.

(Mushtaq et al., 2022) argued that adopting ICT reduces information asymmetry, results in transparent access to financial credit, and improves innovation; this study also complements the findings that the greater access to short-term borrowing improved the ICT Investment decision and resulted in the MSME Firm's performance significantly. These findings are novel for the owner to consider how much to borrow to finance the ICT Investment. Reducing the information asymmetry improved the bills receivable, inventory turnover, bills payable, and supplier-buyer relationships, improving the gross working capital and firm performance (Altaf & Shah, 2018). This study demonstrated that the interaction level of ICT Investment and gross working capital improved the firm performance, and further, this study provides the most suitable levels of ICT Investment, short-term borrowing, and gross working capital as guiding forces for all the stakeholders of MSME sectors.

In conclusion, this thesis has shed light on the critical success factors, Investment levels, and impact of ICT adoption in the Indian MSME Manufacturing sector. The findings provide valuable insights for researchers, policymakers, and practitioners, enabling them to make informed decisions and develop strategies to enhance ICT adoption and firm performance. By addressing the limitations and further exploring the identified research gaps, future studies can build upon this research and contribute to the sustainable growth and competitiveness of the Indian MSME sector.

## 7.2 Recommendations

Based on the findings of this study, the following recommendations:

1. MSMEs may prioritise ICT adoption by investing in appropriate technologies and infrastructure. This Investment will enhance operational efficiency, decision-making capabilities, and overall performance outcomes.

2. Effective working capital management practices could be adopted to ensure adequate liquidity and meet short-term obligations. MSMEs could regularly monitor and optimise their working capital cycle to avoid unnecessary costs and improve financial stability.

3. Policymakers might formulate supportive measures and initiatives to improve access to short-term borrowing for MSMEs. These decisions include developing specialised lending

programs, fostering collaboration between financial institutions and MSMEs, and incentivising lenders to extend credit to the sector.

4. MSMEs could embrace ICT integration across the value chain to maximise potential benefits. MSMEs can unlock potential and drive performance improvements by integrating technology into various business functions, such as production, supply chain management, marketing, and customer service.

5. Considering the effect of the COVID-19 pandemic, MSMEs should continue to adapt and innovate and become more resilient. To thrive in the during-pandemic landscape, they should explore digital transformation opportunities, such as e-commerce platforms, remote work arrangements, and contactless service delivery, for more agility in their business operations.

## 7.3 Limitation of study

Every study has limitation; this study is no exception. This study has covered a wide range of analyses; however, these are the limitations below.:

1. ICT Investment is used as a proxy for ICT adoption in this study. However, this methodology offers a quantitative analysis and measures the impact on the financial performance indicators of MSMEs. There were no differences from the technology used as ICT per se, which means where the Investment is made in hardware, software, storage devices or any other ICT technology. This constraint may vary with the technology used in any firm. An in-depth examination of a particular ICT technology might provide more detailed insights into the diverse patterns of adoption and the ramifications that ensue.
2. This underlying study aims to analyse the impact of ICT Investment quantitatively. It does not delve into why this ICT Investment was made, which means what is the motivation to adopt the ICT. Our focus is to provide a detailed and informed study about the impact of ICT and how various other responsible factors for ICT adoption impact the ICT Investment decision. The intention of ICT adoption may be required in the qualitative study in future.
3. Although the research uses a considerable sample size of 2000 firms, it is advisable to exercise caution when extrapolating the results to the complete population of registered firms in India. Given India's substantial business landscape comprising 63 million registered firms, it is possible that the sample needs to provide a comprehensive representation of the country. To improve the applicability of results to a broader population, scholars may implement stratified sampling methods or conduct a subsequent investigation using a more

heterogeneous and comprehensive sample. Further investigation into industry-specific nuances and regional variations.

4. The research uses Partial Least Squares Structural over and above the Covariance-Based Structural Equation Modelling (CB-SEM) strategy in the analysis part. The Equation Modelling (PLS-SEM) method. PLS-SEM presents certain benefits, including the ability to directly bootstrap results and assess statistical significance via P-Values. This analysis serves the motive and aim of this study. PLS-SEM is more appropriate for exploratory investigations when confronted with intricate models incorporating latent variables like this study has. On the other hand, estimating the relationships between latent constructs might need more precise. Further research could incorporate sensitivity analyses by combining PLS-SEM and CB-SEM to compare outcomes and evaluate the strength of conclusions.
5. This study has dealt with various levels of ICT investment, and with few factors responsible for adoption; hence, the future study could be specific to the factors responsible for ICT adoption in the MSME sector.

## 7.4 Future Study

While this study has shed light on the relationship between ICT adoption, financial resources, and organisational performance in Indian MSMEs, future research could explore several areas to deepen our understanding. Some potential avenues for future study include:

1. Long-term Impact of ICT Adoption: This study focused on the immediate impact of ICT adoption on MSME performance. Future research could examine the long-term effects of ICT adoption on organisational growth, profitability, and sustainability. By tracking the performance of MSMEs over an extended Period, researchers can gain insights into the sustained benefits and challenges associated with ICT adoption.

2. Comparative Analysis: This study specifically focused on Indian MSMEs. Future research could expand the scope by conducting a comparative analysis across different countries or regions. This analysis would enable researchers to identify variations in the impact of ICT adoption and financial resource management on MSME performance, considering cultural, economic, and institutional factors.

3. Role of Organizational Culture and Leadership: The influence of organisational culture and leadership on adopting and integrating ICT tools remains an essential area for investigation. Future research could explore how leadership styles, organisational culture, and employee attitudes impact the successful implementation and utilisation of ICT in MSMEs.

4. Impact of ICT on Specific Performance Indicators: This study primarily examined the overall financial performance of MSMEs. Future research could delve deeper into specific performance indicators, such as productivity, innovation, customer satisfaction, and employee engagement. By examining these specific outcomes, researchers can provide a more nuanced understanding of the relationship between ICT adoption and different dimensions of organisational performance.

5. Policy Implications: While this study proposed recommendations for MSMEs and policymakers, future research could evaluate the effectiveness of specific policy interventions to promote ICT adoption and improve access to financial resources for MSMEs. By assessing the outcomes of policy initiatives, researchers can contribute to evidence-based policymaking and identify best practices for supporting MSMEs in the digital era.

6. The results also emphasise the importance of effective communication, the potential challenges of Government influence, and the role of ICT in enhancing firm performance. It is required to interpret these findings cautiously due to certain relationships' relatively low statistical power. This finding is supported by (Bollen, 2011); in many SEMs with large samples, there is considerable statistical power to detect even minor mistakes in the model specification. In practice, there will be ambiguity in assessing the overall model fit. Additional research with larger sample sizes and higher statistical power is required to confirm and expand upon these findings.

Future research may explore the dynamic relationship between ICT adoption, financial resource management, and organisational performance in MSMEs. Expanding our knowledge in these areas can provide valuable insights and guidance to MSMEs, policymakers, and researchers striving to foster growth, innovation, and resilience in the evolving business landscape.

## REFERENCES


Abed, S. S. (2020). Social commerce adoption using TOE framework: An empirical investigation of Saudi Arabian SMEs. *International Journal of Information Management*, *53*(October 2019), 102118. https://doi.org/10.1016/j.ijinfomgt.2020.102118

Aboelmaged, M. (2018). The drivers of sustainable Manufacturing practices in Egyptian SMEs and their impact on competitive capabilities: A PLS-SEM model. *Journal of Cleaner Production*, *175*, 207–221. https://doi.org/10.1016/j.jclepro.2017.12.053

Abrahamse, J., & Lotriet, H. (2012). Towards an Understanding, Through Action Research, of the Socio-Organizational Issues Impacting on Mobile Technology Adoption and Diffusion Within a Small-to-Medium South African Construction Company. *Systemic Practice and Action Research*, *25*(1), 57–79. https://doi.org/10.1007/s11213-011-9202-z

Acar, E., Koçak, I., Sey, Y., & Arditi, D. (2005). Use of information and communication technologies by Small and Medium-sized enterprises (SMEs) in building construction. *Construction Management and Economics*, *23*(7), 713–722. https://doi.org/10.1080/01446190500127112

Adeniran, T. V, & Johnston, K. A. (2016). The impacts of ICT utilisation and dynamic capabilities on the competitive advantage of South African SMEs. *International Journal of Information Technology and Management*, *15*(1), 59–89. https://doi.org/10.1504/IJITM.2016.073915

Agostini, L., & Nosella, A. (2019). The adoption of Industry 4.0 technologies in SMEs: results of an international study. *Management Decision*, *58*(4), 625–643. https://doi.org/10.1108/MD-09-2018-0973

Agostini, L., Nosella, A., & Venturini, K. (2019). Toward increasing affective commitment in SME strategic networks. *Business Process Management Journal*, *25*(7), 1822–1840. https://doi.org/10.1108/BPMJ-02-2018-0035

Ahuja, V., Yang, J., & Shankar, R. (2010). Benchmarking Framework to Measure Extent of ICT Adoption for Building Project Management. *Journal of Construction Engineering and Management*, *136*(5), 538–545. https://doi.org/10.1061/(asce)co.1943-7862.0000155

Ajibade, P., & Mutula, S. (2020). Promoting SMEs effectiveness through innovative communication strategies and business-IT alignment. *Problems and Perspectives in Management*, *18*(3), 233–244. https://doi.org/10.21511/ppm.18(3).2020.20

Al-Busaidi, K. A., & Al-Muharrami, S. (2021). Beyond profitability: ICT Investments and financial institutions performance measures in developing economies. *Journal of Enterprise Information Management*, *34*(3), 900–921. https://doi.org/10.1108/JEIM-09-2019-0250

AL-Shboul, M. A. M. A. (2019). Towards better understanding of determinants logistical factors in SMEs for cloud ERP adoption in developing economies. *Business Process Management Journal*, *25*(5), 887–907. https://doi.org/10.1108/BPMJ-01-2018-0004

Alam, K., & Adeyinka, A. A. (2020). Does innovation stimulate performance? The case of Small and Medium enterprises in regional Australia. *Australian Economic Papers*, *November*, 1–24. https://doi.org/10.1111/1467-8454.12216

AlBar, A. M., & Hoque, M. R. (2019). Factors affecting the adoption of information and communication technology in Small and Medium enterprises: a perspective from rural Saudi Arabia. *Information Technology for Development*, *25*(4), 715–738. https://doi.org/10.1080/02681102.2017.1390437

Alderete, M. V. (2017). Mobile Broadband: A Key Enabling Technology for Entrepreneurship? *Journal of Small Business Management*, *55*(2), 254–269. https://doi.org/10.1111/jsbm.12314

Alhassan, M. D., & Adam, I. O. (2021). The effects of digital inclusion and ICT access on the quality of life: A global perspective. *Technology in Society*, *64*(September 2020), 101511. https://doi.org/10.1016/j.techsoc.2020.101511

Allan, J., & Lawless, N. (2005). Learning through online collaboration by SME staff: A scoping investigation into likely team-role stressors. *Education and Training*, *47*(8–9), 653–664. https://doi.org/10.1108/00400910510633189

Alshamaila, Y., Papagiannidis, S., & Li, F. (2013). Cloud computing adoption by SMEs in the north east of England: A multi-perspective framework. *Journal of Enterprise Information Management*, *26*(3), 250–275. https://doi.org/10.1108/17410391311325225

Altaf, N., & Shah, F. A. (2018). How does working capital management affect the profitability of Indian companies? *Journal of Advances in Management Research*, *15*(3), 347–366. https://doi.org/10.1108/JAMR-06-2017-0076

Amir, S., Ahmad, A., & Ehsan, M. R. (2013). SMEs on Cloud: Challenges and Opportunities. *National Congress of Electrical Engineering, Computer and Information Technology*

*(CECIT2013)*, *March*, 1–6.

Antonioli, D., Mazzanti, M., & Pini, P. (2010). Productivity, innovation strategies and industrial relations in SMEs. Empirical evidence for a local production system in northern Italy. *International Review of Applied Economics*, *24*(4), 453–482. https://doi.org/10.1080/02692171.2010.483790

Apulu, I., Latham, A., & Moreton, R. (2011). Factors affecting the effective utilisation and adoption of sophisticated ICT solutions: Case studies of SMEs in Lagos, Nigeria. *Journal of Systems and Information Technology*, *13*(2), 125–143. https://doi.org/10.1108/13287261111135972

Aslesen, H. W., & Harirchi, G. (2015). The effect of local and global linkages on the innovativeness in ICT SMEs: does location-specific context matter? *Entrepreneurship and Regional Development*, *27*(9–10), 644–669. https://doi.org/10.1080/08985626.2015.1059897

Awa, H. O., Baridam, D. M., & Nwibere, B. M. (2015). Demographic determinants of electronic commerce (EC) adoption by SMEs: A twist by location factors. *Journal of Enterprise Information Management*, *28*(3), 326–345. https://doi.org/10.1108/JEIM-10-2013-0073

Badi, S., & Murtagh, N. (2019). Green supply chain management in construction: A systematic literature review and future research agenda. *Journal of Cleaner Production*, *223*, 312–322. https://doi.org/10.1016/j.jclepro.2019.03.132

Bayo-Moriones, A., Billón, M., & Lera-López, F. (2013). Perceived performance effects of ICT in Manufacturing SMEs. *Industrial Management and Data Systems*, *113*(1), 117–135. https://doi.org/10.1108/02635571311289700

Bayonne, E., Marin-Garcia, J. A., & Alfalla-Luque, R. (2020). Partial least squares (PLS) in operations management research: Insights from a systematic literature review. *Journal of Industrial Engineering and Management*, *13*(3), 565–597. https://doi.org/10.3926/JIEM.3416

Becchetti, L., Londono Bedoya, D. A., & Paganetto, L. (2003). ICT Investment, Productivity and Efficiency: Evidence at Firm Level Using a Stochastic Frontier Approach. *Journal of Productivity Analysis*, *20*(2), 143–167. https://doi.org/10.1023/A:1025128121853

Bendell, B. L., Sullivan, D. M., & Hanek, K. J. (2020). Gender, technology and decision-

making: insights from an experimental conjoint analysis. *International Journal of Entrepreneurial Behaviour and Research*, *26*(4), 647–670. https://doi.org/10.1108/IJEBR-04-2019-0232

Benitez, J., Castillo, A., Llorens, J., & Braojos, J. (2018). IT-enabled knowledge ambidexterity and innovation performance in Small U.S. firms: The moderator role of social media capability. *Information and Management*, *55*(1), 131–143. https://doi.org/10.1016/j.im.2017.09.004

Benitez, J., Henseler, J., Castillo, A., & Schuberth, F. (2020). How to perform and report an impactful analysis using partial least squares: Guidelines for confirmatory and explanatory IS research. In *Information and Management* (Vol. 57, Issue 2). https://doi.org/10.1016/j.im.2019.05.003

Benitez, J., Llorens, J., & Braojos, J. (2018). How information technology influences opportunity exploration and exploitation Firm's capabilities. *Information and Management*, *55*(4), 508–523. https://doi.org/10.1016/j.im.2018.03.001

Benjaoran, V. (2009). A cost control system development: A collaborative approach for Small and Medium-sized contractors. *International Journal of Project Management*, *27*(3), 270–277. https://doi.org/10.1016/j.ijproman.2008.02.004

Bentzen, J., Madsen, E. S., & Smith, V. (2012). Do firms' growth rates depend on firm size? *Small Business Economics*, *39*(4), 937–947. https://doi.org/10.1007/s11187-011-9341-8

Beynon, M. J., Munday, M., & Roche, N. (2021). ICT resources and use: examining differences in pathways to improved Small firm performance. *International Journal of Entrepreneurial Behaviour and Research*, *27*(7), 1798–1818. https://doi.org/10.1108/IJEBR-12-2020-0847

Bharadwaj, A. S. (2000). A RESOURCE-BASED PERSPECTIVE ON INFORMATION TECHNOLOGY CAPABILITY AND FIRM PERFORMANCE: AN EMPIRICAL INVESTIGATION. *MIS Quarterly*, *24*(1), 169–196.

Biagi, F. (2013). ICT and Productivity : A Review of the Literature. In *Digital Economy Working Paper - European Commission: Vol. 2013 / 09*. https://doi.org/10.2788/32940

Biagi, F., & Falk, M. (2017). The impact of ICT and e-commerce on employment in Europe. *Journal of Policy Modeling*, *39*(1), 1–18. https://doi.org/10.1016/j.jpolmod.2016.12.004

Binuyo, A. O., & Aregbeshola, R. A. (2014). The impact of information and communication

technology (ICT) on commercial bank performance: Evidence from South Africa. *Problems and Perspectives in Management*, *12*(3), 59–68.

Bollen, K. A. (2011). Evaluating effect, composite, and causal indicators in structural equation models. *MIS Quarterly: Management Information Systems*, *35*(2), 359–372. https://doi.org/10.2307/23044047

Bordonaba-Juste, V., Lucia-Palacios, L., & Polo-Redondo, Y. (2012). The influence of organizational factors on e-business use: Analysis of firm size. *Marketing Intelligence and Planning*, *30*(2), 212–229. https://doi.org/10.1108/02634501211211984

Brocke, J. vom, Schmid, A. M., Simons, A., & Safrudin, N. (2021). IT-enabled organizational transformation: a structured literature review. *Business Process Management Journal*, *27*(1), 204–229. https://doi.org/10.1108/BPMJ-10-2019-0423

Brynjolfsson, E., & Hitt, L. M. (1998). Beyond the Productivity Paradox :Computers are the Catalyst for Bigger Changes. *Communications of the ACM*, *41*(8), 49–55. https://doi.org/10.1145/280324.280332

Cegarra-Navarro, J. G., Wensley, A. K. P. P., & Martínez-Conesa, E. Á. (2010). A multi-sector comparison of relational learning and information and communication technologies adoption. *Service Industries Journal*, *30*(6), 991–1005. https://doi.org/10.1080/02642060802342661

Charoenrat, T., & Harvie, C. (2014). The efficiency of SMEs in Thai Manufacturing: A stochastic frontier analysis. *Economic Modelling*, *43*, 372–393. https://doi.org/10.1016/j.econmod.2014.08.009

Cheah, J. H., Roldán, J. L., Ciavolino, E., Ting, H., & Ramayah, T. (2021). Sampling weight adjustments in partial least squares structural equation modeling: guidelines and illustrations. *Total Quality Management and Business Excellence*, *32*(13–14), 1594–1613. https://doi.org/10.1080/14783363.2020.1754125

Chege, S. M., Wang, D., & Suntu, S. L. (2020). Impact of information technology innovation on firm performance in Kenya. *Information Technology for Development*, *26*(2), 316–345. https://doi.org/10.1080/02681102.2019.1573717

Chen, C. L. (2020). Cross-disciplinary innovations by Taiwanese Manufacturing SMEs in the context of Industry 4.0. *Journal of Manufacturing Technology Management*, *31*(6), 1145–1168. https://doi.org/10.1108/JMTM-08-2019-0301

Chiarvesio, M., Di Maria, E., & Micelli, S. (2004). From local networks of SMEs to virtual districts?: Evidence from recent trends in Italy. *Research Policy*, *33*(10), 1509–1528. https://doi.org/10.1016/j.respol.2004.08.009

Chibelushi, C., & Costello, P. (2009). Challenges facing W. Midlands ICT-oriented SMEs. *Journal of Small Business and Enterprise Development*, *16*(2), 210–239. https://doi.org/10.1108/14626000910956029

Chong, B. W., Othman, R., Jaya, R. P., Hasan, M. R. M., Sandu, A. V., Nabiałek, M., Jeż, B., Pietrusiewicz, P., Kwiatkowski, D., Postawa, P., & Abdullah, M. M. A. B. (2021). Design of experiment on concrete mechanical properties prediction: A critical review. *Materials*, *14*(8), 1–17. https://doi.org/10.3390/ma14081866

Choudhury, D., Shetty, J. P., & Panda, R. (2020). MSME initiatives to support Cloud adoption in India. *International Journal of Indian Culture and Business Management*, *1*(1), 1. https://doi.org/10.1504/ijicbm.2020.10028605

Christaki, M., Verboven, P., Van Dyck, T., Nicolaï, B., Goos, P., & Claes, J. (2017). The predictive power of batter rheological properties on cake quality - The effect of pregelatinized flour, leavening acid type and mixing time. *Journal of Cereal Science*, *77*, 219–227. https://doi.org/10.1016/j.jcs.2017.07.001

CMIE. (n.d.). *https://prowessiq.cmie.com/*. https://prowessiq.cmie.com/

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences*.

Colombo, M. G., Croce, A., & Grilli, L. (2013). ICT services and Small businesses' productivity gains: An analysis of the adoption of broadband Internet technology. *Information Economics and Policy*, *25*(3), 171–189. https://doi.org/10.1016/j.infoecopol.2012.11.001

Commissioner, D., & India, M. G. of. (2014). *"Promotion of Information and Communication Technology (ICT) in MSME Sector"* (pp. 1–17).

Contador, J. C., Satyro, W. C., Contador, J. L., & Spinola, M. de M. (2020). Flexibility in the Brazilian Industry 4.0: Challenges and Opportunities. *Global Journal of Flexible Systems Management*, *21*, 15–31. https://doi.org/10.1007/s40171-020-00240-y

Corrocher, N., & Fontana, R. (2008). Objectives, obstacles and drivers of ICT adoption: What do IT managers perceive? *Information Economics and Policy*, *20*(3), 229–242. https://doi.org/10.1016/j.infoecopol.2008.03.001

Cragg, P., Mills, A., & Suraweera, T. (2013). The influence of IT management sophistication and IT support on IT success in Small and Medium-sized enterprises. *Journal of Small Business Management*, *51*(4), 617–636. https://doi.org/10.1111/jsbm.12001

Cragg, T., & McNamara, T. (2018). An ICT-based framework to improve global supply chain integration for final assembly SMES. *Journal of Enterprise Information Management*, *31*(5), 634–657. https://doi.org/10.1108/JEIM-04-2014-0038

Cuadrado-Roura, J. R., & Garcia-Tabuenca, A. (2004). ICT policies for SMEs and regional disparities. The Spanish case. *Entrepreneurship and Regional Development*, *16*(1), 55–75. https://doi.org/10.1080/0898562042000205036

da Silva, N. A., Abreu, J. L., Orsolin Klingenberg, C., Antunes Junior, J. A. V., & Lacerda, D. P. (2022). Industry 4.0 and Micro and Small enterprises: systematic literature review and analysis. *Production and Manufacturing Research*, *10*(1), 696–726. https://doi.org/10.1080/21693277.2022.2124466

Dasgupta, S., & Gupta, B. (2019). Espoused organizational culture values as antecedents of Internet technology adoption in an emerging economy. *Information and Management*, *56*(6), 103142. https://doi.org/10.1016/j.im.2019.01.004

Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, *13*(3), 319–340. https://doi.org/10.5962/bhl.title.33621

Despeisse, M., Chari, A., González Chávez, C. A., Monteiro, H., Machado, C. G., & Johansson, B. (2022). A systematic review of empirical studies on green Manufacturing: eight propositions and a research framework for digitalized sustainable Manufacturing. *Production and Manufacturing Research*, *10*(1), 727–759. https://doi.org/10.1080/21693277.2022.2127428

Development Commissioner (MSME). (2006). Ministry of Micro, Small & Medium Enterprises. In *Government of India*.

DEVELOPMENT, O. F. E. C.-O. A. (2004). ICT, E-BUSINESS AND SMEs ORGANISATION. In *OECD*.

Díaz-Chao, Á., Ficapal-Cusí, P., & Torrent-Sellens, J. (2021). Environmental assets, industry 4.0 technologies and firm performance in Spain: A dynamic capabilities path to reward sustainability. *Journal of Cleaner Production*, *281*(125264).

https://doi.org/10.1016/j.jclepro.2020.125264

Dirsehan, T., & Henseler, J. (2022). Modeling indices using partial least squares: How to determine the optimum weights? *Quality and Quantity*. https://doi.org/10.1007/s11135-022-01515-5

Dwivedi, Y. K., Hughes, L., Ismagilova, E., Aarts, G., Coombs, C., Crick, T., Duan, Y., Dwivedi, R., Edwards, J., Eirug, A., Galanos, V., Ilavarasan, P. V., Janssen, M., Jones, P., Kar, A. K., Kizgin, H., Kronemann, B., Lal, B., Lucini, B., … Williams, M. D. (2021). Artificial Intelligence (AI): Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. *International Journal of Information Management*, *57*(July), 101994. https://doi.org/10.1016/j.ijinfomgt.2019.08.002

Ekman, P., Thilenius, P., Thompson, S., & Whitaker, J. (2020). Digital transformation of global business processes: the role of dual embeddedness. *Business Process Management Journal*, *26*(2), 570–592. https://doi.org/10.1108/BPMJ-02-2019-0080

El-Haddadeh, R. (2020). Digital Innovation Dynamics Influence on Organisational Adoption: The Case of Cloud Computing Services. *Information Systems Frontiers*, *22*(4), 985–999. https://doi.org/10.1007/s10796-019-09912-2

Eldomiaty, T. I., Andrikopoulos, P., & Bishara, M. K. (2019). Financial decisions and growth of the firm under high and low levels of information asymmetry. In *Research in Finance* (Vol. 35, Issue October). https://doi.org/10.1108/S0196-382120190000035002

ENOMATE, B., & AUDU, I. O. (2021). Effect of Information and Communication Technology on Financial Performance of Listed Non-Financial Firms in Nigeria. *Bingham International Journal of Accounting and Finance*, *2*(2), 182–194. http://35.188.205.12:8080/xmlui/handle/123456789/647%0Ahttp://35.188.205.12:8080/xmlui/bitstream/handle/123456789/647/13.pdf?sequence=1&isAllowed=y

Eze, S. C., Olatunji, S., Chinedu-Eze, V. C., & Bello, A. O. (2018). Key success factors influencing SME managers' information behaviour on emerging ICT (EICT) adoption decision-making in UK SMEs. *The Bottom Line*, *31*(3–4), 250–275. https://doi.org/10.1108/BL-02-2018-0008

Eze, S. C., Olatunji, S., Chinedu-Eze, V. C., Bello, A. O., Ayeni, A., & Peter, F. (2019). Determinants of perceived information need for emerging ICT adoption: A study of UK

Small service businesses. *The Bottom Line*, *32*(2), 158–183. https://doi.org/10.1108/BL-01-2019-0059

Findikoglu, M. N., & Watson-Manheim, M. B. (2015). Do Small and Medium-Sized IT Firms Form Service Partnerships with Nonlocal IT Firms? An Assessment of Facilitators. *Journal of Small Business Management*, *53*(4), 986–1010. https://doi.org/10.1111/jsbm.12117

Flores, M., Bor, C., Huber, C., Pluss, A., Schoch, R., & Pouly, M. (2009). Universities as key enablers to develop new collaborative environments for innovation: Successful experiences from Switzerland and India. *International Journal of Production Research*, *47*(17), 4935–4953. https://doi.org/10.1080/00207540902847454

Forbes. (n.d.). *https://www.forbes.com/advisor/investing/roa-return-on-assets/#:~:text=What%20Is%20a%20Good%20ROA,the%20same%20industry%20and%20sector.* https://www.forbes.com/advisor/investing/roa-return-on-assets/#:~:text=What Is a Good ROA,the same industry and sector.

Force, N. T. (2020). *Improving Economic Dynamism and Accelerating MSME growth* (Issue June).

Foroudi, P., Gupta, S., Nazarian, A., & Duda, M. (2017). Digital technology and marketing management capability: achieving growth in SMEs. *Qualitative Market Research*, *20*(2), 230–246. https://doi.org/10.1108/QMR-01-2017-0014

Gäre, K., & Melin, U. (2011). SMEs need formative infrastructure for business transformation. *Journal of Enterprise Information Management*, *24*(6), 520–533. https://doi.org/10.1108/17410391111166558

Ghobakhloo, M., Arias-Aranda, D., & Benitez-Amado, J. (2011). Adoption of e-commerce applications in SMEs. *Industrial Management & Data Systems*, *111*(8), 1238–1269. https://doi.org/10.1108/02635571111170785

Glavas, C., Mathews, S., & Russell-Bennett, R. (2019). Knowledge acquisition via Internet-enabled platforms: Examining incrementally and non-incrementally internationalizing SMEs. *International Marketing Review*, *36*(1), 74–107. https://doi.org/10.1108/IMR-02-2017-0041

Goel, S., Dwivedi, R., & Sherry, A. M. (2012). Critical factors for successful implementation of e-governance programs: A case study of huda. *Global Journal of Flexible Systems*

*Management*, *13*(4), 233–244. https://doi.org/10.1007/s40171-013-0021-1

Goos, P. (2016). Discussion of "21st century screening experiments: What, why, and how." *Quality Engineering*, *28*(1), 111–114. https://doi.org/10.1080/08982112.2015.1100464

Gray, C. (2006). Absorptive capacity, knowledge management and innovation in entrepreneurial Small firms. *International Journal of Entrepreneurial Behaviour and Research*, *12*(6), 345–360. https://doi.org/10.1108/13552550610710144

Grudinschi, D., Sintonen, S., & Hallikas, J. (2014). Relationship risk perception and determinants of the collaboration fluency of buyer-supplier relationships in public service procurement. *Journal of Purchasing and Supply Management*, *20*(2), 82–91. https://doi.org/10.1016/j.pursup.2014.03.004

Guerrieri, P., & Pietrobelli, C. (2004). Industrial districts' evolution and technological regimes: Italy and Taiwan. *Technovation*, *24*(11), 899–914. https://doi.org/10.1016/S0166-4972(03)00048-8

Guo, H., Ph, D., & Mettas, A. (2012). Design of Experiments and Data Analysis. *Reliability and Maintainability Symposium*, 1–11.

Gupta, H., & Barua, M. K. (2016). Identifying enablers of technological innovation for Indian MSMEs using best-worst multi criteria decision making method. *Technological Forecasting and Social Change*, *107*, 69–79. https://doi.org/10.1016/j.techfore.2016.03.028

Gupta, P., Seetharaman, A., & Raj, J. R. (2013). The usage and adoption of cloud computing by Small and Medium businesses. *International Journal of Information Management*, *33*(5), 861–874. https://doi.org/10.1016/j.ijinfomgt.2013.07.001

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*, *31*(1), 2–24. https://doi.org/10.1108/EBR-11-2018-0203

Hajro, N., Smaje, K., Vieira, B., & Zemmel, R. (2022). Digital resilience: Consumer survey finds ample scope for growth. *McKinsey Digital*, *October*, 1–13.

Harland, C. M., Caldwell, N. D., Powell, P., & Zheng, J. (2007). Barriers to supply chain information integration: SMEs adrift of eLands. *Journal of Operations Management*, *25*(6), 1234–1254. https://doi.org/10.1016/j.jom.2007.01.004

Harrigan, P., Ramsey, E., & Ibbotson, P. (2008). e-CRM in SMEs: An exploratory study in Northern Ireland. *Marketing Intelligence and Planning*, *26*(4), 385–404. https://doi.org/10.1108/02634500810879296

Hassan, S. S., Reuter, C., & Bzhalava, L. (2020). PERCEPTION or CAPABILITIES? AN EMPIRICAL INVESTIGATION of the FACTORS INFLUENCING the ADOPTION of SOCIAL MEDIA and PUBLIC CLOUD in German SMEs. *International Journal of Innovation Management*, *2150002*(1), 1–26. https://doi.org/10.1142/S136391962150002X

Hastig, G. M., & Sodhi, M. M. S. (2020). Blockchain for Supply Chain Traceability: Business Requirements and Critical Success Factors. *Production and Operations Management*, *29*(4), 935–954. https://doi.org/10.1111/poms.13147

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 and Knowledge*, *7*(2), 100171. https://doi.org/10.1016/j.jik.2022.100171

Ho, C. K. Y. Y., Ke, W., Liu, H., & Chau, P. Y. K. K. (2020). Separate versus joint evaluation: The roles of evaluation mode and construal level in technology adoption. *MIS Quarterly: Management Information Systems*, *44*(2), 725–746. https://doi.org/10.25300/MISQ/2020/14246

Ho, W. M. (2021). International outsourcing, exchange rates, and monetary policy☆. *Journal of International Money and Finance*, *118*, 102461. https://doi.org/10.1016/j.jimonfin.2021.102461

Hong, W., Chan, F. K. Y. Y., Thong, J. Y. L. L., Chasalow, L. C., & Dhillon, G. (2014). A framework and guidelines for context-specific theorizing in information systems research. *Information Systems Research*, *25*(1), 111–136. https://doi.org/10.1287/isre.2013.0501

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, *6*(1), 1–55. https://doi.org/10.1080/10705519909540118

Hua, G. B. (2007). Applying the strategic alignment model to business and ICT strategies of Singapore's Small and Medium-sized architecture, engineering and construction enterprises. *Construction Management and Economics*, *25*(2), 157–169.

https://doi.org/10.1080/01446190600827041

Iacovou, C. L., Benbasat, I., & Dexter, A. S. (1995). Electronic Data Interchange and Small Businesses: Adoption and Impact of Technology. *MIS Quarterly: Management Information Systems*, *19*(4), 465–485.

Ilavarasan, P. V. (2019). Present and future of the use and impact of information and communication technology in informal Microenterprises: Insights from India. *Electronic Journal of Information Systems in Developing Countries*, *85*(3), 1–9. https://doi.org/10.1002/isd2.12091

Industry, F. of I. C. of C. and. (2012). Usage of Information & Communication Technology (ICT) tools by Indian SMEs and its impact on their business. In *Federation of Indian Chamber of Commerce and Industry*.

*Information_and_communications_technology @ en.wikipedia.org*. (n.d.). https://en.wikipedia.org/wiki/Information_and_communications_technology

Jayeola, O., Sidek, S., Sanyal, S., Hasan, S. I., An, N. B., Mofoluwa Ajibade, S. S., & Phan, T. T. H. (2022). Government financial support and financial performance of SMEs: A dual sequential mediator approach. *Heliyon*, *8*(11). https://doi.org/10.1016/j.heliyon.2022.e11351

Jewalikar, A. D., & Shelke, A. (2017). Lean Integrated Management Systems in MSME Reasons, Advantages and Barriers on Implementation. *Materials Today: Proceedings*, *4*(2), 1037–1044. https://doi.org/10.1016/j.matpr.2017.01.117

Jiménez-Zarco, A. I., González-González, I., Martínez-Ruíz, M. P., & Izquierdo-Yusta, A. (2015). New service innovation success: Analyzing the influence of performance indicator nature. *Computers in Human Behavior*, *51*, 1024–1031. https://doi.org/10.1016/j.chb.2014.09.046

Johnston, D. A., & Wright, L. (2004). The e-business capability of Small and Medium sized firms in international supply chains. *Information Systems and E-Business Management*, *2*(2–3), 223–240. https://doi.org/10.1007/s10257-004-0038-2

Jones, B. (2021). The prediction profiler at 30. *Quality Engineering*, *33*(3), 417–424. https://doi.org/10.1080/08982112.2021.1874015

Jones, P., Packham, G., Beynon-Davies, P., & Pickernell, D. (2011). False promises: E-business deployment in Wales' SME community. *Journal of Systems and Information*

*Technology*, *13*(2), 163–178. https://doi.org/10.1108/13287261111135990

Jorgenson, D. W., & Vu, K. M. (2016). The ICT revolution, world economic growth, and policy issues. *Telecommunications Policy*, *40*(5), 383–397. https://doi.org/10.1016/j.telpol.2016.01.002

Kabanda, S., & Brown, I. (2017). Interrogating the effect of environmental factors on e-commerce institutionalization in Tanzania: a test and validation of Small and Medium enterprise claims. *Information Technology for Development*, *23*(1), 59–85. https://doi.org/10.1080/02681102.2016.1263593

Karjalainen, K., & Kemppainen, K. (2008). The involvement of Small- and Medium-sized enterprises in public procurement: Impact of resource perceptions, electronic systems and enterprise size. *Journal of Purchasing and Supply Management*, *14*(4), 230–240. https://doi.org/10.1016/j.pursup.2008.08.003

Kavathatzopoulos, I. (2015). ICT and sustainability: Skills and methods for dialogue and policy making. *Journal of Information, Communication and Ethics in Society*, *13*(1), 13–18. https://doi.org/10.1108/JICES-12-2014-0063

Kaynak, E., Tatoglu, E., & Kula, V. (2005). An analysis of the factors affecting the adoption of electronic commerce by SMEs: Evidence from an emerging market. *International Marketing Review*, *22*(6), 623–640. https://doi.org/10.1108/02651330510630258

Kazakov, S., Ruiz-Alba, J. L., & Muñoz, M. M. (2020). The impact of information and communication technology and internal market orientation blending on organisational performance in Small and Medium enterprises. *European Journal of Management and Business Economics*, *30*(2), 129–151. https://doi.org/10.1108/EJMBE-04-2020-0068

Khalil Moghaddam, B., & Khatoon-Abadi, A. (2013). Factors affecting ICT adoption among rural users: A case study of ICT Center in Iran. *Telecommunications Policy*, *37*(11), 1083–1094. https://doi.org/10.1016/j.telpol.2013.02.005

Khalil, S., & Belitski, M. (2020). Dynamic capabilities for firm performance under the information technology governance framework. *European Business Review*, *32*(2), 129–157. https://doi.org/10.1108/EBR-05-2018-0102

Khanna, R., & Sharma, C. (2022). Impact of information technology on firm performance: New evidence from Indian Manufacturing. *Information Economics and Policy*, *60*, 100986. https://doi.org/10.1016/j.infoecopol.2022.100986

Khanzode, A. G., Sarma, P. R. S. S., Mangla, S. K., Yuan, H., Masngla, S. K., Yuan, H., Mangla, S. K., Yuan, H., Masngla, S. K., Yuan, H., Mangla, S. K., & Yuan, H. (2021). Modeling the Industry 4.0 adoption for sustainable production in Micro, Small & Medium Enterprises. *Journal of Cleaner Production*, *279*, 123489. https://doi.org/10.1016/j.jclepro.2020.123489

Kharub, M., Mor, R. S., & Sharma, R. (2019). The relationship between cost leadership competitive strategy and firm performance: A mediating role of quality management. *Journal of Manufacturing Technology Management*, *30*(6), 920–936. https://doi.org/10.1108/JMTM-06-2017-0116

Kijkasiwat, P., Wellalage, N. H., & Locke, S. (2021). The impact of symbiotic relations on the performance of Micro, Small and Medium enterprises in a Small-town context: The perspective of risk and return. *Research in International Business and Finance*, *56*(December 2019), 101388. https://doi.org/10.1016/j.ribaf.2021.101388

Kim, S. H., Jang, S. Y., & Yang, K. H. (2017). Analysis of the Determinants of Software-as-a-Service Adoption in Small Businesses: Risks, Benefits, and Organizational and Environmental Factors. *Journal of Small Business Management*, *55*(2), 303–325. https://doi.org/10.1111/jsbm.12304

Kim, S. S. (2009). The integrative framework of technology use: An extension and test. *MIS Quarterly: Management Information Systems*, *33*(3), 513–537. https://doi.org/10.2307/20650307

Kohn, S., & Hüsig, S. (2006). Potential benefits, current supply, utilization and barriers to adoption: An exploratory study on German SMEs and innovation software. *Technovation*, *26*(8), 988–998. https://doi.org/10.1016/j.technovation.2005.08.003

Koufteros, X. A., Vonderembse, M. A., & Doll, W. J. (2002). Integrated product development practices and competitive capabilities: The effects of uncertainty, equivocality, and platform strategy. *Journal of Operations Management*, *20*(4), 331–355. https://doi.org/10.1016/S0272-6963(02)00018-9

Koufteros, X., Vonderembse, M., & Jayaram, J. (2005). Internal and External Integration for Product Development: The Contingency Effects of Uncertainty, Equivocality, and Platform Strategy. *Decision Sciences*, *36*(1), 97–133. https://doi.org/10.1111/j.1540-5915.2005.00067.x

Kumar, M., Antony, J., Singh, R. K., Tiwari, M. K., & Perry, D. (2006). Implementing the lean sigma framework in an Indian SME: A case study. *Production Planning and Control*, *17*(4), 407–423. https://doi.org/10.1080/09537280500483350

Lal, K. (2002). E-business and Manufacturing sector: A study of Small and Medium-sized enterprises in India. *Research Policy*, *31*(7), 1199–1211. https://doi.org/10.1016/S0048-7333(01)00191-3

Lal, Kaushalesh. (2011). Asian Journal of Technology Innovation Information and communication technology adoption in Malaysian SMEs Information and Communication Technology Adoption in Malaysian SMEs. *Asian Journal of Technology Innovation*, *16*(1), 161–186.

Lauto, G., Pittino, D., & Visintin, F. (2020). Satisfaction of entrepreneurs: A comparison between founders and family business successors. *Journal of Small Business Management*, *58*(3), 474–510. https://doi.org/10.1080/00472778.2019.1660937

Lee, J., Choi, M., & Lee, H. (2015). Factors affecting smart learning adoption in workplaces: comparing large enterprises and SMEs. *Information Technology and Management*, *16*(4), 291–302. https://doi.org/10.1007/s10799-014-0201-5

Lee, Y. C., Chu, P. Y., & Tseng, H. L. (2011). Corporate performance of ICT-enabled business process re-engineering. *Industrial Management and Data Systems*, *111*(5), 735–754. https://doi.org/10.1108/02635571111137287

Li, G., Luo, Z., Anwar, M., Lu, Y., Wang, X., & Liu, X. (2020). Intellectual capital and the efficiency of SMEs in the transition economy China; Do financial resources strengthen the routes? *PLoS ONE*, *15*(7), 1–26. https://doi.org/10.1371/journal.pone.0235462

Li, W., Liu, K., Belitski, M., Ghobadian, A., & O'Regan, N. (2016). e-Leadership through strategic alignment: An empirical study of Small- and Medium-sized enterprises in the digital age. *Journal of Information Technology*, *31*(2), 185–206. https://doi.org/10.1057/jit.2016.10

Liu, Y., Soroka, A., Han, L., Jian, J., & Tang, M. (2020). Cloud-based big data analytics for customer insight-driven design innovation in SMEs. *International Journal of Information Management*, *51*(April 2019), 102034. https://doi.org/10.1016/j.ijinfomgt.2019.11.002

Lopez-Nicolas, C., & Soto-Acosta, P. (2010). Analyzing ICT adoption and use effects on knowledge creation: An empirical investigation in SMEs. *International Journal of*

*Information Management*, *30*(6), 521–528. https://doi.org/10.1016/j.ijinfomgt.2010.03.004

Loukis, E., Arvanitis, S., & Kyriakou, N. (2017). An empirical investigation of the effects of firm characteristics on the propensity to adopt cloud computing. *Information Systems and E-Business Management*, *15*(4), 963–988. https://doi.org/10.1007/s10257-017-0338-y

Lytras, M. D., Castillo-Merino, D., & Serradell-Lopez, E. (2010). New human resources practices, technology and their impact on SMEs' efficiency. *Information Systems Management*, *27*(3), 267–273. https://doi.org/10.1080/10580530.2010.493843

Lyver, M. J., & Lu, T. J. (2018). Sustaining innovation performance in SMEs: Exploring the roles of strategic entrepreneurship and IT capabilities. *Sustainability (Switzerland)*, *10*(2), 1–27. https://doi.org/10.3390/su10020442

Macpherson, A., Jones, O., & Zhang, M. (2005). Virtual reality and innovation networks: Opportunity exploitation in dynamic SMEs. *International Journal of Technology Management*, *30*(1–2), 49–66. https://doi.org/10.1504/IJTM.2005.006345

Madrid-Guijarro, A., Garcia, D., & Van Auken, H. (2009). Barriers to innovation among spanish Manufacturing SMEs. *Journal of Small Business Management*, *47*(4), 465–488. https://doi.org/10.1111/j.1540-627X.2009.00279.x

Maguire, S., Koh, S. C. L., & Magrys, A. (2007). The adoption of e-business and knowledge management in SMEs. *Benchmarking: An International Journal*, *14*(1), 37–58. https://doi.org/10.1108/14635770710730928

Maiti, M. (2018). Scope for alternative avenues to promote financial access to MSMEs in developing nation evidence from India. *International Journal of Law and Management*, *60*(5), 1210–1222. https://doi.org/10.1108/IJLMA-06-2017-0141

Marasini, R., Ions, K., & Ahmad, M. (2008). Assessment of e-business adoption in SMEs: A study of Manufacturing industry in the UK North East region. *Journal of Manufacturing Technology Management*, *19*(5), 627–644. https://doi.org/10.1108/17410380810877294

Martínez-Caro, E., & Cegarra-Navarro, J. G. (2010). The impact of e-business on capital productivity: An analysis of the UK telecommunications sector. *International Journal of Operations and Production Management*, *30*(5), 488–507. https://doi.org/10.1108/01443571011039597

Mastercard, & NITIAayog. (2021). *Connected Commerce: Creating a roadmap for a Digitally*

*inclusive Bharat* (Issue May). https://doi.org/10.1201/b19025-15

Matanda, M. J., & Freeman, S. (2009). Effect of perceived environmental uncertainty on exporter-importer inter-organisational relationships and export performance improvement. *International Business Review*, *18*(1), 89–107. https://doi.org/10.1016/j.ibusrev.2008.12.004

Mathur, A., Mittal, M. L., & Dangayach, G. S. (2012). The Management of Operations Improving productivity in Indian SMEs. *Production Planning & Control*, *23*(10–11), 754–768. https://doi.org/10.1080/09537287.2011.642150

Melville, N., Kraemer, K., & Gurbaxani, V. (2004). Information Technology and Organizational Performance: An Integrative Model of IT Business Value. *MIS Quarterly*, *28*(2), 283–322.

Ministry of MSME(GOI). (n.d.). *https://msme.gov.in/know-about-msme*. https://msme.gov.in/know-about-msme

Miroshnychenko, I., Barontini, R., & Testa, F. (2017). Green practices and financial performance: A global outlook. *Journal of Cleaner Production*, *147*, 340–351. https://doi.org/10.1016/j.jclepro.2017.01.058

Mittal, S., Khan, M. A., Purohit, J. K., Menon, K., Romero, D., & Wuest, T. (2020). A smart Manufacturing adoption framework for SMEs. *International Journal of Production Research*, *58*(5), 1555–1573. https://doi.org/10.1080/00207543.2019.1661540

Modjo, M. I., Loekman, S., & Limijaya, A. (2022). The ICT Paradox in Indonesia: ICT Investment and Firm Profitability. *Proceedings of 2022 International Conference on Information Management and Technology, ICIMTech 2022*, *August*, 111–115. https://doi.org/10.1109/ICIMTech55957.2022.9915152

Moeuf, A., Pellerin, R., Lamouri, S., Tamayo-Giraldo, S., Barbaray, R., Moeuf, A., Pellerin, R., Lamouri, S., Tamayo-, S., & Barbaray, R. (2018). The industrial management of SMEs in the era of Industry 4.0. *International Journal of Production Research*, *56*(3), 1118–1136. https://doi.org/10.1080/00207543.2017.1372647

Mohanty, E., & Mishra, A. J. (2020). Understanding the gendered nature of developing country MSMEs' access, adoption and use of information and communication technologies for development (ICT4D). In *International Journal of Gender and Entrepreneurship* (Vol. 12, Issue 3, pp. 273–295). https://doi.org/10.1108/IJGE-07-2019-0117

Mohd Salleh, N. A., Rohde, F., Green, P., Mohd, A., Rohde, F., Green, P., Mohd Salleh, N. A., Rohde, F., & Green, P. (2017). Information Systems Enacted Capabilities and Their Effects on SMEs' Information Systems Adoption Behavior. *Journal of Small Business Management*, *55*(3), 332–364. https://doi.org/10.1111/jsbm.12226

Molinillo, S., & Japutra, A. (2017). Organizational adoption of digital information and technology: a theoretical review. *The Bottom Line*, *30*(1), 33–46. https://doi.org/10.1108/BL-01-2017-0002

Montgomery, D. C. A. S. U. (2017). Design and Analysis of Experiments Ninth Edition. In *Willey*. www.wiley.com/go/permissions.%0Ahttps://lccn.loc.gov/2017002355

Mukhopadhyay, T., Kekre, S., & Kalathur, S. (1995). Business Value of Information Technology: A Study of Electronic Data Interchange. *MIS Quarterly*, *19*(2), 137–156. https://doi.org/10.2307/249685

Müller, J. M., Veile, J. W., & Voigt, K. I. (2020). Prerequisites and incentives for digital information sharing in Industry 4.0 – An international comparison across data types. *Computers and Industrial Engineering*, *148*, 106733. https://doi.org/10.1016/j.cie.2020.106733

Mushtaq, R., Gull, A. A., & Usman, M. (2022). ICT adoption, innovation, and SMEs' access to finance. *Telecommunications Policy*, *46*(3). https://doi.org/10.1016/j.telpol.2021.102275

MYERS, R. H., Montgomery, D. C., & ANDERSON-COOK, C. M. (2009). *Response surface methodology : process and product optimization using designed experiments*.

Naala, M. N. I., Nordin, N. B., & Omar, W. A. B. W. (2017). Innovation Capability and Firm Performance Relationship: a Study of Pls-Structural Equation Modeling (Pls-Sem). *International Journal of Organization & Business Excellence*, *2*(1), 39–50. http://ijobe.uum.edu.my/images/Full_Text/Vol.2_Issue.1_2017/Innovation-Capability-and-Firm-Performance-Relationship.pdf

Nagayya, D., & Tirumala Rao, P. (2013). Small and Medium enterprises in the era of globalisation. *Journal of Rural Development*, *32*(1), 1–17.

Nasiri, M., Saunila, M., Ukko, J., Rantala, T., & Rantanen, H. (2020). Shaping Digital Innovation Via Digital-related Capabilities. *Information Systems Frontiers*, *2019*. https://doi.org/10.1007/s10796-020-10089-2

Neirotti, P., Raguseo, E., & Paolucci, E. (2018). How SMEs develop ICT-based capabilities in response to their environment: past evidence and implications for the uptake of the new ICT paradigm. *Journal of Enterprise Information Management*, *31*(1), 10–37. https://doi.org/10.1108/JEIM-09-2016-0158

Ng, J. J. M., & Li, K. X. (2003). Implications of ICT for knowledge management in globalization. *Information Management and Computer Security*, *11*(4), 167–174. https://doi.org/10.1108/09685220310489535

Nguyen, T. H., Newby, M., & Macaulay, M. J. (2015). Information technology adoption in Small business: Confirmation of a proposed framework. *Journal of Small Business Management*, *53*(1), 207–227. https://doi.org/10.1111/jsbm.12058

NITI Aayong. (2020). *India Innovation Index*. https://niti.gov.in/sites/default/files/2021-01/IndiaInnovationReport2020Book.pdf

Nolan, T., Brizland, R., & MacAulay, L. (2007). Individual trust and development of online business communities. *Information Technology and People*, *20*(1), 53–71. https://doi.org/10.1108/09593840710730554

Nousala, S., Ifandoudas, P., Terziovski, M., & Chapman, R. (2008). Process improvement and ICTs in Australian SMEs: A selection and implementation framework. *Production Planning and Control*, *19*(8), 735–753. https://doi.org/10.1080/09537280802476169

Ntwoku, H., Negash, S., & Meso, P. (2017). ICT adoption in Cameroon SME: application of Bass diffusion model*. *Information Technology for Development*, *23*(2), 296–317. https://doi.org/10.1080/02681102.2017.1289884

OECD. (2008). Measuring the Impacts of ICT Using Official Statistics. *OECD Digital Economy Papers*, *136*, Paris: OECD Publishing. http://www.oecd.org/dataoecd/43/25/39869939.pdf%5Cnhttp://dx.doi.org/10.1787/10.1787/9789264113541-en

Oh, K. Y., Anderson, A. R., & Cruickshank, D. (2012). Perceived barriers towards the use of e-trade processes by Korean SMEs. *Business Process Management Journal*, *18*(1), 43–57. https://doi.org/10.1108/14637151211215000

Okundaye, K., Fan, S. K., & Dwyer, R. J. (2019). Impact of information and communication technology in Nigerian Small-to Medium-sized enterprises. *Journal of Economics, Finance and Administrative Science*, *24*(47), 29–46. https://doi.org/10.1108/JEFAS-08-

2018-0086

Oliveira, T., Thomas, M., & Espadanal, M. (2014). Assessing the determinants of cloud computing adoption: An analysis of the Manufacturing and services sectors. *Information and Management*, *51*(5), 497–510. https://doi.org/10.1016/j.im.2014.03.006

Oni, O., & Papazafeiropoulou, A. (2014). Diverse views on IT innovation diffusion among SMEs: Influencing factors of broadband adoption. *Information Systems Frontiers*, *16*(4), 729–747. https://doi.org/10.1007/s10796-012-9384-7

Onyinyi, B., & Kaberuka, W. (2019). ICT fusion on the relationship between resource transformation capabilities and quality management practices among SMEs in Uganda. *Cogent Business and Management*, *6*(1). https://doi.org/10.1080/23311975.2019.1586063

Osborn, E., & Simpson, A. (2017). On Small-scale IT users' system architectures and cyber security: A UK case study. *Computers and Security*, *70*, 27–50. https://doi.org/10.1016/j.cose.2017.05.001

Paul, J., & Criado, A. R. (2020). The art of writing literature review: What do we know and what do we need to know? *International Business Review*, *29*(4), 101717. https://doi.org/10.1016/j.ibusrev.2020.101717

Pavlou, P. A., & Fygenson, M. (2006). Understanding and Predicting Electronic Commerce adoption : An Extension of The Theory of Planned Behavior. *MIS Quarterly: Management Information Systems*, *30*(1), 115–143. https://doi.org/10.2307/25148720

Pickernell, D., Jones, P., Packham, G., Thomas, B., White, G., & Willis, R. (2013). E-commerce trading activity and the SME sector: An FSB perspective. *Journal of Small Business and Enterprise Development*, *20*(4), 866–888. https://doi.org/10.1108/JSBED-06-2012-0074

Pilat, D. (2005). The ICT Productivity Paradox. *OECD Economic Studies*, *2004*(1), 37–65. https://doi.org/10.1787/eco_studies-v2004-art3-en

Piplani, R., & Viswanathan, S. (2003). A model for evaluating supplier-owned inventory strategy. *International Journal of Production Economics*, *81–82*, 565–571. https://doi.org/10.1016/S0925-5273(02)00298-0

Pradhan, R. P., Arvin, M. B., Nair, M., & Bennett, S. E. (2020). Sustainable economic growth in the European Union: The role of ICT, venture capital, and innovation. *Review of*

*Financial Economics*, *38*(1), 34–62. https://doi.org/10.1002/rfe.1064

Prashar, A. (2018). Toward cycle time reduction in Manufacturing SMEs: Proposal and evaluation. *Quality Engineering*, *30*(3), 469–484. https://doi.org/10.1080/08982112.2018.1460669

Rai, A., Patnayakuni, R., & Seth, N. (2006). Firm Performance Impacts of Digitally Enabled Supply Chain Integration Capabilities V-llCLrLvrrl V RESEARCH NOTE Firm Performance Impacts of Digitally Enabled Supply Chain Integration Capabilities1. *MIS Quarterly*, *30*(2), 226–246.

Rantapuska, T., & Ihanainen, O. (2008). Knowledge use in ICT Investment decision making of SMEs. *Journal of Enterprise Information Management*, *21*(6), 585–596. https://doi.org/10.1108/17410390810911195

Rasel, F. (2016a). Combining Information Technology and Decentralized Workplace Organization: SMEs versus Larger Firms. *International Journal of the Economics of Business*, *23*(2), 199–241. https://doi.org/10.1080/13571516.2015.1106065

Rasel, F. (2016b). the empirical results show different productivity contributions from combining IT and decentralization for SMEs than for large firms. For SMEs, the combination of IT and decentralized workplace organization is not robustly related to higher productivity. *International Journal of the Economics of Business*, *23*(2), 199–241. https://doi.org/10.1080/13571516.2015.1106065

Rasiah, R., & Thangiah, G. (2017). Government policies, regional trading agreements and the economic performance of local electronics component producing SMEs in Malaysia. *Journal of Southeast Asian Economies*, *34*(2), 302–321. https://doi.org/10.1355/ae34-2d

Renkema, T. J. W., & Berghout, E. W. (1997). Methodologies for information systems Investment evaluation at the proposal stage: A comparative review. *Information and Software Technology*, *39*(1), 1–13. https://doi.org/10.1016/0950-5849(96)85006-3

Rufaro, E., & Dick, A. L. (2008). The use of ICTs in Namibia's SME sector to access business information services. *The Electronic Library*, *26*(2), 145–157. https://doi.org/10.1108/02640470810864055

Sabherwal, R., & Chan, Y. E. (2001). Alignment between Business and IS Strategies: A Study of Prospectors, Analyzers, and Defenders. *Information Systems Research*, *12*(1), 11–33. https://doi.org/10.1287/isre.12.1.11.9714

Sabi, H. M., Uzoka, F. M. E., Langmia, K., & Njeh, F. N. (2016). Conceptualizing a model for adoption of cloud computing in education. *International Journal of Information Management*, *36*(2), 183–191. https://doi.org/10.1016/j.ijinfomgt.2015.11.010

Saffu, K., Walker, J. H., & Hinson, R. (2008). Strategic value and electronic commerce adoption among Small and Medium-sized enterprises in a transitional economy. *Journal of Business and Industrial Marketing*, *23*(6), 395–404. https://doi.org/10.1108/08858620810894445

Santhosh, C. (2019). Impact of determinants on early internationalization: An exploratory study of Indian engineering SMEs. *Journal of Engineering, Design and Technology*, *17*(5), 1018–1034. https://doi.org/10.1108/JEDT-01-2019-0001

Saxena, S. (2017). Enhancing ICT infrastructure in public services: Factors influencing mobile Government (m-Government) adoption in India. *The Bottom Line*, *30*(4), 279–296. https://doi.org/10.1108/BL-08-2017-0017

Schubert, P., & Leimstoll, U. (2007). Importance and Use of Information Technology in Small and Medium-Sized Companies. *Electronic Markets*, *17*(1), 38–55. https://doi.org/10.1080/10196780601136799

Schweikl, S., & Obermaier, R. (2020). Lessons from three decades of IT productivity research : towards a better understanding of IT - induced productivity effects. *Management Review Quarterly*, *70*(4), 461–507. https://doi.org/10.1007/s11301-019-00173-6

Seth, D., & Gupta, V. (2005). Application of value stream mapping for lean operations and cycle time reduction: An Indian case study. *Production Planning and Control*, *16*(1), 44–59. https://doi.org/10.1080/09537280512331325281

Shaltoni, A. M., West, D., Alnawas, I., & Shatnawi, T. (2018). Electronic marketing orientation in the Small and Medium-sized Enterprises context. *European Business Review*, *30*(3), 272–284. https://doi.org/10.1108/EBR-02-2017-0034

Sharma, M. K., Bhagwat, R., & Dangayach, G. S. (2005). Practice of performance measurement: experience from Indian SMEs. *Int. J. Globalisation and Small Business*, *1*(2), 183–213. https://doi.org/10.1504/IJGSB.2005.008014

Sharma, N. (2017). Innovation for Survival: Entrepreneurial Response of Indian MSMEs to Demonetization. *SSRN Electronic Journal*, *XV*(4). https://doi.org/10.2139/ssrn.2971489

Sharma, R., Kamble, S. S., Gunasekaran, A., Kumar, V., & Kumar, A. (2020). A systematic

literature review on machine learning applications for sustainable agriculture supply chain performance. *Computers and Operations Research*, *119*, 104926. https://doi.org/10.1016/j.cor.2020.104926

Shi, M., & Yu, W. (2013). Supply chain management and financial performance: Literature review and future directions. In *International Journal of Operations and Production Management* (Vol. 33, Issue 10). https://doi.org/10.1108/IJOPM-03-2012-0112

Shirokova, G., Vega, G., & Sokolova, L. (2013). Performance of Russian SMEs: Exploration, exploitation and strategic entrepreneurship. *Critical Perspectives on International Business*, *9*(1), 173–203. https://doi.org/10.1108/17422041311299941

Shmueli, G., Sarstedt, M., Hair, J. F., Cheah, J. H., Ting, H., Vaithilingam, S., & Ringle, C. M. (2019). Predictive model assessment in PLS-SEM: guidelines for using PLSpredict. *European Journal of Marketing*, *53*(11), 2322–2347. https://doi.org/10.1108/EJM-02-2019-0189

Shrimali, A. K., Soni, V. K., Pawar, S. S., Kraja, Y., Osmani, D., Gupta, H., Barua, M. K., Mantok, S., Sekhon, H., Sahi, G. K., Jones, P., Verma, N., Sharma, V., Jaiswal, P., Kumar, A. A. A. A. A., Gupta, S. S. S., Russo, D., Bersano, G., Birolini, V., … DASCALU, L. (2019). Design and evaluation of a Lean Manufacturing framework using Value Stream Mapping (VSM) for a plastic bag Manufacturing unit. *Journal of Operations Management*, *8*(2), 1–11. https://doi.org/10.1080/23311916.2016.1155839

Singh, D., Khamba, J. S., & Nanda, T. (2018). Problems and prospects of Indian MSMEs: A literature review. *International Journal of Business Excellence*, *15*(2), 129–188. https://doi.org/10.1504/IJBEX.2018.091923

Singh, R. K. (2011). Developing the framework for coordination in supply chain of SMEs. *Business Process Management Journal*, *17*(4), 619–638. https://doi.org/10.1108/14637151111149456

Singh, S., Sharma, M., & Dhir, S. (2021). Modeling the effects of digital transformation in Indian Manufacturing industry. *Technology in Society*, *67*(August), 101763. https://doi.org/10.1016/j.techsoc.2021.101763

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, *104*(August), 333–339. https://doi.org/10.1016/j.jbusres.2019.07.039

Solaymani, S., Sohaili, K., & Yazdinejad, E. A. (2012). Adoption and use of e-commerce in SMEs: A case study. *Electronic Commerce Research*, *12*(3), 249–263. https://doi.org/10.1007/s10660-012-9096-6

Sony, M., & Naik, S. (2020). Critical factors for the successful implementation of Industry 4.0: a review and future research direction. *Production Planning and Control*, *31*(10), 799–815. https://doi.org/10.1080/09537287.2019.1691278

Soong, K. K., Ahmed, E. M., & Tan, K. S. (2020). Factors Affecting Malaysia's SMEs in Using Public Electronic Procurement. *Journal of Information and Knowledge Management*, *19*(2), 1–22. https://doi.org/10.1142/S0219649220500082

Spiezia, V. (2011). Are ICT Users More Innovative?: an Analysis of ICT-Enabled Innovation in OECD Firms. *OECD Journal: Economic Studies*, *2011*(1), 1–21. https://doi.org/10.1787/eco_studies-2011-5kg2d2hkn6vg

Spurge, V., & Roberts, C. (2005). Broadband technology: An appraisal of Government policy and use by Small- and Medium-sized enterprises. In *Journal of Property Investment and Finance* (Vol. 23, Issue 6, pp. 516–524). https://doi.org/10.1108/14635780510626556

Subrahmanya, M. H. B. (2014). External technology acquisition of SMEs in the engineering industry of Bangalore: What prompts them to move faster for acquisition? *Journal of Manufacturing Technology Management*, *25*(8), 1174–1194. https://doi.org/10.1108/JMTM-07-2012-0069

Sultan, N. A. (2011). Reaching for the "cloud": How SMEs can manage. *International Journal of Information Management*, *31*(3), 272–278. https://doi.org/10.1016/j.ijinfomgt.2010.08.001

Sunday, C. E., & Vera, C. C. E. (2018). Examining information and communication technology (ICT) adoption in SMEs: A dynamic capabilities approach. *Journal of Enterprise Information Management*, *31*(2), 338–356. https://doi.org/10.1108/JEIM-12-2014-0125

Svensson, G., Ferro, C., Høgevold, N., Padin, C., Carlos Sosa Varela, J., & Sarstedt, M. (2018). Framing the triple bottom line approach: Direct and mediation effects between economic, social and environmental elements. *Journal of Cleaner Production*, *197*, 972–991. https://doi.org/10.1016/j.jclepro.2018.06.226

Szczepanski, M., Malec, D., Maussion, P., & Manfe, P. (2020). Design of Experiments Predictive Models as a Tool for Lifespan Prediction and Comparison for Enameled Wires

Used in Low-Voltage Inverter-Fed Motors. *IEEE Transactions on Industry Applications*, *56*(3), 3100–3113. https://doi.org/10.1109/TIA.2020.2970855

Tan, K. S., Chong, S. C., Lin, B., & Eze, U. C. (2010). Internet-based ICT adoption among SMEs: Demographic versus benefits, barriers, and adoption intention. *Journal of Enterprise Information Management*, *23*(1), 27–55. https://doi.org/10.1108/17410391011008897

Thanki, S. J., & Thakkar, J. (2014). Status of lean Manufacturing practices in Indian industries and Government initiatives: A pilot study. *Journal of Manufacturing Technology Management*, *25*(5), 655–675. https://doi.org/10.1108/JMTM-05-2012-0057

Thomas, A., Barton, R., & Chuke-Okafor, C. (2009). Applying lean six sigma in a Small engineering company - A model for change. *Journal of Manufacturing Technology Management*, *20*(1), 113–129. https://doi.org/10.1108/17410380910925433

Torrent-Sellens, J., Ficapal-Cusí, P., Boada-Grau, J., & Vigil-Colet, A. (2016). Information and communication technology, co-innovation, and perceived productivity in tourism Small and Medium enterprises: an exploratory analysis. *Current Issues in Tourism*, *19*(13), 1295–1308. https://doi.org/10.1080/13683500.2015.1029878

UNCTAD. (2018). Harnessing Frontier Technologies for Sustainable Development. In *Technology*. https://unctad.org/en/PublicationsLibrary/tir2018_en.pdf

UNCTAD. (2019). *DIGITAL ECONOMY REPORT 2019 : Value creation and capture - implications for developing countries*.

United Nations. (2007). *Statistical Commission Background document Thirty-eighth session* (Vol. 3, Issue March).

Valaei, N., Rezaei, S., & Emami, M. (2017). Explorative learning strategy and its impact on creativity and innovation: An empirical investigation among ICT-SMEs. *Business Process Management Journal*, *23*(5), 957–983. https://doi.org/10.1108/BPMJ-12-2015-0179

Van Deursen, A., & Van Dijk, J. (2014). Loss of labor time due to malfunctioning ICTs and ICT skill insufficiencies. *International Journal of Manpower*, *35*(5), 703–719. https://doi.org/10.1108/IJM-07-2012-0102

Venkatesh, V., & Bala, H. (2012). Adoption and impacts of interorganizational business process standards: Role of partnering synergy. *Information Systems Research*, *23*(4),

1131–1157. https://doi.org/10.1287/isre.1110.0404

Venkatesh, V., Brown, S. A., Maruping, L. M., & Bala, H. (2008). Predicting different conceptualizations of system USE: The competing roles of behavioral intention, facilitating conditions, and behavioral expectation. *MIS Quarterly: Management Information Systems*, *32*(3), 483–502. https://doi.org/10.2307/25148853

Venkatesh, V., Davis, F. D., & College, S. M. W. (2000). Theoretical Acceptance Extension Model:Four Longitudinal Field Studies. *Management Science*, *46*(2), 186–204.

Venkatesh, V., Davis, F. D., & Morris, M. G. (2007). Dead or alive? The development, trajectory and future of technology adoption research. *Journal of the Association for Information Systems*, *8*(4), 267–286. https://doi.org/10.17705/1jais.00120

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). USER ACCEPTANCE OF INFORMATION TECHNOLOGY: TOWARD A UNIFIED VIEW. *MIS Quarterly*, *27*(3), 425–478. https://doi.org/10.2307/30036540

Venkatesh, V., Speier, C., & Morris, M. G. (2002). User acceptance enablers in individual decision making about technology: Towards an integrated model. *Decision Sciences*, *33*(2), 297–316. https://doi.org/10.1111/j.1540-5915.2002.tb01646.x

Venkatesh, V., Thong, J. Y. L. L., & Xu, X. (2012). Consumer Acceptance and Use of Information Technology. *MIS Quarterly*, *36*(1), 157–178. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2002388

Venkatesh, V., Thong, J. Y. L. L., & Xu, X. (2016). Unified theory of acceptance and use of technology: A synthesis and the road ahead. *Journal of the Association for Information Systems*, *17*(5), 328–376. https://doi.org/10.17705/1jais.00428

Venkatesh, V., & Zhang, X. (2010). Unified theory of acceptance and use of technology: U.S. vs. China. *Journal of Global Information Technology Management*, *13*(1), 5–27. https://doi.org/10.1080/1097198X.2010.10856507

Villa, E., Ruiz, L., Valencia, A., & Picón, E. (2018). Electronic commerce: factors involved in its adoption from a bibliometric analysis. *Journal of Theoretical and Applied Electronic Commerce Research*, *13*(1), 39–70. https://doi.org/10.4067/S0718-18762018000100104

Voghouei, H., Jamali, M. A., & Sharifi, H. (2021). Effect of Information and Communication Technology on Firms Performance in Iran. *Asian Journal of Information Technology*, *20*(4), 103–111. https://doi.org/10.1097/NXN.0b013e3182842103

Vu, K. M., & Asongu, S. (2020). Backwardness advantage and economic growth in the information age: A cross-country empirical study. *Technological Forecasting and Social Change*, *159*(July), 120197. https://doi.org/10.1016/j.techfore.2020.120197

Wakunuma, K., & Masika, R. (2017). Cloud computing, capabilities and intercultural ethics: Implications for Africa. *Telecommunications Policy*, *41*(7–8), 695–707. https://doi.org/10.1016/j.telpol.2017.07.006

Wang, J., Zhao, L., & Huchzermeier, A. (2021). Operations-Finance Interface in Risk Management: Research Evolution and Opportunities. *Production and Operations Management*, *30*(2), 355–389. https://doi.org/10.1111/poms.13269

Wang, X. V., & Wang, L. (2017). A cloud-based production system for information and service integration: an Internet of things case study on waste electronics. *Enterprise Information Systems*, *11*(7), 952–968. https://doi.org/10.1080/17517575.2016.1215539

Welker, G. A., van der Vaart, T., & Pieter van Donk, D. (2008). The influence of business conditions on supply chain information-sharing mechanisms: A study among supply chain links of SMEs. *International Journal of Production Economics*, *113*(2), 706–720. https://doi.org/10.1016/j.ijpe.2007.04.016

Whah, C. Y., & Lim, E. S. (2018). Policies and performance of SMEs in Malaysia. *Journal of Southeast Asian Economies*, *35*(3), 470–487. https://doi.org/10.1355/ae35-3i

Wided, R. (2023). IT Capabilities, Strategic Flexibility and Organizational Resilience in SMEs Post-COVID-19: A Mediating and Moderating Role of Big Data Analytics Capabilities. In *Global Journal of Flexible Systems Management* (Vol. 24, Issue 1, pp. 123–142). https://doi.org/10.1007/s40171-022-00327-8

Won, J. Y., & Park, M. J. (2020). Smart factory adoption in Small and Medium-sized enterprises: Empirical evidence of Manufacturing industry in Korea. *Technological Forecasting and Social Change*, *157*(July 2019), 120117. https://doi.org/10.1016/j.techfore.2020.120117

Wonglimpiyarat, J. (2016). Government policies towards Israel's high-tech powerhouse. *Technovation*, *52–53*, 18–27. https://doi.org/10.1016/j.technovation.2016.02.001

Worldbank. (n.d.). *https://data.worldbank.org/indicator/FR.INR.LEND?end=2021&locations=IN&start=2000*.

https://data.worldbank.org/indicator/FR.INR.LEND?end=2021&locations=IN&start=2000

Yan, M., Filieri, R., & Gorton, M. (2021). Continuance intention of online technologies: A systematic literature review. *International Journal of Information Management*, *58*(January), 102315. https://doi.org/10.1016/j.ijinfomgt.2021.102315

Yildirim, N., & Ansal, H. (2011). Foresighting FLOSS (free/libre/open source software) from a developing country perspective: The case of Turkey. *Technovation*, *31*(12), 666–678. https://doi.org/10.1016/j.technovation.2011.07.004

Yu, Y., Li, M., Li, X., Zhao, J. L., & Zhao, D. (2018). Effects of entrepreneurship and IT fashion on SMEs' transformation toward cloud service through mediation of trust. *Information and Management*, *55*(2), 245–257. https://doi.org/10.1016/j.im.2017.07.001

Zhang, L., Luo, Y., Tao, F., Li, B. H., Ren, L., Zhang, X., Guo, H., Cheng, Y., Hu, A., & Liu, Y. (2014). Cloud Manufacturing: a new Manufacturing paradigm. *Enterprise Information Systems*, *8*(2), 167–187. https://doi.org/10.1080/17517575.2012.683812

Zhu, K., Kraemer, K. L., Gurbaxani, V., Xu, S. X., Zhu, Kraemer, K. L., Gurbaxani, Xu, Zhu, K., Kraemer, K. L., Gurbaxani, V., & Xu, S. X. (2006). Migration to Open-Standard Interorganizational Systems: Network Effects, Switching Costs, and Path Dependency. *MIS Quarterly*, *30*(SPEC. ISS.), 515–539. https://doi.org/10.2307/25148771

Zhu, K., Kraemer, K., & Xu, S. (2003). Electronic business adoption by European firms: A cross-country assessment of the facilitators and inhibitors. *European Journal of Information Systems*, *12*(4), 251–268. https://doi.org/10.1057/palgrave.ejis.3000475

Zhu, M., Yeung, A. C. L., & Zhou, H. (2021). Diversify or concentrate: The impact of customer concentration on corporate social responsibility. *International Journal of Production Economics*, *240*(December 2020), 108214. https://doi.org/10.1016/j.ijpe.2021.108214

# LIST OF PUBLICATIONS

**Joshi A.K., Matai R., and Murthy N. N. (2023), "***Information and Communication Technology (ICT) in Small Medium Enterprises (SME) Manufacturing Sector: A systematic literature review and future agenda."* Under review in *Journal of Science and Technology Policy Management.*

**Joshi A.K., Matai R., and Murthy N. N. (2023),** *"Measuring the Impact of Information and Communication Technology on the Profitability of Micro, Small, and Medium Enterprises: A Design of Experiment approach" Revised paper submitted and u*nder review in *The Bottom Line.*

**Joshi A.K., Matai R., and Murthy N. N. (2023),** *"The Information and Communication Technology Investment and Indian MSME Manufacturing firm performance paradox-A PLS-SEM approach investigation",* under review in *Global Business Review.*

**Joshi A.K., Matai R., and Murthy N. N. (2023),** *"Impact of Information and Communication Technology (ICT), Gross Working Capital and Short-term Borrowing on Indian MSME Performance: A Design of Experiment (DoE) Approach"*, under review *in Information Technology for Development.*

**Papers presented at conferences.**

**Joshi A.K., Matai R., (2020),** *"Cloud computing adoption in Indian MSME Manufacturing sector: A Study and Future agenda"* in the International Conference on Evolution in Manufacturing, organised by MNIT In association with NIT Uttarakhand & NIT Warangal, Jaipur (December 10-12, 2020).

**Joshi A.K., Matai R., (2023),** *"A Literature review on Cloud computing adoption in the Indian SME Manufacturing sector and the Future agenda"* is accepted in the IEEE Conference in 3rd International Conference on Smart Generation Computing, Communication and Networking (SMARTGEN), Bengaluru, India (December 29-31, 2023).

# APPENDIX – A

**Sample Data for Chapter 4 analysis**

| Company Name | Investment in Plant and Machinery (in MN INR) | Industry type | ICT INVESTMENT (in MN INR) | ICT Level based on Investment | PBDITA (in MN INR) |
|---|---|---|---|---|---|
| Bohra Exports Pvt. Ltd. | 7.50 | Micro | **3.2** | **Level 2** | 67.90 |
| Gratex Industries Ltd. | 3.60 | Micro | **0.8** | **Level 1** | 2.60 |
| V S F Projects Ltd. | 1.00 | Micro | **0** | **Level 1** | 1.80 |
| Proma Industries Ltd. | 4.60 | Micro | **1.8** | **Level 2** | 57.80 |
| Solex Energy Ltd. | 3.70 | Micro | **3.9** | **Level 2** | 24.10 |
| Orosil Smiths India Ltd. | 1.80 | Micro | **0.6** | **Level 1** | -0.60 |
| Radhika Mahila Agro Farmers Producer Co. Ltd. | 8.00 | Micro | **0.3** | **Level 1** | 4.20 |
| Pulz Electronics Ltd. | 4.70 | Micro | **3.7** | **Level 2** | 18.10 |
| Peptech Biosciences Ltd. | 8.00 | Micro | **0.8** | **Level 1** | 105.50 |
| Pennwalt Pvt. Ltd. | 3.30 | Micro | **7.8** | **Level 3** | 224.30 |
| Ausom Enterprise Ltd. | 1.00 | Micro | **0.8** | **Level 1** | 294.70 |
| Bankim Plast Pvt. Ltd. | 9.70 | Micro | **1.6** | **Level 2** | 19.20 |
| F S N E-Commerce Ventures Ltd. | 2.00 | Micro | **194.6** | **Level 4** | 1346.20 |
| P M T Health Care Pvt. Ltd. | 5.10 | Micro | **0.1** | **Level 1** | 2.40 |
| Colinz Laboratories Ltd. | 1.10 | Micro | **1.8** | **Level 2** | 7.50 |
| Karamveer Electronics Ltd. | 2.20 | Micro | **0.9** | **Level 1** | 12.90 |
| Manisha Engineers Pvt. Ltd. | 1.40 | Micro | **1.9** | **Level 2** | 9.10 |
| Savoir Faire Mfg. Co. Pvt. Ltd. | 3.00 | Micro | **1.3** | **Level 2** | 27.30 |
| Jagsonpal Pharmaceuticals Ltd. | 8.30 | Micro | **97.1** | **Level 4** | 276.50 |
| Marigold Paints Pvt. Ltd. | 8.50 | Micro | **3.1** | **Level 2** | 10.30 |
| Poona Dal & Oil Inds. Ltd. | 8.70 | Micro | **1.5** | **Level 2** | 24.20 |
| Vivo Bio Tech Ltd. | 6.40 | Micro | **105.4** | **Level 4** | 162.80 |
| Izmo Ltd. | 0.20 | Micro | **34** | **Level 4** | 23.60 |
| Suviron Equipments Pvt. Ltd. | 5.70 | Micro | **1.1** | **Level 2** | 18.10 |
| R R Trends Pvt. Ltd. | 7.20 | Micro | **9.3** | **Level 3** | 31.40 |
| Crest Precision Screws Pvt. Ltd. | 7.80 | Micro | **1.6** | **Level 2** | 18.40 |
| Fenasia Ltd. | 1.10 | Micro | **2.5** | **Level 2** | 9.00 |

| Company Name | Investment in Plant and Machinery (in MN INR) | Industry type | ICT INVESTMENT (in MN INR) | ICT Level based on Investment | PBDITA (in MN INR) |
|---|---|---|---|---|---|
| Sharda Auto Inds. Ltd. | 80.50 | Small | **1.6** | **Level 2** | 11.70 |
| Rajesh Exports Ltd. | 15.50 | Small | **5.4** | **Level 3** | 1771.40 |
| Brijbasi Art Press Ltd. | 52.40 | Small | **6.6** | **Level 3** | 92.10 |
| S A L Automotive Ltd. | 91.10 | Small | **9.3** | **Level 3** | 7.40 |
| Accurate Gauging & Instruments Pvt. Ltd. | 21.80 | Small | **2.7** | **Level 2** | 67.70 |
| Elegant Floriculture & Agrotech (India) Ltd. | 10.90 | Small | **0.5** | **Level 1** | 7.50 |
| Badra Estates & Inds. Ltd. | 13.80 | Small | **0.8** | **Level 1** | 9.60 |
| Hi-Tech Polyplast Nagpur Pvt. Ltd. | 50.00 | Small | **1.7** | **Level 2** | 29.80 |
| Khedut Solvexp Pvt. Ltd. | 60.40 | Small | **0.7** | **Level 1** | 112.50 |
| Shriram Rubber Products Pvt. Ltd. | 15.80 | Small | **3.1** | **Level 2** | 18.40 |
| Pragati Graphics & Packaging Pvt. Ltd. | 97.00 | Small | **3.8** | **Level 2** | 16.60 |
| Rama Pashu Aahar Pvt. Ltd. | 12.60 | Small | **0.2** | **Level 1** | 13.30 |
| Fasttrack Packers Pvt. Ltd. | 79.70 | Small | **5** | **Level 2** | 45.40 |
| Vera Synthetic Ltd. | 18.00 | Small | **0.6** | **Level 1** | 33.90 |
| Permanent Magnets Ltd. | 54.80 | Small | **31.4** | **Level 4** | 311.30 |
| Tapi Fruit Processing Ltd. | 18.20 | Small | **0.5** | **Level 1** | 12.10 |
| Norben Tea & Exports Ltd. | 30.90 | Small | **0.4** | **Level 1** | 9.70 |
| Sambhaav Media Ltd. | 17.70 | Small | **29.7** | **Level 4** | 98.80 |
| Apollo Inffratech Pvt. Ltd. | 30.20 | Small | **11.5** | **Level 4** | 32.00 |
| Rivaa Exports Ltd. | 68.50 | Small | **1.3** | **Level 2** | 51.70 |
| Vanaz Engineers Ltd. | 76.80 | Small | **7.5** | **Level 3** | 325.10 |
| B E W Engineering Ltd. | 12.40 | Small | **6.9** | **Level 3** | 121.20 |
| K P L Oil Mills Pvt. Ltd. | 18.10 | Small | **1.7** | **Level 2** | 99.40 |
| Manchukonda Prakasham Inds. India Pvt. Ltd. | 51.40 | Small | **4.2** | **Level 2** | 108.00 |
| Indian Chillies Trdg. Co. Ltd. | 11.40 | Small | **2.1** | **Level 2** | 14.40 |
| D & H India Ltd. | 59.10 | Small | **7.8** | **Level 3** | 53.10 |
| Rajan Technocast Pvt. Ltd. | 84.50 | Small | **6.7** | **Level 3** | 81.60 |
| Rhydburg Pharmaceuticals Ltd. | 72.20 | Small | **2.8** | **Level 2** | 30.40 |

| Company Name | Investment in Plant and Machinery (in MN INR) | Industry type | ICT INVESTMENT (in MN INR) | ICT Level based on Investment | PBDITA (in MN INR) |
|---|---|---|---|---|---|
| Eureka Iron & Energy Pvt. Ltd. | 17.60 | Small | **0.5** | **Level 1** | -34.10 |
| Padmavati Decor Pvt. Ltd. | 10.40 | Small | **0.8** | **Level 1** | 31.50 |
| Savas Engineering Co. Pvt. Ltd. | 25.20 | Small | **9.8** | **Level 3** | 36.80 |
| L M Van Moppes Diamond Tools India Pvt. Ltd. | 81.70 | Small | **2.5** | **Level 2** | 52.70 |
| Vippy Spinpro Ltd. | 82.00 | Small | **2.9** | **Level 2** | 179.70 |
| Mulay Polymers Pvt. Ltd. | 40.80 | Small | **1.3** | **Level 2** | -2.50 |
| Building Envelope Systems India Ltd. | 25.80 | Small | **1.7** | **Level 2** | 23.60 |
| Shashi Cables Ltd. | 28.80 | Small | **0.1** | **Level 1** | 23.70 |
| Alliance Filaments Ltd. | 34.10 | Small | **0.1** | **Level 1** | 1.90 |
| Buchi Operations India Pvt. Ltd. | 24.00 | Small | **4.3** | **Level 2** | 104.90 |
| Chitrakoot Steel & Power Pvt. Ltd. | 16.40 | Small | **2.1** | **Level 2** | 41.30 |
| Alpa Laboratories Ltd. | 71.20 | Small | **15.1** | **Level 4** | 220.20 |
| S N Q S Internationals Pvt. Ltd. | 38.00 | Small | **3.6** | **Level 2** | 73.20 |
| Sasmos Het Technologies Ltd. | 97.80 | Small | **75.1** | **Level 4** | 236.80 |
| Hind Tools (India) Pvt. Ltd. | 12.60 | Small | **0.1** | **Level 1** | 3.40 |
| Unisur Lifecare Pvt. Ltd. | 13.80 | Small | **4.2** | **Level 2** | 18.70 |
| Madhumilan Industries Ltd. | 22.10 | Small | **0.5** | **Level 1** | 30.10 |
| Jai Jagadhambiga Textile Mills Pvt. Ltd. | 95.20 | Small | **0.2** | **Level 1** | 81.40 |
| Samarth Engineering Co. Pvt. Ltd. | 38.40 | Small | **1.5** | **Level 2** | 75.20 |
| Superfine Knitters Ltd. | 71.10 | Small | **0.8** | **Level 1** | 16.40 |
| Maxheal Pharmaceuticals (India) Ltd. | 47.00 | Small | **6.2** | **Level 3** | 68.80 |
| Hero Electric Vehicles Pvt. Ltd. | 30.70 | Small | **221.4** | **Level 4** | -139.10 |
| Shriram Polytech Ltd. | 77.20 | Small | **6.5** | **Level 3** | 87.10 |
| Premier Evolvics Pvt. Ltd. | 36.50 | Small | **9.4** | **Level 3** | 253.90 |
| Resins & Plastics Ltd. | 79.20 | Small | **26.2** | **Level 4** | 168.60 |
| Omfurn India Ltd. | 29.20 | Small | **4.1** | **Level 2** | 32.70 |

| Company Name | Investment in Plant and Machinery (in MN INR) | Industry type | ICT INVESTMENT (in MN INR) | ICT Level based on Investment | PBDITA (in MN INR) |
|---|---|---|---|---|---|
| Southfield Paints Ltd. | 17.70 | Small | **11.3** | **Level 4** | 62.50 |
| Dutron Plastics Pvt. Ltd. | 55.00 | Small | **1.6** | **Level 2** | 128.50 |
| Kamdhenu Cattle Feeds Pvt. Ltd. | 84.60 | Small | **31.8** | **Level 4** | 491.30 |
| Asiatic Electrical & Switchgear Pvt. Ltd. | 41.20 | Small | **8.6** | **Level 3** | 62.70 |
| Nabha Duplex Ltd. | 13.70 | Small | **0** | **Level 1** | 5.60 |
| Apex Bright Bars (C B E) Pvt. Ltd. | 24.20 | Small | **0.4** | **Level 1** | 6.30 |
| Inflame Appliances Ltd. | 50.70 | Small | **2.9** | **Level 2** | 19.00 |
| Siddhi Decor Pvt. Ltd. | 13.60 | Small | **0.3** | **Level 1** | 11.20 |
| Gourika India Ltd. | 29.00 | Small | **0.3** | **Level 1** | 9.20 |
| H N I Office India Ltd. | 153.30 | Medium | **34.2** | **Level 4** | 5.70 |
| I T W India Pvt. Ltd. | 493.80 | Medium | **89** | **Level 4** | 2887.20 |
| Vamshadhara Paper Mills Ltd. | 414.20 | Medium | **1.7** | **Level 2** | 155.30 |
| Speciality Sintered Products Pvt. Ltd. | 402.20 | Medium | **14.2** | **Level 4** | 218.10 |
| Sigachi Industries Ltd. | 311.60 | Medium | **29.3** | **Level 4** | 532.60 |
| Venlon Enterprises Ltd. | 252.40 | Medium | **3** | **Level 2** | 64.30 |
| Dollar Industries Ltd. | 482.20 | Medium | **77** | **Level 4** | 2256.90 |
| Behr-Hella Thermocontrol India Pvt. Ltd. | 182.70 | Medium | **64.4** | **Level 4** | 180.90 |
| Sri Venkatesh Iron & Alloys (India) Ltd. | 133.70 | Medium | **0.1** | **Level 1** | 256.60 |
| Maya Appliances Pvt. Ltd. | 135.90 | Medium | **31.6** | **Level 4** | 148.40 |
| Milk Mantra Dairy Pvt. Ltd. | 298.90 | Medium | **34.9** | **Level 4** | 209.30 |
| V T M Ltd. | 444.80 | Medium | **3.8** | **Level 2** | 284.40 |
| Mukka Proteins Ltd. | 240.00 | Medium | **12.5** | **Level 4** | 401.40 |
| Mauli Fresh Agro Inds. Pvt. Ltd. | 173.90 | Medium | **0.6** | **Level 1** | 29.50 |
| K C L Ltd. | 465.50 | Medium | **26** | **Level 4** | 339.50 |
| Rakon India Pvt. Ltd. | 114.80 | Medium | **22.8** | **Level 4** | 159.50 |
| Unitop Chemicals Pvt. Ltd. | 258.80 | Medium | **4.2** | **Level 2** | 920.00 |
| Shree Tirupati Balajee Agro Trading Co. Pvt. Ltd. | 176.30 | Medium | **4.4** | **Level 2** | 229.50 |
| Cheviot Co. Ltd. | 121.80 | Medium | **0.9** | **Level 1** | 1066.20 |
| Network Clothing Co. Pvt. Ltd. | 112.00 | Medium | **19.4** | **Level 4** | 116.70 |

| Company Name | Investment in Plant and Machinery (in MN INR) | Industry type | ICT INVESTMENT (in MN INR) | ICT Level based on Investment | PBDITA (in MN INR) |
|---|---|---|---|---|---|
| Simmonds Marshall Ltd. | 260.10 | Medium | **18.3** | **Level 4** | 119.10 |
| Micas Organics Ltd. | 269.00 | Medium | **29.6** | **Level 4** | 350.40 |
| Gromax Agri Equipment Ltd. | 124.90 | Medium | **43.7** | **Level 4** | 397.80 |
| Birla Precision Technologies Ltd. | 189.40 | Medium | **61.3** | **Level 4** | 365.90 |
| Metro Tyres Ltd. | 357.40 | Medium | **29.9** | **Level 4** | 393.40 |
| Tamboli Castings Ltd. | 124.20 | Medium | **14.5** | **Level 4** | 238.50 |
| Natural Capsules Ltd. | 489.00 | Medium | **18.5** | **Level 4** | 321.10 |
| Actionware India Pvt. Ltd. | 123.10 | Medium | **1.5** | **Level 2** | 82.60 |
| Best Koki Automotive Pvt. Ltd. | 328.60 | Medium | **31.6** | **Level 4** | 62.70 |
| K L Hi-Tech Secure Print Ltd. | 475.00 | Medium | **25.7** | **Level 4** | 120.40 |
| U P Twiga Fiberglass Ltd. | 136.40 | Medium | **20.9** | **Level 4** | 265.40 |
| Kirloskar Chillers Pvt. Ltd. | 125.80 | Medium | **39.8** | **Level 4** | 234.60 |
| Samvardhana Motherson Auto Component Pvt. Ltd. | 398.80 | Medium | **16.7** | **Level 4** | 4.10 |
| Alom Poly Extrusions Ltd. | 124.10 | Medium | **1.1** | **Level 2** | -17.20 |
| Madras Silks India Pvt. Ltd. | 198.00 | Medium | **14.8** | **Level 4** | 662.40 |
| Heavy Engineering Corpn. Pvt. Ltd. | 307.90 | Medium | **278.8** | **Level 4** | -1485.70 |
| Synokem Pharmaceuticals Ltd. | 194.40 | Medium | **55.2** | **Level 4** | 1135.50 |
| Kakatiya Cement Sugar & Inds. Ltd. | 319.00 | Medium | **2.8** | **Level 2** | 322.90 |
| Leakless Gasket India Pvt. Ltd. | 178.90 | Medium | **5.6** | **Level 3** | 125.30 |
| P B S Foods (Sugar) Pvt. Ltd. | 301.50 | Medium | **8.9** | **Level 3** | 190.60 |
| Avon Tubetech Pvt. Ltd. | 464.70 | Medium | **4.9** | **Level 2** | 185.40 |
| Rajdhani Flour Mills Ltd. | 119.20 | Medium | **3** | **Level 2** | 292.50 |
| Supreme Engineering Ltd. | 138.80 | Medium | **8** | **Level 3** | 19.50 |
| Polynova Industries Ltd. | 181.60 | Medium | **17.2** | **Level 4** | 207.00 |
| Shingora Textiles Ltd. | 165.30 | Medium | **49.8** | **Level 4** | 88.70 |
| Radiant Textiles Pvt. Ltd. | 135.20 | Medium | **0.5** | **Level 1** | 450.50 |

| Company Name | Investment in Plant and Machinery (in MN INR) | Industry type | ICT INVESTMENT (in MN INR) | ICT Level based on Investment | PBDITA (in MN INR) |
|---|---|---|---|---|---|
| Celebrity Biopharma Ltd. | 133.70 | Medium | **3.1** | **Level 2** | 32.80 |
| Noble Tech Inds. Pvt. Ltd. | 415.10 | Medium | **120.9** | **Level 4** | -475.50 |
| Murlidhar Ratanlal Exports Ltd. | 215.30 | Medium | **5.8** | **Level 3** | 260.10 |
| Shree Ganesh Remedies Ltd. | 130.20 | Medium | **5** | **Level 2** | 215.80 |
| Dekson Castings Ltd. | 131.60 | Medium | **4.4** | **Level 2** | 34.60 |
| Sharman Woollen Mills Pvt. Ltd. | 130.10 | Medium | **1.2** | **Level 2** | 35.30 |
| E C E Industries Ltd. | 164.70 | Medium | **29.7** | **Level 4** | 729.30 |

# APPENDIX – B

**Sample Data for Chapter 5 analysis**

| Company Name | Firm Type | ICT Investment (in MN INR) | Firm Age (in Year) | Firm Size (in MN INR) | Government aid (in MN INR) | Short-term borrowings (in MN INR) | Return on Assets (in %) |
|---|---|---|---|---|---|---|---|
| A V S L Industries Ltd. | Small | 0.4 | 19 | 800.9 | 3.9 | 186.6 | 0.078 |
| A V T Mccormick Ingredients Pvt. Ltd. | Medium | 2.3 | 29 | 4611.3 | 0 | 880.7 | 0.066 |
| A V Thomas Leather & Allied Products Pvt. Ltd. | Medium | 6.4 | 45 | 2997.2 | 0 | 75.6 | 0.116 |
| A-One Phthalo Colors Pvt. Ltd. | Medium | 0.2 | 9 | 1124.3 | 0 | 30.1 | 0.063 |
| Aamor Inox Ltd. | Medium | 3.5 | 18 | 2693.7 | 0 | 725.8 | 0.038 |
| Aaron Industries Ltd. | Small | 0.8 | 9 | 261.7 | 0 | 13.3 | 0.12 |
| Aartech Solonics Ltd. | Micro | 1.5 | 40 | 230.2 | 0.3 | 6.5 | 0.041 |
| Abhilasha Pharma Pvt. Ltd. | Small | 0.2 | 17 | 374.8 | 0 | 21.4 | 0.073 |
| Ace Multi Axes Systems Ltd. | Medium | 3.2 | 27 | 1312.8 | 10.6 | 282.6 | 0.145 |
| Acer Granito Pvt. Ltd. | Medium | 0.1 | 14 | 732.5 | 0 | 84.8 | 0.04 |
| Achiever Apparels Pvt. Ltd. | Small | 2.8 | 18 | 249.1 | 0 | 38 | 0.011 |
| Acknit Industries Ltd. | Medium | 3.3 | 32 | 1583.9 | 0 | 558.5 | 0.054 |
| Acoem Ecotech Inds. Pvt. Ltd. | Small | 4 | 9 | 747.7 | 0 | 277.8 | 0.007 |
| Adico Escorts Agri Equipments Pvt. Ltd. | Small | 0.4 | 11 | 341.3 | 0 | 10 | 0.016 |
| Adinath Agro Processed Foods Pvt. Ltd. | Medium | 0.7 | 27 | 706.1 | 0 | 64.9 | 0.031 |
| Aditi Toys Pvt. Ltd. | Small | 1.4 | 5 | 201 | 0 | 48.5 | 0.042 |
| Aditya Ispat Ltd. | Small | 0.3 | 32 | 422.6 | 0 | 164 | 0.007 |
| Aditya Spinners Ltd. | Medium | 0.1 | 31 | 525 | 0 | 47.2 | 0.061 |
| Advance Cropcare (India) Pvt. Ltd. | Micro | 0.3 | 15 | 597.8 | 0 | 163.2 | 0.008 |
| Advance Steel Tubes Ltd. | Small | 0.9 | 44 | 1038.6 | 0.3 | 47.5 | 0.045 |
| Advanced Appliances Pvt. Ltd. | Small | 0.7 | 26 | 590.3 | 0 | 57.2 | 0.003 |
| Advantek Air Systems Pvt. Ltd. | Micro | 0.5 | 9 | 123.7 | 0 | 11.5 | 0.035 |

| Company Name | Firm Type | ICT Investment (in MN INR) | Firm Age (in Year) | Firm Size (in MN INR) | Government aid (in MN INR) | Short-term borrowings (in MN INR) | Return on Assets (in %) |
|---|---|---|---|---|---|---|---|
| Advantek Fuel Systems Pvt. Ltd. | Micro | 159.5 | 17 | 1374.7 | 0 | 128.7 | 0.091 |
| Adwaith Textiles Pvt. Ltd. | Medium | 0.3 | 66 | 855.5 | 0 | 201.5 | 0.12 |
| Aeon Formulations Pvt. Ltd. | Small | 0.9 | 14 | 303.8 | 0 | 50.9 | 0.036 |
| Agya Auto Ltd. | Small | 0.6 | 37 | 900.1 | 4.7 | 71.5 | 0.051 |
| Ahimsa Industries Ltd. | Small | 0.4 | 26 | 242.5 | 0 | 25.9 | 0.013 |
| Aimco Pesticides Ltd. | Medium | 0.6 | 35 | 1897.7 | 0 | 0.3 | 0.06 |
| Akshar Spintex Ltd. | Medium | 0.5 | 9 | 1076.8 | 33.2 | 75.5 | 0.073 |
| Alkali Metals Ltd. | Medium | 1 | 54 | 838.5 | 1 | 142.7 | 0.035 |
| Allena Auto Inds. Pvt. Ltd. | Medium | 6.6 | 46 | 1577.2 | 0 | 242.6 | 0.018 |
| Allied Recycling Ltd. | Medium | 0.4 | 19 | 2220.1 | 0 | 135 | 0.055 |
| Almaha Foods Intl. Pvt. Ltd. | Micro | 2.2 | 24 | 2142 | 0 | 951.8 | 0.023 |
| Anand Engineers Pvt. Ltd. | Small | 3.4 | 49 | 630.6 | 0 | 44 | 0.183 |
| Anand I-Power Ltd. | Medium | 2.3 | 60 | 949.9 | 0 | 137.4 | 0.001 |
| Ananda Vikatan Publishers Pvt. Ltd. | Micro | 4.6 | 10 | 344.3 | 0 | 111.7 | 0.092 |
| Anaparai Estates Ltd. | Small | 0.6 | 79 | 243 | 0 | 54.5 | 0.146 |
| Ancalima Lifesciences Ltd. | Small | 1 | 34 | 213.4 | 0 | 45.7 | 0.015 |
| Anest Iwata Motherson Pvt. Ltd. | Small | 7.2 | 22 | 1019.7 | 0 | 2.6 | 0.199 |
| Angi Plast Pvt. Ltd. | Small | 1.7 | 28 | 376 | 0 | 21.1 | 0.043 |
| Anjani Synthetics Ltd. | Medium | 1.3 | 38 | 2530.6 | 20.7 | 490.1 | 0.019 |
| Anjani Tiles Ltd. | Medium | 0.5 | 7 | 1097.5 | 0 | 99.7 | 0.036 |
| Ankit India Ltd. | Medium | 0.5 | 41 | 2127 | 0.5 | 59.8 | 0.081 |
| Ankur Chemfood Ltd. | Small | 1.5 | 29 | 1784.1 | 0 | 334.7 | 0.003 |
| Aquarelle India Pvt. Ltd. | Medium | 17 | 15 | 3166.7 | 179.7 | 774.9 | 0.067 |
| Aquarius Engineers Pvt. Ltd. | Micro | 1.2 | 25 | 737 | 0 | 119.5 | 0.014 |
| Archidply Decor Ltd. | Small | 0.8 | 5 | 582.1 | 0 | 167.6 | 0.003 |
| Archidply Industries Ltd. | Medium | 4.3 | 27 | 2334.2 | 0 | 530.6 | 0.042 |
| Asoj Soft Caps Pvt. Ltd. | Small | 0.9 | 41 | 358.4 | 0 | 20.8 | 0.034 |
| Aspee Springs Ltd. | Medium | 1.1 | 41 | 781.1 | 0 | 91.3 | 0.044 |

| Company Name | Firm Type | ICT Investment (in MN INR) | Firm Age (in Year) | Firm Size (in MN INR) | Government aid (in MN INR) | Short-term borrowings (in MN INR) | Return on Assets (in %) |
|---|---|---|---|---|---|---|---|
| Assam Carbon Products Ltd. | Medium | 0.9 | 59 | 517.9 | 0 | 20.5 | 0.115 |
| Associated Ceramics Ltd. | Small | 0.1 | 52 | 340.1 | 0 | 31.6 | 0.12 |
| Asta India Pvt. Ltd. | Medium | 4.7 | 17 | 1965.1 | 0 | 900.3 | 0.012 |
| Astra Specialty Compounds India Pvt. Ltd. | Medium | 0.8 | 10 | 1190.2 | 0 | 665.2 | 0.007 |
| Austin Plywood Pvt. Ltd. | Small | 1.9 | 40 | 1363 | 0 | 131.6 | 0.049 |
| Auto Pins (India) Ltd. | Small | 0.7 | 47 | 228.6 | 0 | 18.7 | 0.043 |
| Auto Profiles Ltd. | Medium | 2.5 | 33 | 2151.4 | 0 | 211.6 | 0.032 |
| Autocomp Corporation Panse Pvt. Ltd. | Medium | 4.9 | 16 | 4397 | 0 | 523.3 | 0.054 |
| Autometers Energitec Ltd. | Micro | 0.2 | 17 | 457.9 | 0 | 10.6 | 0.097 |
| Automobile Corpn. Of Goa Ltd. | Medium | 3.7 | 42 | 2592.9 | 0 | 423.6 | 0.012 |
| Automotive Components Technology India Pvt. Ltd. | Medium | 0.6 | 11 | 882.9 | 0 | 249 | 0.101 |
| Autoneum Nittoku Soundproof Products India Pvt. Ltd. | Small | 7.3 | 14 | 543.7 | 0 | 87.5 | 0.03 |
| Avalon Technologies Ltd. | Medium | 8.3 | 23 | 4094.9 | 0 | 1154.1 | 0.061 |
| Avani Seeds Ltd. | Micro | 0.5 | 29 | 659.5 | 0 | 64.8 | 0.157 |
| Avani Textiles Ltd. | Medium | 2.5 | 16 | 2711 | 0 | 367.2 | 0.137 |
| Avantel Ltd. | Small | 9.6 | 32 | 883 | 0 | 128.7 | 0.173 |
| Avichal Buildcon Pvt. Ltd. | Small | 1.2 | 16 | 740.3 | 1.9 | 51.7 | 0.009 |
| Angi Plast Pvt. Ltd. | Small | 8.1 | 30 | 992.4 | 0 | 12.7 | 0.125 |
| B & A Ltd. | Medium | 1.5 | 107 | 1343.3 | 0.1 | 60.9 | 0.149 |
| B & A Packaging India Ltd. | Medium | 0.9 | 36 | 872.7 | 0 | 81.8 | 0.105 |
| B D H Industries Ltd. | Small | 0.7 | 32 | 658.3 | 0 | 22.5 | 0.105 |
| B S L Castings Pvt. Ltd. | Medium | 0.9 | 18 | 2381.6 | 0 | 204.3 | 0.138 |
| B S L Ltd. | Medium | 2 | 52 | 3541.8 | 3.8 | 1278.6 | 0.032 |
| Baba Global Ltd. | Micro | 0.4 | 24 | 1187.6 | 0 | 734.4 | 0.057 |
| Baerlocher India Additives Pvt. Ltd. | Medium | 28.4 | 25 | 4049.6 | 10.9 | 250.9 | 0.056 |

| Company Name | Firm Type | ICT Investment (in MN INR) | Firm Age (in Year) | Firm Size (in MN INR) | Government aid (in MN INR) | Short-term borrowings (in MN INR) | Return on Assets (in %) |
|---|---|---|---|---|---|---|---|
| Bafna Pharmaceuticals Ltd. | Medium | 10.7 | 27 | 749.5 | 0 | 11.5 | 0.057 |
| Bajaj Kagaj Ltd. | Small | 0.4 | 17 | 453.4 | 0 | 44.1 | 0.023 |
| Bajaj Steels & Inds. Ltd. | Micro | 0.1 | 50 | 384 | 0 | 60 | 0.023 |
| Bajaj Superpack India Ltd. | Small | 0.2 | 15 | 353.4 | 0 | 77.9 | 0.077 |
| Bal Pharma Ltd. | Medium | 3.2 | 35 | 2515.3 | 0 | 662.7 | 0.03 |
| Balaji Agro Oils Ltd. | Small | 0.5 | 28 | 806.7 | 0 | 192.2 | 0.027 |
| Balark Metals Pvt. Ltd. | Small | 0.3 | 27 | 411.1 | 14.8 | 7.5 | 0.211 |
| Baliapatam Tiles & Business Ventures Ltd. | Micro | 0.4 | 75 | 109.1 | 0 | 2.1 | 0.049 |
| Bateli Tea Co. Ltd. | Small | 0.5 | 103 | 1178.5 | 0.7 | 260.2 | 0.043 |
| Beardsell Ltd. | Medium | 2.8 | 86 | 1352.5 | 0 | 134.1 | 0.023 |
| Behr-Hella Thermocontrol India Pvt. Ltd. | Medium | 10.5 | 16 | 1114.1 | 10.4 | 246.8 | 0.044 |
| Bella Casa Fashion & Retail Ltd. | Small | 7.1 | 26 | 1584.6 | 0.1 | 479 | 0.067 |
| Argus Cosmetics Ltd. | Micro | 5.8 | 26 | 2367.6 | 17.5 | 2.8 | 0.083 |
| Bharat Rubber Works Pvt. Ltd. | Medium | 2.7 | 15 | 515.4 | 1.2 | 195.6 | 0.029 |
| Bharat Textiles & Proofing Inds. Ltd. | Small | 0.3 | 32 | 134.8 | 0 | 49.5 | 0.007 |
| Asiatic Electrical & Switchgear Pvt. Ltd. | Small | 0.6 | 34 | 478.6 | 0 | 103.6 | 0.024 |
| Bijur Delimon India Pvt. Ltd. | Micro | 1 | 30 | 187.6 | 0 | 90.3 | 0.057 |
| Bimetal Bearings Ltd. | Medium | 3.1 | 61 | 2126.7 | 0 | 52.8 | 0.015 |
| Binayak Tex Processors Ltd. | Medium | 1 | 39 | 1925.9 | 0 | 392.9 | 0.027 |
| Bindlas Duplux Ltd. | Medium | 1.1 | 33 | 2232.4 | 0 | 329.2 | 0.013 |
| Biop Steels & Power Pvt. Ltd. | Medium | 0.3 | 12 | 1108.8 | 0 | 227 | 0.062 |
| Biotech International Ltd. | Micro | 0.5 | 29 | 319.8 | 0 | 114.7 | 0.088 |
| Birbal International Pvt. Ltd. | Small | 1.3 | 17 | 237.4 | 0 | 64.7 | 0.008 |
| Bird Machines Pvt. Ltd. | Small | 0.3 | 14 | 518.1 | 0 | 114 | 0.009 |
| Birla Precision Technologies Ltd. | Medium | 4.4 | 36 | 2029.6 | 0 | 233.7 | 0.052 |

| Company Name | Firm Type | ICT Investment (in MN INR) | Firm Age (in Year) | Firm Size (in MN INR) | Government aid (in MN INR) | Short-term borrowings (in MN INR) | Return on Assets (in %) |
|---|---|---|---|---|---|---|---|
| Air Control & Chemical Engg. Co. Ltd. | Small | 0.5 | 19 | 1905.3 | 0 | 253.6 | 0.048 |
| C J Gelatine Products Ltd. | Small | 0.2 | 42 | 342.3 | 0 | 83.1 | 0.01 |
| C Krishniah Chetty Jewellers Pvt. Ltd. | Micro | 1.9 | 31 | 868.7 | 0 | 315.2 | 0.025 |
| C M C Textiles Pvt. Ltd. | Medium | 2 | 20 | 1240.9 | 0 | 210 | 0.058 |
| C R I Ltd. | Medium | 1.7 | 48 | 1555.5 | 0 | 619.8 | 0.068 |
| Cantabil Retail India Ltd. | Medium | 11.6 | 33 | 4010.4 | 0.4 | 335.8 | 0.075 |
| Capital Ispat Ltd. | Small | 0.2 | 25 | 610.2 | 0 | 65 | 0.047 |
| Capital Power Systems Ltd. | Small | 3.6 | 34 | 1240.9 | 0 | 375.1 | 0.028 |
| B C H Electric Ltd. | Medium | 0.2 | 14 | 188.8 | 0 | 68.1 | 0.008 |
| Celebrity Fashions Ltd. | Small | 7.3 | 34 | 2155.9 | 0 | 496.4 | 0.049 |
| Cellcomm Solutions Ltd. | Small | 2.6 | 28 | 608.9 | 0 | 0.1 | 0.046 |
| Cenlub Industries Ltd. | Small | 0.8 | 30 | 511.4 | 0 | 50.7 | 0.118 |
| Centenial Surgical Suture Ltd. | Small | 2.1 | 27 | 563.2 | 0 | 99.8 | 0.01 |
| Centum Electronics Ltd. | Medium | 3.3 | 29 | 5034.2 | 10.5 | 989 | 0.021 |
| Centurywells Roofing India Pvt. Ltd. | Small | 0.5 | 20 | 1305.2 | 0 | 172.3 | 0.028 |
| Centwin Textile Mills Pvt. Ltd. | Medium | 0.2 | 34 | 492.8 | 0 | 79.4 | 0.043 |
| Chengmari Tea Co. Ltd. | Medium | 0.1 | 47 | 663.5 | 2.5 | 230.6 | 0.082 |
| Cheran Spinner Pvt. Ltd. | Medium | 0.8 | 33 | 1331.6 | 2.7 | 237.2 | 0.032 |
| Chimique (India) Ltd. | Medium | 0.6 | 9 | 3844.2 | 57.7 | 340.4 | 0.088 |
| Clad Metal India Pvt. Ltd. | Medium | 5.6 | 18 | 1898.1 | 13.3 | 33.8 | 0.072 |
| Classic Electrodes (India) Ltd. | Small | 0.2 | 25 | 840.9 | 0 | 208.8 | 0.016 |
| Clear Polyplast India Pvt. Ltd. | Small | 1.9 | 36 | 722.7 | 0 | 144.2 | 0.053 |
| Clearsynth Labs Ltd. | Small | 10.8 | 12 | 593.6 | 0 | 13.7 | 0.044 |
| Coastal Agro Industries Pvt. Ltd. | Medium | 0.4 | 41 | 576.7 | 0 | 13.6 | 0.041 |

| Company Name | Firm Type | ICT Investment (in MN INR) | Firm Age (in Year) | Firm Size (in MN INR) | Government aid (in MN INR) | Short-term borrowings (in MN INR) | Return on Assets (in %) |
|---|---|---|---|---|---|---|---|
| Coastal Corporation Ltd. | Medium | 0.7 | 41 | 4133.2 | 6.3 | 1412.9 | 0.036 |
| Colinz Laboratories Ltd. | Micro | 0.3 | 36 | 83.5 | 0 | 5.4 | 0.034 |
| Comet Technocom Pvt. Ltd. | Micro | 0.2 | 30 | 251.8 | 0 | 87.2 | 0.024 |
| Continental Petroleums Ltd. | Small | 0.6 | 36 | 620.5 | 0 | 90.3 | 0.106 |
| Control Print Ltd. | Medium | 5.3 | 31 | 2589 | 1.1 | 11.4 | 0.125 |
| Bajaj Kagaj Ltd. | Small | 0.5 | 7 | 437.1 | 0 | 54 | 0.047 |
| Copmed Pharmaceuticals Pvt. Ltd. | Medium | 5.1 | 34 | 2624.9 | 0 | 5.2 | 0.106 |
| Coral Laboratories Ltd. | Medium | 6 | 25 | 1266.5 | 0 | 60.4 | 0.048 |
| Coral Telecom Ltd. | Small | 1.2 | 26 | 279 | 4 | 55.4 | 0.147 |
| Cords Cable Inds. Ltd. | Medium | 5.9 | 31 | 3862.1 | 0 | 679.8 | 0.02 |
| Core Carbons Pvt. Ltd. | Medium | 2 | 24 | 2346.9 | 0 | 301 | 0.062 |
| Coromandel Agro Products & Oils Ltd. | Small | 0.6 | 47 | 893.9 | 0 | 53.3 | 0.153 |
| D & H India Ltd. | Small | 1.3 | 37 | 770 | 0.4 | 136.5 | 0.037 |
| Concord United Products Pvt. Ltd. | Small | 0.7 | 31 | 1087 | 0 | 2.8 | 0.203 |
| D K Enterprises Global Ltd. | Small | 0.4 | 3 | 374.5 | 0 | 37.3 | 0.102 |
| Anest Iwata Motherson Pvt. Ltd. | Small | 2.6 | 29 | 229.9 | 0 | 0.2 | 0.037 |
| D P Wires Ltd. | Medium | 1.3 | 24 | 3078.2 | 0 | 106.8 | 0.148 |
| D S Connectors & Cables India Pvt. Ltd. | Small | 1.6 | 12 | 1176.6 | 0 | 268.8 | 0.046 |
| Dali & Samir Engg. Pvt. Ltd. | Small | 1.7 | 43 | 1055.3 | 0 | 189.4 | 0.061 |
| Dalmia Laminators Ltd. | Medium | 1 | 36 | 3395.1 | 1.8 | 1052.4 | 0.016 |
| Danish Pvt. Ltd. | Small | 0.2 | 37 | 1053.6 | 0 | 124.2 | 0.048 |
| Dantal Hydraulics Pvt. Ltd. | Medium | 4.1 | 32 | 2841.6 | 0 | 238.1 | 0.165 |
| Darling Pumps Pvt. Ltd. | Small | 1.7 | 40 | 302.8 | 0 | 5.8 | 0.177 |
| Data Patterns (India) Ltd. | Medium | 50.2 | 24 | 3402.8 | 0 | 69.4 | 0.132 |
| Davinder Sandhu Impex Pvt. Ltd. | Medium | 0.8 | 25 | 1391.2 | 0 | 296.6 | 0.038 |

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|---|---|---|---|---|---|---|---|
| Deccan Alloys Pvt. Ltd. | Micro | 0.1 | 42 | 255 | 0 | 1.9 | 0.019 |
| Avro India Ltd. | Small | 0.8 | 31 | 123.4 | 0 | 69.4 | 0.001 |
| Chemcrux Enterprises Ltd. | Medium | 3.3 | 53 | 1006.9 | 0 | 50 | 0.063 |
| Deco-Mica Ltd. | Small | 2.1 | 34 | 569 | 0 | 189.3 | 0.032 |
| Decor Paper Mills Ltd. | Medium | 0.3 | 30 | 906.8 | 0 | 201.4 | 0.063 |
| Dee Tee Industries Pvt. Ltd. | Medium | 1.6 | 48 | 728.5 | 0 | 216.4 | 0.048 |
| Broadway Overseas Ltd. | Small | 0.5 | 18 | 133.7 | 0.1 | 10.9 | 0.037 |
| Deepak International Ltd. | Small | 2.4 | 46 | 1599.6 | 0 | 28.4 | 0.037 |
| Deepkiran Foods Pvt. Ltd. | Medium | 7.3 | 24 | 2298.8 | 0 | 144.2 | 0.067 |
| Deevyashakti India Pvt. Ltd. | Medium | 1 | 18 | 2714.5 | 0 | 31.2 | 0.145 |
| Delhi Press Patra Prakashan Pvt. Ltd. | Small | 4.1 | 43 | 328.7 | 0 | 126.2 | 0.021 |
| Delta Finochem Pvt. Ltd. | Medium | 1.8 | 22 | 2170.1 | 0 | 143.9 | 0.134 |
| Delta Manufacturing Ltd. | Medium | 0.6 | 40 | 1059.3 | 0.8 | 397.9 | 0.202 |
| A G Universal Ltd. | Micro | 0.9 | 17 | 1197.2 | 0 | 34.1 | 0.017 |
| Delton Cables Ltd. | Small | 3 | 58 | 1434 | 0 | 574.4 | 0.005 |
| Delux Bearings Pvt. Ltd. | Medium | 9.6 | 22 | 1335.1 | 0 | 137.1 | 0.082 |
| Deora Wires N Machines Pvt. Ltd. | Small | 0.1 | 30 | 369.8 | 0 | 9.9 | 0.133 |
| Deoria Paper Mills Ltd. | Medium | 0.1 | 30 | 469.9 | 0 | 19.6 | 0.08 |
| Derewala Industries Ltd. | Medium | 2.7 | 15 | 3071.6 | 0 | 1322.1 | 0.039 |
| Desh Rakshak Aushdhalaya Ltd. | Small | 0.1 | 41 | 101.7 | 0 | 0.2 | 0.03 |
| Dev Priya Papers Pvt. Ltd. | Medium | 1 | 35 | 1914 | 0 | 57.5 | 0.017 |
| Devkripa Yarns Pvt. Ltd. | Small | 0.4 | 31 | 325.8 | 0 | 76.5 | 0.042 |
| Dhabriya Polywood Ltd. | Medium | 1.7 | 30 | 787.9 | 0 | 215.7 | 0.01 |
| Dhanlaxmi Fabrics Ltd. | Small | 0.6 | 30 | 692.3 | 7 | 125.5 | 0.007 |
| Dharmaj Crop Guard Ltd. | Medium | 3.6 | 7 | 2235.9 | 0 | 72.6 | 0.131 |

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|---|---|---|---|---|---|---|---|
| Anand Electronics & Inds. Pvt. Ltd. | Small | 1.1 | 44 | 1237.7 | 0 | 13.6 | 0.114 |
| Auto Pins (India) Ltd. | Small | 0.4 | 18 | 912.8 | 0 | 48 | 0.037 |
| Diach Chemicals & Pigments Pvt. Ltd. | Small | 0.7 | 18 | 2152.2 | 0 | 295.7 | 0.05 |
| Diffusion Engineers Ltd. | Medium | 1.9 | 22 | 1680.7 | 0 | 213.1 | 0.082 |
| Allied Recycling Ltd. | Medium | 0.4 | 27 | 687.5 | 0 | 127 | 0.024 |
| Dimo Castings Pvt. Ltd. | Medium | 0.2 | 38 | 676.1 | 0 | 81.6 | 0.025 |
| Dirk India Pvt. Ltd. | Small | 0.6 | 22 | 206.3 | 0 | 203 | 0.261 |
| Autoneum Nittoku Soundproof Products India Pvt. Ltd. | Small | 62.3 | 38 | 2989.5 | 0 | 8.5 | 0.086 |
| Discreet Solutions Pvt. Ltd. | Micro | 0.6 | 18 | 123.4 | 0 | 38.4 | 0.169 |
| Aartech Solonics Ltd. | Micro | 0.1 | 11 | 299.5 | 0 | 36.9 | 0.022 |
| Divine Tubes Pvt. Ltd. | Small | 0.4 | 18 | 889.1 | 0 | 271.7 | 0.022 |
| Divy Rollform Ltd. | Small | 0.1 | 24 | 174 | 0 | 32.3 | 0 |
| Donear Industries Ltd. | Medium | 25.6 | 35 | 5178.5 | 0 | 2887.6 | 0.036 |
| Dormakaba India Pvt. Ltd. | Small | 6 | 25 | 4913.5 | 0 | 9.3 | 0.058 |
| Dorset Industries Pvt. Ltd. | Medium | 7.1 | 5 | 1961.5 | 0 | 643.8 | 0.062 |
| Dempo Dairy Inds. Ltd. | Small | 0.5 | 20 | 309.6 | 0 | 26.7 | 0.019 |
| Drools Pet Food Pvt. Ltd. | Medium | 10.3 | 4 | 1884.9 | 0 | 186.4 | 0.197 |
| Dwarka Gems Ltd. | Micro | 1.3 | 30 | 232 | 0.2 | 92.2 | 0.03 |
| Dwarkadhish Sakhar Karkhana Ltd. | Medium | 1.1 | 23 | 2622.2 | 0 | 715.4 | 0.027 |
| Dekson Castings Ltd. | Medium | 0.9 | 9 | 307.4 | 0 | 70.4 | 0.005 |
| Dynamic Cables Ltd. | Medium | 4 | 15 | 3840.9 | 0.8 | 447.9 | 0.087 |
| Dynamic Industries Ltd. | Small | 0.7 | 33 | 550.3 | 0 | 30.4 | 0.021 |
| E C P Industries Ltd. | Small | 0.5 | 39 | 305.2 | 0 | 72.5 | 0.009 |
| E F D Induction Pvt. Ltd. | Small | 6.3 | 31 | 1320 | 0 | 134 | 0.047 |
| E K K Eagle Products India Pvt. Ltd. | Small | 0.7 | 14 | 0 | 0 | 17.4 | 0.048 |

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|---|---|---|---|---|---|---|---|
| E P Biocomposites Ltd. | Micro | 0.2 | 2 | 40.7 | 0 | 18.7 | 0.087 |
| E R Automotives Ltd. | Medium | 0.8 | 17 | 352.5 | 0 | 29 | 0.016 |
| Eagleburgmann India Pvt. Ltd. | Medium | 11 | 49 | 5818.4 | 0 | 63.6 | 0.149 |
| Earthstahl & Alloys Ltd. | Medium | 0.1 | 13 | 327.7 | 0 | 31.8 | 0.206 |
| Electro Crimp Contacts (I) Pvt. Ltd. | Small | 0.8 | 25 | 218.6 | 0.6 | 43.4 | 0.057 |
| Electronica Plastic Machines Ltd. | Medium | 4.2 | 15 | 1365.8 | 0 | 11.9 | 0.092 |
| Bharat Glass Tube Ltd. | Small | 1.2 | 27 | 1381.3 | 20 | 102.4 | 0.046 |
| Elektromag-Joest Vibration Pvt. Ltd. | Small | 1.1 | 13 | 459.6 | 0 | 44.7 | 0.106 |
| Elin Appliances Pvt. Ltd. | Medium | 2.5 | 20 | 1617.5 | 0 | 154.8 | 0.065 |
| Elkayem Auto Ancillaries Pvt. Ltd. | Small | 1.4 | 34 | 1364.4 | 0 | 326.8 | 0.029 |
| Calcom Vision Ltd. | Medium | 5.7 | 35 | 3804.7 | 0 | 100 | 0.191 |
| Elkos Pens Ltd. | Medium | 2.3 | 19 | 948.4 | 0 | 40.1 | 0.076 |
| Elofic Industries Ltd. | Medium | 3.7 | 49 | 2353.2 | 0.1 | 1 | 0.181 |
| Elysium Pharmaceuticals Ltd. | Micro | 29.3 | 27 | 1645.2 | 0 | 583.3 | 0.133 |
| Emdet Engineers Pvt. Ltd. | Small | 3.2 | 52 | 546.4 | 0 | 26.5 | 0.007 |
| Emkay Taps & Cutting Tools Ltd. | Medium | 2.5 | 27 | 1238.1 | 0 | 21.4 | 0.173 |
| Emmbros Autocomp Ltd. | Medium | 1.4 | 31 | 800.1 | 0 | 11.5 | 0.118 |
| Empire Spices & Foods Ltd. | Medium | 3.4 | 28 | 1694.4 | 9.9 | 149.5 | 0.117 |
| Emrald Resilient Tyre Mfrs. Pvt. Ltd. | Medium | 2.6 | 20 | 1067.1 | 0 | 448.2 | 0.03 |
| Enkay Texfab Pvt. Ltd. | Small | 0.6 | 25 | 220.4 | 0 | 18.2 | 0.027 |
| Enpay Transformer Components India Pvt. Ltd. | Medium | 2.5 | 13 | 1210.1 | 0 | 160.8 | 0.066 |
| Enpro Industries Pvt. Ltd. | Medium | 21.4 | 23 | 3495.8 | 0 | 1180 | 0.088 |
| Entremonde Polycoaters Ltd. | Medium | 2 | 54 | 1244.7 | 0 | 422.1 | 0.183 |
| Erawat Pharma Ltd. | Medium | 1.9 | 29 | 520 | 0 | 58.8 | 0.144 |
| Escon Elevators Pvt. Ltd. | Micro | 4.7 | 32 | 635.2 | 0 | 27.2 | 0.056 |

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|---|---|---|---|---|---|---|---|
| Essae-Teraoka Pvt. Ltd. | Small | 10 | 36 | 3145.6 | 0 | 5.3 | 0.151 |
| Essem Jute Inds. Ltd. | Micro | 0.1 | 28 | 209.4 | 0 | 32.6 | 0.034 |
| Auto Pins (India) Ltd. | Small | 2.5 | 28 | 387 | 0 | 35.9 | 0.005 |
| Bhat Bio-Tech (India) Pvt. Ltd. | Small | 2.7 | 37 | 83.1 | 0 | 3.4 | 0.002 |
| Advance Rotoflex Pvt. Ltd. | Small | 0.1 | 20 | 154.1 | 0 | 19.1 | 0.03 |
| Exedy India Ltd. | Medium | 3.1 | 49 | 2434.2 | 0 | 53.7 | 0.001 |
| Exicom Tele-Systems Ltd. | Medium | 62.6 | 28 | 4097.8 | 0 | 330 | 0.008 |
| Exotic Agro Pvt. Ltd. | Micro | 0.3 | 19 | 227.2 | 0 | 93.7 | 0.005 |
| Exotic Fruits Pvt. Ltd. | Medium | 20.2 | 23 | 3336.4 | 0 | 219.4 | 0.169 |
| F S N E-Commerce Ventures Ltd. | Micro | 43.2 | 10 | 5947.8 | 0 | 366.9 | 0.061 |
| Centenial Surgical Suture Ltd. | Small | 0.5 | 12 | 1371.2 | 0 | 116.4 | 0.09 |
| Fabri-Tek Equipments Pvt. Ltd. | Micro | 0.8 | 8 | 72.4 | 0 | 19.4 | 0.012 |
| Farseen Rubber Inds. Ltd. | Small | 0.3 | 44 | 403.8 | 0 | 126 | 0.067 |
| Fathimuthu Amma Mills Pvt. Ltd. | Medium | 0.3 | 33 | 792.3 | 0 | 99.7 | 0.103 |
| Faze Three Autofab Ltd. | Medium | 1.8 | 25 | 1472.7 | 0 | 471.3 | 0.091 |
| Fibre Foils Ltd. | Small | 0.4 | 54 | 767 | 0 | 134.5 | 0.095 |
| Ficus Pax Pvt. Ltd. | Small | 2.6 | 21 | 1531.3 | 0 | 157.4 | 0.076 |
| Atul Rajasthan Date Palms Ltd. | Micro | 1.1 | 28 | 171.5 | 0 | 27 | 0.06 |
| Fimakem India Ltd. | Medium | 0.6 | 40 | 866.9 | 0 | 137.5 | 0.032 |
| Fine Jewellery Mfg. Ltd. | Small | 6.3 | 21 | 2082 | 0 | 595.9 | 0.093 |
| Flex Foods Ltd. | Medium | 1.8 | 32 | 1493.9 | 1.7 | 346.7 | 0.03 |
| Flint Group India Pvt. Ltd. | Medium | 6.9 | 33 | 2917.2 | 0 | 75.5 | 0.072 |
| Flourish Paper & Chemicals Ltd. | Small | 0.5 | 27 | 185 | 0 | 48.9 | 0.019 |
| Flowmore Ltd. | Medium | 7.4 | 55 | 5234 | 0 | 1047 | 0.023 |
| Copmed Pharmaceuticals Pvt. Ltd. | Medium | 7.7 | 17 | 760.4 | 0 | 19.6 | 0.042 |
| Fokker Elmo Sasmos Interconnection Systems Ltd. | Small | 2.1 | 8 | 927.2 | 0 | 171.6 | 0.027 |

| Company Name | Firm Type | ICT Investment (in MN INR) | Firm Age (in Year) | Firm Size (in MN INR) | Government aid (in MN INR) | Short-term borrowings (in MN INR) | Return on Assets (in %) |
|---|---|---|---|---|---|---|---|
| Foods & Inns Ltd. | Medium | 1.7 | 55 | 4731.2 | 0 | 1639.7 | 0.027 |
| Forbes Marshall Pvt. Ltd. | Medium | 64.3 | 37 | 8220.6 | 0 | 43 | 0.083 |
| Forech India Pvt. Ltd. | Medium | 2.4 | 39 | 3297.2 | 0 | 108.8 | 0.121 |
| Fores Elastomech India Pvt. Ltd. | Medium | 0.2 | 17 | 828.8 | 0 | 90.2 | 0.002 |
| Formulated Polymers Ltd. | Medium | 1.1 | 31 | 1139.8 | 0 | 162.5 | 0.129 |
| Forstar Frozen Foods Pvt. Ltd. | Medium | 1.3 | 30 | 2942.1 | 0 | 1054.4 | 0.01 |
| Fortune Rice Ltd. | Small | 0.3 | 17 | 1688.3 | 0 | 144.9 | 0.026 |
| Fortune Stones Ltd. | Medium | 0.9 | 26 | 1257.6 | 0 | 150.8 | 0.094 |
| Agribiotech Industries Ltd. | Medium | 0.2 | 14 | 232.7 | 0 | 57.7 | 0.022 |
| Devicolam Distilleries Ltd. | Small | 6.6 | 22 | 1584.6 | 0 | 110.8 | 0.078 |
| Fredun Pharmaceuticals Ltd. | Small | 4.8 | 35 | 1607.8 | 0 | 186.1 | 0.034 |
| Freshtrop Fruits Ltd. | Medium | 1.2 | 30 | 1671.8 | 0 | 165.7 | 0.044 |
| Frick India Ltd. | Small | 2.3 | 60 | 2812.5 | 0 | 155.3 | 0.048 |
| Frog Cellsat Ltd. | Small | 6.3 | 18 | 1030.3 | 9.4 | 23.8 | 0.152 |
| Frontier Springs Ltd. | Medium | 0.9 | 41 | 888.2 | 0 | 21.4 | 0.081 |
| Frost Falcon Distilleries Ltd. | Medium | 0.5 | 39 | 704.4 | 0 | 403.3 | 0.001 |
| Funskool (India) Ltd. | Medium | 5 | 36 | 1996.7 | 0 | 375.4 | 0.04 |
| Fusion Industries Ltd. | Small | 1.2 | 20 | 746.1 | 0 | 196.8 | 0.009 |
| G A Foods (India) Pvt. Ltd. | Small | 0.8 | 20 | 205.3 | 0 | 63.1 | 0.018 |
| G D Foods Mfg. (India) Pvt. Ltd. | Medium | 9.9 | 25 | 2612.9 | 0 | 340.7 | 0.026 |
| G E Ltd. | Medium | 3.9 | 62 | 2782.9 | 0 | 634.8 | 0.051 |
| G E Power Conversion India Pvt. Ltd. | Medium | 27.8 | 15 | 5699.2 | 0 | 2412.2 | 0.022 |
| G G Automotive Gears Ltd. | Medium | 0.8 | 48 | 566.3 | 0 | 171.8 | 0.006 |
| G I Auto Pvt. Ltd. | Small | 1.8 | 36 | 764.5 | 0 | 11.8 | 0.052 |
| G K P Printing & Packaging Ltd. | Micro | 0.3 | 4 | 343.2 | 0 | 1.1 | 0.021 |
| G K Winding Wires Ltd. | Medium | 2.8 | 37 | 2906.3 | 0 | 217.4 | 0.056 |
| G M Polyplast Ltd. | Small | 0.2 | 19 | 471.4 | 0 | 5 | 0.107 |
| G M Tea Packers Pvt. Ltd. | Small | 2.1 | 11 | 1074.5 | 0 | 97.8 | 0.159 |

| Company Name | Firm Type | ICT Investment (in MN INR) | Firm Age (in Year) | Firm Size (in MN INR) | Government aid (in MN INR) | Short-term borrowings (in MN INR) | Return on Assets (in %) |
|---|---|---|---|---|---|---|---|
| Clear Polyplast India Pvt. Ltd. | Small | 0.1 | 32 | 799.7 | 0 | 150 | 0.031 |
| G O C L Corpn. Ltd. | Medium | 9.6 | 61 | 4131.8 | 0 | 28.9 | 0.056 |
| G P A Capital Foods Pvt. Ltd. | Small | 1.5 | 11 | 4540.5 | 0 | 593 | 0.035 |
| G P Petroleums Ltd. | Small | 4.1 | 39 | 4947.2 | 0 | 323.6 | 0.057 |
| G R B Dairy Foods Pvt. Ltd. | Medium | 9.2 | 21 | 4058.9 | 0 | 229.6 | 0.189 |
| G R Engineering Pvt. Ltd. | Medium | 2.6 | 32 | 3180.5 | 0 | 417.9 | 0.036 |
| G S Alloy Castings Pvt. Ltd. | Medium | 0.4 | 35 | 572.8 | 0 | 129 | 0.01 |
| G T V Engineering Ltd. | Medium | 0.3 | 32 | 595.7 | 4 | 58.5 | 0.02 |
| G T X Pvt. Ltd. | Small | 1 | 28 | 3031.4 | 0 | 140.2 | 0.129 |
| G T Z (India) Pvt. Ltd. | Small | 1.3 | 49 | 950.7 | 0 | 184.6 | 0.064 |
| Gajra Gears Pvt. Ltd. | Medium | 1.8 | 48 | 1429.8 | 0 | 171.2 | 0.004 |
| Gala Precision Engg. Pvt. Ltd. | Medium | 2.5 | 13 | 1347.8 | 0 | 294.2 | 0.051 |
| Galaxy Bearings Ltd. | Small | 2 | 32 | 696.9 | 0 | 33.6 | 0.163 |
| Control Print Ltd. | Medium | 0.3 | 9 | 317.7 | 0 | 38.4 | 0.001 |
| Gampa Alcoats Ltd. | Small | 0.3 | 35 | 286.5 | 0 | 1 | 0.038 |
| Gandhi Automations Pvt. Ltd. | Small | 15.1 | 19 | 1486.3 | 0 | 540.9 | 0.065 |
| Gandhi Special Tubes Ltd. | Medium | 0.6 | 37 | 1443.3 | 0 | 31.4 | 0.231 |
| Ganesh Food Products Pvt. Ltd. | Small | 0.9 | 29 | 347.4 | 0 | 33.7 | 0.085 |
| Ganesh Grains Ltd. | Medium | 1.8 | 22 | 3597.2 | 0 | 300 | 0.108 |
| Ewac Alloys Ltd. | Small | 0.2 | 34 | 286.4 | 0 | 50.3 | 0.029 |
| Ganga Kaveri Seeds Pvt. Ltd. | Small | 4.2 | 39 | 2449.3 | 0 | 179.9 | 0.037 |
| Ganga Papers India Ltd. | Medium | 0.4 | 37 | 1411.9 | 0 | 249.1 | 0.057 |
| Ganga Pharmaceuticals Ltd. | Micro | 0.4 | 33 | 53 | 0 | 9.2 | 0.005 |
| Ganga Spintex Pvt. Ltd. | Small | 0.4 | 12 | 468.7 | 0 | 95.3 | 0.025 |
| Acoem Ecotech Inds. Pvt. Ltd. | Small | 33.2 | 34 | 3105.7 | 0 | 223.6 | 0.027 |
| Garment Mantra Lifestyle Ltd. | Micro | 1.5 | 11 | 804.7 | 0 | 226.6 | 0.022 |
| Gartech Equipments Pvt. Ltd. | Medium | 2.1 | 21 | 1084.5 | 0 | 88.7 | 0.046 |
| Gates India Pvt. Ltd. | Medium | 13.1 | 27 | 4301.9 | 0 | 19 | 0.127 |

| Company Name | Firm Type | ICT Investment (in MN INR) | Firm Age (in Year) | Firm Size (in MN INR) | Government aid (in MN INR) | Short-term borrowings (in MN INR) | Return on Assets (in %) |
|---|---|---|---|---|---|---|---|
| Gates Unitta India Co. Pvt. Ltd. | Medium | 2.3 | 20 | 3455.9 | 0 | 12.7 | 0.114 |
| Coastal Agro Industries Pvt. Ltd. | Medium | 0.3 | 37 | 345.5 | 1.6 | 17.7 | 0.052 |
| Gee Emm Spinfab Pvt. Ltd. | Small | 0.4 | 13 | 983.3 | 0 | 314.1 | 0.046 |
| Geekay Wires Ltd. | Medium | 3.1 | 33 | 1835.7 | 0 | 663.8 | 0.045 |
| Gemini Engi-Fab Pvt. Ltd. | Micro | 0.7 | 24 | 893.2 | 0 | 434.6 | 0.013 |
| Gemscab Industries Ltd. | Medium | 1.3 | 28 | 5141.2 | 0 | 1059.4 | 0.047 |
| Genau Extrusions Pvt. Ltd. | Medium | 3.9 | 28 | 1024.4 | 0 | 367.4 | 0.054 |
| General Commodities Pvt. Ltd. | Small | 0.2 | 58 | 852.1 | 0 | 371.3 | 0.011 |
| Emmbros Autocomp Ltd. | Medium | 0.4 | 43 | 315.6 | 0 | 0.5 | 0.033 |
| Gennex Laboratories Ltd. | Small | 0.7 | 32 | 629.2 | 0 | 101.2 | 0.057 |
| Geno Pharmaceuticals Pvt. Ltd. | Medium | 9.4 | 47 | 1943.2 | 0 | 214.7 | 0.049 |
| Genus Innovation Ltd. | Medium | 12.4 | 24 | 2308.2 | 0 | 416 | 0.022 |
| Geofast Industries (India) Ltd. | Small | 0.4 | 16 | 530 | 0 | 61 | 0.08 |
| Ghaziabad Precision Products Pvt. Ltd. | Medium | 4 | 34 | 1944.6 | 0 | 368.6 | 0.131 |
| Gillanders Arbuthnot & Co. Ltd. | Medium | 2.9 | 87 | 5743.6 | 0 | 632.4 | 0.024 |
| Gini Silk Mills Ltd. | Medium | 0.6 | 41 | 433.1 | 0 | 58.9 | 0.006 |
| Global Acqua Pvt. Ltd. | Medium | 0.4 | 23 | 768.2 | 0 | 62.7 | 0.048 |
| Global Aluminium Pvt. Ltd. | Medium | 4.6 | 26 | 4286.4 | 0 | 445.3 | 0.142 |
| Global Leathers Pvt. Ltd. | Small | 3.2 | 18 | 547.6 | 0 | 158.7 | 0.082 |
| D'Ranflex India Pvt. Ltd. | Small | 6.7 | 21 | 721.3 | 0 | 8.3 | 0.048 |
| Globe Cotyarn Pvt. Ltd. | Small | 3.4 | 20 | 1450 | 0 | 339 | 0.049 |
| Globe Steels Pvt. Ltd. | Medium | 0.3 | 36 | 887.5 | 0 | 138.3 | 0.051 |
| Globe Textiles (India) Ltd. | Medium | 4.5 | 27 | 2625.3 | 2.7 | 698 | 0.02 |
| Globus Infocom Ltd. | Micro | 4.9 | 21 | 2050 | 0 | 359 | 0.151 |

| Company Name | Firm Type | ICT Investment (in MN INR) | Firm Age (in Year) | Firm Size (in MN INR) | Government aid (in MN INR) | Short-term borrowings (in MN INR) | Return on Assets (in %) |
|---|---|---|---|---|---|---|---|
| Gloster Cables Ltd. | Medium | 3.2 | 27 | 2905 | 0 | 212.5 | 0.028 |
| Goa Ispat Pvt. Ltd. | Small | 0.4 | 25 | 1640.9 | 0 | 371 | 0.005 |
| Goa Roller Flour Mills Pvt. Ltd. | Micro | 0.1 | 14 | 448.9 | 0 | 52.8 | 0.048 |
| Goa Sponge & Power Ltd. | Medium | 0.8 | 27 | 3940.9 | 0 | 496.4 | 0.024 |
| Godavari Edible Bran Oil Pvt. Ltd. | Medium | 0.5 | 40 | 1276.8 | 0 | 194.8 | 0.067 |
| Donaldson India Filter Systems Pvt. Ltd. | Small | 2.1 | 24 | 341.3 | 0 | 58.5 | 0.086 |
| Goldi Solar Pvt. Ltd. | Small | 2.7 | 11 | 2971.5 | 0 | 150 | 0.049 |
| Goldstar Power Ltd. | Small | 0.2 | 23 | 404.8 | 0 | 79.7 | 0.015 |
| Golkunda Diamonds & Jewellery Ltd. | Small | 1.5 | 32 | 1310.7 | 0 | 409.9 | 0.076 |
| Good Greens India Pvt. Ltd. | Small | 0.7 | 13 | 413.8 | 0 | 128 | 0.012 |
| Gopal Glass Works Ltd. (1996) | Medium | 2.3 | 26 | 2256.8 | 0 | 43.5 | 0.225 |
| Gopalpur Tea Co. Ltd. | Small | 0.3 | 109 | 266.2 | 2.5 | 16.8 | 0.086 |
| Gopani Metal Inds. Pvt. Ltd. | Medium | 1.6 | 25 | 2322.6 | 0 | 94.1 | 0.032 |
| Gorani Industries Ltd. | Small | 0.5 | 27 | 190.7 | 0 | 67.7 | 0.08 |
| Gourika India Ltd. | Small | 0.2 | 16 | 240 | 0 | 92.1 | 0.001 |
| Govind Steel Co. Ltd. | Small | 0.4 | 64 | 1027 | 0 | 385.2 | 0.032 |
| Goyal Edibles Pvt. Ltd. | Small | 0.7 | 23 | 3376.6 | 0 | 157 | 0.031 |
| Granite Mart Ltd. | Small | 0.1 | 23 | 339.3 | 0 | 173.5 | 0.001 |
| Graviss Foods Pvt. Ltd. | Small | 3.3 | 38 | 1828.4 | 0 | 487.5 | 0.057 |
| Great Eastern Retail Pvt. Ltd. | Micro | 2.3 | 24 | 5414.2 | 0 | 1628.9 | 0.008 |
| Green Field Material Handling Pvt. Ltd. | Small | 1.4 | 15 | 725.8 | 0 | 260.5 | 0.028 |
| Green Gold Seeds Pvt. Ltd. | Small | 2.1 | 21 | 1109 | 0 | 247.3 | 0.024 |
| Greenchef Appliances Ltd. | Medium | 7.3 | 12 | 2084.5 | 0 | 352.4 | 0.003 |
| Greenvision Technologies Pvt. Ltd. | Small | 0.2 | 14 | 1036.9 | 0 | 201.5 | 0.007 |
| Gromax Agri Equipment Ltd. | Medium | 1.6 | 44 | 1459.2 | 0 | 14 | 0.212 |

| Company Name | Firm Type | ICT Investment (in MN INR) | Firm Age (in Year) | Firm Size (in MN INR) | Government aid (in MN INR) | Short-term borrowings (in MN INR) | Return on Assets (in %) |
|---|---|---|---|---|---|---|---|
| Grotek Enterprises Pvt. Ltd. | Medium | 1.6 | 25 | 504.7 | 0 | 62.6 | 0.048 |
| Bagrrys India Pvt. Ltd. | Small | 11.5 | 42 | 879.8 | 0 | 21.3 | 0.078 |
| Grupo Antolin India Pvt. Ltd. | Medium | 3.5 | 26 | 4086.7 | 0 | 77.1 | 0.035 |
| Guardian Controls Ltd. | Small | 0.3 | 37 | 166 | 0 | 0.9 | 0.23 |
| Guhan Textile Mills Pvt. Ltd. | Small | 0.3 | 30 | 497.4 | 0 | 73.3 | 0.034 |
| Gujarat Apollo Inds. Ltd. | Small | 1.6 | 36 | 1564.7 | 0 | 81.5 | 0.003 |
| Gujarat Containers Ltd. | Small | 0.5 | 30 | 775.5 | 0 | 246.9 | 0.145 |
| Gujarat Credo Mineral Inds. Ltd. | Medium | 0.6 | 10 | 950.5 | 0 | 231.6 | 0.003 |
| Gujarat Dyestuff Inds. Pvt. Ltd. | Small | 0.5 | 41 | 889.8 | 0 | 150.8 | 0.063 |
| Gujarat Flotex Pvt. Ltd. | Medium | 17.6 | 22 | 1723.8 | 0 | 457.7 | 0.051 |
| Gujarat Forgings Pvt. Ltd. | Small | 2.8 | 48 | 1489.8 | 0 | 373.8 | 0.002 |
| Gujarat H Y-Spin Ltd. | Medium | 0.1 | 11 | 517.8 | 16.9 | 91.5 | 0.008 |
| Brooks Laboratories Ltd. | Small | 0.6 | 36 | 316.7 | 0 | 35.4 | 0.019 |
| Amity Thermosets Pvt. Ltd. | Small | 0.5 | 45 | 270.2 | 0 | 0.5 | 0.013 |
| Gujarat Terce Laboratories Ltd. | Small | 3.9 | 37 | 294.3 | 0 | 37.7 | 0.032 |
| Gujarat Themis Biosyn Ltd. | Medium | 0.3 | 41 | 961.5 | 0 | 7.5 | 0.354 |
| Gulbrandsen Technologies (India) Pvt. Ltd. | Medium | 10.8 | 19 | 4737.1 | 0 | 696.1 | 0.093 |
| Gulf Engineers & Constructors Pvt. Ltd. | Micro | 0.8 | 27 | 374.2 | 0 | 180.3 | 0.024 |
| Gupta Metal Sheets Ltd. | Medium | 1 | 27 | 2878.1 | 0 | 750 | 0.025 |
| Gurukrupa Polyplast Ltd. | Micro | 0.1 | 29 | 140.8 | 0 | 37.2 | 0.014 |
| H M M Infra Ltd. | Medium | 1.3 | 26 | 1810 | 0 | 371.3 | 0.079 |
| H N V Castings Pvt. Ltd. | Medium | 1.4 | 17 | 1230.1 | 0 | 575 | 0.001 |
| H P Adhesives Ltd. | Small | 5 | 3 | 1246.1 | 0 | 64.8 | 0.03 |

| Company Name | Firm Type | ICT Investment (in MN INR) | Firm Age (in Year) | Firm Size (in MN INR) | Government aid (in MN INR) | Short-term borrowings (in MN INR) | Return on Assets (in %) |
|---|---|---|---|---|---|---|---|
| H P Cotton Textile Mills Ltd. | Medium | 5.3 | 41 | 957.5 | 0 | 210.6 | 0.065 |
| H P M Chemicals & Fertilizers Ltd. | Medium | 3.3 | 37 | 3950.3 | 0 | 158.3 | 0.059 |
| H R Polycoats Pvt. Ltd. | Medium | 1.5 | 13 | 1522.6 | 0 | 281.4 | 0.036 |
| A C G Inspection Systems Pvt. Ltd. | Small | 4.6 | 19 | 1291.7 | 0 | 5 | 0.19 |
| Agappe Diagnostics Ltd. | Medium | 10.5 | 24 | 1247.4 | 0 | 6.9 | 0.054 |
| Haldiram Products Pvt. Ltd. | Medium | 14.6 | 26 | 1686.5 | 0 | 234.2 | 0.038 |
| Haldyn Glass Ltd. | Medium | 3.3 | 31 | 2135.2 | 0 | 83.3 | 0.047 |
| Halonix Technologies Pvt. Ltd. | Small | 12 | 13 | 4044.6 | 0 | 582.6 | 0.043 |
| Happy Steels Pvt. Ltd. | Medium | 0.6 | 26 | 708.1 | 0 | 220.7 | 0 |
| Harbauer (India) Pvt. Ltd. | Micro | 1.3 | 19 | 163.9 | 0 | 59.7 | 0.032 |
| Hardcarb Technologies Pvt. Ltd. | Small | 2.3 | 23 | 286.6 | 0 | 88.6 | 0.008 |
| Hardoli Paper Mills Ltd. | Medium | 0.3 | 27 | 672.9 | 0 | 56.8 | 0.007 |
| Hariom Pipe Inds. Ltd. | Medium | 1 | 15 | 2701.8 | 0 | 413.7 | 0.148 |
| Harish Textile Engineers Ltd. | Medium | 1.1 | 12 | 840.7 | 0 | 217 | 0.006 |
| Harmony Plastics Pvt. Ltd. | Medium | 2.9 | 17 | 2025.1 | 0 | 235.2 | 0.04 |
| Empee Equipments Pvt. Ltd. | Small | 0.4 | 11 | 672.1 | 0 | 0.6 | 0.026 |
| Harsh Polyfabric Pvt. Ltd. | Micro | 0.1 | 30 | 583.1 | 0 | 262.5 | 0.033 |
| Actionware India Pvt. Ltd. | Medium | 0.2 | 19 | 719.2 | 0 | 105.2 | 0.124 |
| Haryana Polymers Ltd. | Small | 0.2 | 25 | 284.2 | 0 | 35.9 | 0.016 |
| Hasbro Clothing Pvt. Ltd. | Micro | 10.4 | 18 | 1517.6 | 0 | 148.3 | 0.064 |
| Enkay Texfab Pvt. Ltd. | Small | 1.2 | 25 | 209.1 | 0 | 17.6 | 0.108 |
| Hella India Lighting Ltd. | Medium | 71.7 | 63 | 1988 | 0 | 261.3 | 0.081 |
| Hemadri Cements Ltd. | Small | 1.1 | 41 | 778.5 | 0 | 47.8 | 0.006 |

| Company Name | Firm Type | ICT Investment (in MN INR) | Firm Age (in Year) | Firm Size (in MN INR) | Government aid (in MN INR) | Short-term borrowings (in MN INR) | Return on Assets (in %) |
|---|---|---|---|---|---|---|---|
| Hemant Surgical Inds. Ltd. | Small | 1.1 | 33 | 0 | 0 | 40.5 | 0.051 |
| Herbal Isolates Pvt. Ltd. | Medium | 0.8 | 38 | 797.6 | 0 | 123.2 | 0.054 |
| Hercules Hoists Ltd. | Medium | 10.1 | 60 | 3185.4 | 0 | 0.7 | 0.022 |
| Heritage Nutrivet Ltd. | Medium | 1.2 | 14 | 860.6 | 0 | 0.6 | 0.017 |
| Hester Biosciences Ltd. | Medium | 3.9 | 35 | 2656.9 | 0 | 332.9 | 0.093 |
| Hexagon Nutrition Ltd. | Small | 9.6 | 29 | 1016.7 | 0 | 190.7 | 0.077 |
| Hi-Tech Polyplast Nagpur Pvt. Ltd. | Small | 0.7 | 10 | 302.6 | 0 | 42 | 0.022 |
| High Energy Batteries (India) Ltd. | Small | 1.9 | 61 | 834.2 | 6.2 | 241.8 | 0.178 |
| Fimakem India Ltd. | Medium | 0.9 | 97 | 765.1 | 0 | 80.2 | 0.059 |
| Hills Cement Co. Ltd. | Medium | 1.6 | 19 | 2441.8 | 0 | 0.7 | 0.141 |
| Hilton Metal Forging Ltd. | Medium | 0.7 | 17 | 1019 | 0 | 387.7 | 0.015 |
| Him Chem Pvt. Ltd. | Medium | 0.2 | 47 | 466.7 | 0 | 23.2 | 0.005 |
| Himachal Energy Pvt. Ltd. | Medium | 0.1 | 19 | 1057.4 | 0 | 171.6 | 0.008 |
| Himanshu Flour Mills Ltd. | Small | 0.2 | 36 | 376.1 | 0 | 51.3 | 0.015 |
| Bansal Ship Breakers Pvt. Ltd. | Small | 1.2 | 30 | 1411.4 | 0 | 2.8 | 0.039 |
| Hind High Vacuum Co. Pvt. Ltd. (2001) | Medium | 4.4 | 21 | 1219.2 | 0 | 154.4 | 0.165 |
| Hisar Metal Inds. Ltd. | Medium | 0.6 | 32 | 1572.8 | 0 | 448.3 | 0.088 |
| Hooghly Extrusions Ltd. | Small | 0.2 | 28 | 331.6 | 0.7 | 49 | 0.012 |
| Hooghly Mills Co. Ltd. | Small | 0.5 | 109 | 1617.9 | 0 | 284.1 | 0.023 |
| Hussain Sheth & Sons (Ship Breakers) Pvt. Ltd. | Micro | 0.1 | 23 | 161 | 0 | 0.9 | 0.024 |
| Hwaseung Materials (India) Pvt. Ltd. | Medium | 8.7 | 15 | 3182.5 | 0 | 379 | 0.035 |
| Hydrodyne Teikoku (India) Pvt. Ltd. | Small | 0.3 | 36 | 393.5 | 0 | 49 | 0.185 |
| Hyloc Hydrotechnic Pvt. Ltd. | Small | 0.9 | 31 | 367.4 | 0 | 15 | 0.114 |
| Hyundai Engineering Plastics India Pvt. Ltd. | Medium | 3.1 | 15 | 4028.2 | 0 | 630.9 | 0.012 |

| Company Name | Firm Type | ICT Investment (in MN INR) | Firm Age (in Year) | Firm Size (in MN INR) | Government aid (in MN INR) | Short-term borrowings (in MN INR) | Return on Assets (in %) |
|---|---|---|---|---|---|---|---|
| Bay-Forge Pvt. Ltd. | Medium | 7.6 | 7 | 2646.5 | 0 | 18.2 | 0.044 |
| I D L Explosives Ltd. | Medium | 2.7 | 12 | 3230.7 | 0 | 1399.3 | 0.002 |
| Ahlstrom Munksjo Fibercomposites India Pvt. Ltd. | Medium | 0.7 | 27 | 167.3 | 0 | 20.5 | 0.031 |
| Ice Make Refrigeration Ltd. | Small | 2.5 | 13 | 1337.4 | 2.4 | 54.7 | 0.066 |
| Ideal Carpets Ltd. | Micro | 0.2 | 31 | 196.4 | 0 | 71.4 | 0.003 |
| Ideal Industrial Explosives Ltd. | Medium | 0.9 | 35 | 3811 | 0 | 320.9 | 0.033 |
| Iden Graphics Pvt. Ltd. | Micro | 0.3 | 26 | 109.2 | 0 | 5.9 | 0.026 |
| Ikio Lighting Ltd. | Small | 3.5 | 6 | 1275.3 | 0 | 148.6 | 0.249 |
| Incredible Industries Ltd. | Medium | 1.2 | 43 | 3491 | 0 | 226.2 | 0.018 |
| Indcon Projects & Equipment Ltd. | Small | 5.4 | 36 | 737.2 | 0 | 230 | 0.038 |
| India Steel Summit Pvt. Ltd. | Medium | 8.1 | 16 | 1631.4 | 0 | 517 | 0.097 |
| Indian Chillies Trdg. Co. Ltd. | Small | 0.1 | 29 | 185.7 | 0 | 33 | 0.044 |
| Indrayani Biotech Ltd. | Micro | 0.3 | 30 | 450.5 | 0 | 99.5 | 0.086 |
| Indsil Hydro Power & Manganese Ltd. | Medium | 1.6 | 32 | 2281.2 | 0 | 809.8 | 0.113 |
| Inducto Steels Ltd. | Small | 0.2 | 34 | 459.9 | 0 | 50 | 0.027 |
| I I Inspection & Export Pvt. Ltd. | Micro | 0.4 | 38 | 348.6 | 0.8 | 27.6 | 0.008 |
| Innova Rubbers Pvt. Ltd. | Medium | 3.7 | 22 | 1810.6 | 0 | 196.5 | 0.067 |
| Innovative Cuisine Pvt. Ltd. | Medium | 0.7 | 16 | 1398.4 | 0 | 81.6 | 0.107 |
| Insolation Energy Ltd. | Small | 1.5 | 7 | 1022.7 | 0.4 | 183.1 | 0.103 |
| Intech Systems Chennai Pvt. Ltd. | Small | 2.3 | 19 | 983.6 | 0 | 56.1 | 0.019 |
| Integra Engineering India Ltd. | Medium | 2.9 | 41 | 809.6 | 0 | 245.2 | 0.084 |
| Advance Rotoflex Pvt. Ltd. | Small | 10.1 | 20 | 4523.5 | 0 | 9.1 | 0.053 |
| Inter Gold (India) Pvt. Ltd. | Small | 1.9 | 37 | 4970.4 | 0 | 525.4 | 0.098 |
| Inter Solar Systems Pvt. Ltd. | Small | 0.6 | 23 | 356.8 | 0 | 43.7 | 0.04 |
| Interarch Building Products Pvt. Ltd. | Medium | 8.7 | 39 | 5801.5 | 0 | 23.4 | 0.044 |

| Company Name | Firm Type | ICT Investment (in MN INR) | Firm Age (in Year) | Firm Size (in MN INR) | Government aid (in MN INR) | Short-term borrowings (in MN INR) | Return on Assets (in %) |
|---|---|---|---|---|---|---|---|
| J S W Structural Metal Decking Ltd. | Small | 0.8 | 13 | 695 | 0 | 120.7 | 0.116 |
| J T L Industries Ltd. | Medium | 2.3 | 31 | 3799.1 | 0 | 707.2 | 0.181 |
| J U Agri Sciences Pvt. Ltd. | Small | 8.5 | 36 | 5814.3 | 0 | 2115.4 | 0.077 |
| Jacobi Carbons India Pvt. Ltd. | Medium | 2.1 | 14 | 1536.7 | 0 | 261 | 0.143 |
| Jagan Lamps Ltd. | Medium | 0.1 | 29 | 329.7 | 0 | 44.5 | 0.064 |
| Jagdamba T M T Mills Ltd. | Small | 0.2 | 37 | 471.1 | 0 | 36.2 | 0.02 |
| Bhat Bio-Tech (India) Pvt. Ltd. | Small | 3.1 | 27 | 1080.7 | 0 | 13 | 0.178 |
| Jagruti Synthetics Pvt. Ltd. | Small | 0.3 | 34 | 286.9 | 0 | 28.7 | 0.035 |
| Jai Balaji Jyoti Steels Ltd. | Medium | 1.1 | 19 | 3224.3 | 0 | 310.6 | 0.188 |
| Jai Bharat Gum & Chemicals Ltd. | Medium | 0.8 | 26 | 4014.4 | 0 | 438.6 | 0.08 |
| Jai Bhavani Mata Engitech Pvt. Ltd. | Small | 0.8 | 12 | 689.4 | 0 | 35 | 0.023 |
| Jai Hind Wire Rod Mills Pvt. Ltd. | Small | 0.2 | 31 | 797.5 | 0 | 229.8 | 0.002 |
| Jai Jagadhambiga Textile Mills Pvt. Ltd. | Small | 0.1 | 33 | 465.7 | 0 | 14.2 | 0.108 |
| Jaiambe Ispat Pvt. Ltd. | Micro | 0.2 | 17 | 509.6 | 0 | 78.8 | 0.018 |
| Jainex Aamcol Ltd. | Small | 0.6 | 75 | 148 | 0 | 20.9 | 0.093 |
| Jaipur Rugs Co. Pvt. Ltd. | Small | 20.3 | 16 | 1929.6 | 0 | 610.6 | 0.103 |
| Jakap Metind Pvt. Ltd. | Small | 0.5 | 31 | 523.6 | 0 | 179.9 | 0.07 |
| Jalaram Ceramics Ltd. | Medium | 0.6 | 27 | 538.2 | 0 | 130.8 | 0.009 |
| Janani Industries Pvt. Ltd. | Small | 0.2 | 18 | 434.1 | 0 | 51.5 | 0.017 |
| Jansons Industries Ltd. | Medium | 0.6 | 32 | 2460.9 | 0 | 807.3 | 0.013 |
| Jash Engineering Ltd. | Medium | 6.6 | 49 | 2851.5 | 1.6 | 586.5 | 0.065 |
| Jasmine Concrete Exports Pvt. Ltd. | Medium | 3 | 31 | 1135.4 | 0 | 603.8 | 0.003 |
| Jat Metal Pressing Pvt. Ltd. | Small | 0.5 | 27 | 196.1 | 0 | 33.8 | 0.044 |
| Jnana Mandal Pvt. Ltd. | Micro | 1.3 | 82 | 455.4 | 0 | 83.2 | 0.011 |

| Company Name | Firm Type | ICT Investment (in MN INR) | Firm Age (in Year) | Firm Size (in MN INR) | Government aid (in MN INR) | Short-term borrowings (in MN INR) | Return on Assets (in %) |
|---|---|---|---|---|---|---|---|
| Johari Digital Healthcare Ltd. | Small | 5.5 | 27 | 592.1 | 0 | 73.7 | 0.271 |
| John Cockerill India Ltd. | Medium | 9.7 | 36 | 3800.2 | 0 | 0.2 | 0.013 |
| Jonas Woodhead & Sons (India) Ltd. | Small | 0.8 | 59 | 227.2 | 0 | 23.1 | 0.003 |
| Jost'S Engineering Co. Ltd. | Small | 5.4 | 115 | 855.3 | 0 | 12 | 0.064 |
| Jumbo Bag Ltd. | Small | 1.5 | 32 | 991.1 | 0 | 419.1 | 0.01 |
| Jumps Auto Inds. Ltd. | Small | 2.4 | 23 | 558.4 | 0 | 65.1 | 0.091 |
| Jupiter Pharmaceuticals Ltd. | Small | 2.1 | 46 | 191.3 | 0 | 25.6 | 0.138 |
| Arrow Greentech Ltd. | Medium | 3.5 | 29 | 1306.9 | 0 | 0.5 | 0.13 |
| Deccan Alloys Pvt. Ltd. | Micro | 0.2 | 30 | 226.6 | 0.3 | 13.8 | 0.113 |
| K C L Ltd. | Medium | 5.5 | 39 | 2910.8 | 0 | 82.1 | 0.045 |
| I T L Industries Ltd. | Small | 4.5 | 41 | 2528.2 | 0 | 86 | 0.058 |
| Genus Apparels Ltd. | Micro | 5 | 57 | 1577.1 | 0 | 50.2 | 0.036 |
| K K Polycolor Asia Ltd. | Small | 0.4 | 13 | 318.4 | 0 | 108.3 | 0.001 |
| K P T Industries Ltd. | Medium | 1.1 | 46 | 980.3 | 1.4 | 191.2 | 0.056 |
| Goenka Diamond & Jewels Ltd. | Micro | 1.1 | 30 | 1921.8 | 0 | 1.3 | 0.144 |
| Kansara Bearings Ltd. | Small | 0.9 | 37 | 371.9 | 0 | 49.9 | 0.022 |
| Kansara Modler Ltd. | Small | 0.3 | 27 | 425.8 | 0 | 82.4 | 0.06 |
| Eppinger Tooling Asia Pvt. Ltd. | Medium | 0.3 | 17 | 143.6 | 0 | 11.8 | 0.008 |
| Kanyaka Parameshwari Engg. Ltd. | Small | 0.2 | 39 | 651.4 | 0 | 77.6 | 0.053 |
| Kapila Feeds Pvt. Ltd. | Micro | 0.1 | 31 | 107.4 | 0 | 2.2 | 0.084 |
| Carysil Steel Ltd. | Small | 2 | 35 | 1786 | 0 | 33.6 | 0.079 |
| Karamveer Electronics Ltd. | Micro | 0.7 | 38 | 279 | 0 | 64.1 | 0.009 |
| Kariwala Industries Ltd. | Small | 2.4 | 33 | 607.4 | 0 | 82.5 | 0.184 |
| Fine-Line Circuits Ltd. | Small | 0.2 | 31 | 381.9 | 0 | 39.3 | 0.006 |
| Karnavati Polyester Pvt. Ltd. | Small | 0.1 | 35 | 531.7 | 1.4 | 40.1 | 0.012 |

| Company Name | Firm Type | ICT Investment (in MN INR) | Firm Age (in Year) | Firm Size (in MN INR) | Government aid (in MN INR) | Short-term borrowings (in MN INR) | Return on Assets (in %) |
|---|---|---|---|---|---|---|---|
| D S Connectors & Cables India Pvt. Ltd. | Small | 1.1 | 37 | 2328.7 | 0 | 244.3 | 0.051 |
| Kasuma Auto Engg. Pvt. Ltd. | Small | 1.1 | 27 | 352.6 | 0 | 44.4 | 0.038 |
| Kataria Plastics Pvt. Ltd. | Small | 1.2 | 26 | 4727.1 | 0 | 737 | 0.069 |
| Gartech Equipments Pvt. Ltd. | Medium | 0.1 | 24 | 419.7 | 0 | 87.7 | 0.053 |
| Kaveri Ginning Mills Pvt. Ltd. | Micro | 0.2 | 14 | 527.6 | 0 | 106 | 0.024 |
| Keerthi Industries Ltd. | Medium | 2.3 | 40 | 1912.5 | 11.5 | 78.1 | 0.095 |
| Kejriwal Bee Care India Pvt. Ltd. | Small | 0.6 | 20 | 1688.3 | 0 | 700.1 | 0.007 |
| Kejriwal Industries Pvt. Ltd. | Medium | 1 | 22 | 1681.4 | 0 | 132.9 | 0.048 |
| Keltech Energies Ltd. | Medium | 2.1 | 45 | 2124.2 | 0 | 129.6 | 0.035 |
| Gee Emm Spinfab Pvt. Ltd. | Small | 2.6 | 52 | 2424.6 | 0 | 272.9 | 0.036 |
| Kewal Kiran Clothing Ltd. | Medium | 6.9 | 30 | 5931.3 | 0 | 774.9 | 0.106 |
| Khaitan Chemicals & Fertilizers Ltd. | Medium | 6.3 | 40 | 5175.3 | 0 | 1264.4 | 0.138 |
| Khandoba Distilleries Ltd. | Medium | 0.4 | 15 | 1311.2 | 0 | 469.6 | 0.041 |
| Khator Technical Textiles Ltd. | Small | 0.3 | 9 | 273.3 | 0 | 60.5 | 0.006 |
| Kilitch Drugs (India) Ltd. | Small | 2.8 | 30 | 1438 | 0 | 203.4 | 0.045 |
| Kilpest India Ltd. | Micro | 0.2 | 50 | 245.4 | 0 | 16.9 | 0.253 |
| Kinetic Electric Motor Co. Pvt. Ltd. | Small | 0.4 | 9 | 753.5 | 0 | 1.4 | 0.14 |
| Kinetic Taigene Electrical Co. Pvt. Ltd. | Small | 0.2 | 24 | 1073.8 | 0 | 1 | 0.093 |
| Kings Infra Ventures Ltd. | Small | 0.3 | 35 | 449.6 | 0 | 80 | 0.052 |
| Dhanlaxmi Fabrics Ltd. | Small | 1 | 28 | 446.6 | 0 | 127.1 | 0.053 |
| Agnice Fire Protection Pvt. Ltd. | Micro | 0.5 | 27 | 107.5 | 0 | 0.5 | 0.13 |
| Kirloskar Chillers Pvt. Ltd. | Medium | 2.5 | 27 | 1140.2 | 0 | 75.6 | 0.115 |
| Kisan Irrigations & Infrastructure Ltd. | Medium | 2.5 | 49 | 2896.9 | 12.1 | 187.3 | 0.07 |

| Company Name | Firm Type | ICT Investment (in MN INR) | Firm Age (in Year) | Firm Size (in MN INR) | Government aid (in MN INR) | Short-term borrowings (in MN INR) | Return on Assets (in %) |
|---|---|---|---|---|---|---|---|
| Kasuma Auto Engg. Pvt. Ltd. | Small | 1 | 27 | 647.6 | 0.2 | 44.5 | 0.062 |
| Iden Graphics Pvt. Ltd. | Micro | 0.3 | 12 | 1618.6 | 0 | 19.9 | 0.123 |
| Kolors India Pvt. Ltd. | Medium | 7.9 | 18 | 1808.7 | 0 | 347.8 | 0.094 |
| Konkan Agro Marine Inds. Pvt. Ltd. | Medium | 0.8 | 51 | 3144.9 | 0 | 443.8 | 0.037 |
| Bijur Delimon India Pvt. Ltd. | Micro | 1.1 | 33 | 796.5 | 0 | 87.2 | 0.09 |
| Kopran Ltd. | Medium | 5.6 | 64 | 2919.5 | 0 | 347.4 | 0.025 |
| Arvind Goodhill Suit Mfg. Pvt. Ltd. | Medium | 0.4 | 4 | 124.1 | 0 | 6.5 | 0.094 |
| Koso India Pvt. Ltd. | Medium | 4.5 | 18 | 4416 | 0 | 309 | 0.065 |
| Avichal Buildcon Pvt. Ltd. | Small | 32.9 | 14 | 1840.4 | 0 | 22 | 0.002 |
| Kovilpatti Lakshmi Roller Flour Mills Ltd. | Medium | 3.9 | 61 | 1718 | 0 | 168.4 | 0.061 |
| Lambodhara Textiles Ltd. | Medium | 0.3 | 28 | 1555.8 | 2.3 | 0.1 | 0.1 |
| Lamina Suspension Products Ltd. | Medium | 1.2 | 47 | 751.6 | 0 | 149.6 | 0.012 |
| Apollo Inffratech Pvt. Ltd. | Small | 0.1 | 25 | 342.1 | 0 | 106.5 | 0.014 |
| Advance Steel Tubes Ltd. | Small | 4 | 15 | 844.5 | 0 | 73.4 | 0.115 |
| Laxmi Agni Components & Forgings Pvt. Ltd. | Medium | 0.4 | 19 | 2211.4 | 0 | 208.2 | 0.059 |
| Laxmi Cotspin Ltd. | Medium | 0.4 | 17 | 1326.7 | 0 | 294.1 | 0.05 |
| Laxmi Govind Paper & Pulp Mill Pvt. Ltd. | Small | 0.3 | 18 | 129.7 | 0 | 5.1 | 0.024 |
| Laxmipati Engineering Works Ltd. | Small | 1.9 | 10 | 286 | 0 | 8 | 0.006 |
| Jatinga Tea Ltd. | Micro | 3.3 | 43 | 619 | 0 | 28.9 | 0.012 |
| Leebo Metals Pvt. Ltd. | Small | 0.4 | 27 | 1302.5 | 0 | 124.6 | 0.106 |
| Leewon Precision Pvt. Ltd. | Medium | 0.9 | 15 | 1076.2 | 0 | 206.6 | 0.016 |
| Lehar Footwears Ltd. | Medium | 0.9 | 28 | 1409.3 | 3.6 | 381.2 | 0.015 |
| Lexus Exports Private Ltd. | Micro | 1 | 12 | 159.3 | 0 | 4.8 | 0.027 |
| House Of Anita Dongre Pvt. Ltd. | Micro | 0.5 | 14 | 1391.5 | 0 | 221.7 | 0.089 |

| Company Name | Firm Type | ICT Investment (in MN INR) | Firm Age (in Year) | Firm Size (in MN INR) | Government aid (in MN INR) | Short-term borrowings (in MN INR) | Return on Assets (in %) |
|---|---|---|---|---|---|---|---|
| Libas Consumer Products Ltd. | Micro | 0.1 | 18 | 486.9 | 0 | 97.6 | 0.044 |
| Livlong Nutraceuticals Ltd. | Micro | 0.8 | 21 | 96.5 | 0 | 0.3 | 0.281 |
| Billets Elektro Werke Pvt. Ltd. | Small | 1.5 | 28 | 1281.9 | 0 | 3.6 | 0.031 |
| Coastal Agro Industries Pvt. Ltd. | Medium | 6.1 | 15 | 305 | 0 | 33.9 | 0.142 |
| Lona Industries Ltd. | Medium | 1.5 | 60 | 2316.2 | 0 | 210.6 | 0.04 |
| Lotus Chocolate Co. Ltd. | Small | 0.4 | 34 | 459.8 | 0 | 76.4 | 0.219 |
| Gates India Pvt. Ltd. | Medium | 2.1 | 35 | 1549.2 | 0 | 22 | 0.028 |
| Loxim Industries Ltd. | Medium | 4.5 | 19 | 1821.9 | 0 | 141.7 | 0.126 |
| Flourish Paper & Chemicals Ltd. | Small | 17.6 | 15 | 1258.3 | 0 | 43.8 | 0.049 |
| Lumax Cornaglia Auto Technologies Pvt. Ltd. | Medium | 2.9 | 15 | 740.1 | 0 | 17.6 | 0.16 |
| Lumax Mannoh Allied Technologies Ltd. | Medium | 5.2 | 9 | 1257.3 | 0.6 | 70.5 | 0.155 |

# APPENDIX – C

**Sample Data for Chapter 6 analysis**

**a. Sample data –Pre COVID**

| Company Name | ICT Investment (MN INR) | ICT Investment per sales (in %) | Short-term borrowings (MN INR) | Short-term borrowings per sales (in %) | Sales (MN INR) | Gross working capital cycle (days) | ROA (in %) | Financial Year |
|---|---|---|---|---|---|---|---|---|
| B M D Chemicals Pvt. Ltd. | 0 | 0.00% | 25.1 | 7.29% | 344.4 | 114.82 | -0.91% | 2015 |
| Containe Technologies Ltd. | 0.5 | 2.38% | 44.3 | 210.95 % | 21 | 367.55 | 0.90% | 2015 |
| Dynalec Controls Pvt. Ltd. | 1 | 0.30% | 36.7 | 11.06% | 331.8 | 167.22 | 17.76% | 2015 |
| Efcee Global Ship Recycling Pvt. Ltd. | 0 | 0.00% | 154.1 | 9.43% | 1634.8 | 151.76 | 2.15% | 2015 |
| Elysium Pharmaceuticals Ltd. | 3 | 0.40% | 208.1 | 27.91% | 745.7 | 182.99 | 4.33% | 2015 |
| Fenasia Ltd. | 0.1 | 0.02% | 59 | 13.88% | 425.2 | 185.22 | 0.37% | 2015 |
| Filtron Engineers Ltd. | 0 | 0.00% | 3.1 | 31.96% | 9.7 | 642.9 | 28.03% | 2015 |
| Govind Poy Oxygen Ltd. | 0 | 0.00% | 7.3 | 8.87% | 82.3 | 85.18 | -1.23% | 2015 |
| Kaveri Ginning Mills Pvt. Ltd. | 0.3 | 0.03% | 134.6 | 15.51% | 867.9 | 98.56 | 1.52% | 2015 |
| M K Shipping & Allied Inds. Pvt. Ltd. | 0 | 0.00% | 3.7 | 0.27% | 1375.3 | 207.36 | 2.00% | 2015 |
| Maco Pvt. Ltd. | 0.5 | 0.23% | 55 | 25.13% | 218.9 | 546.89 | 0.53% | 2015 |
| B M D Chemicals Pvt. Ltd. | 0 | 0.00% | 22.5 | 7.50% | 299.9 | 141.66 | 1.06% | 2016 |
| Containe Technologies Ltd. | 1.3 | 1.70% | 27.3 | 35.73% | 76.4 | 81.09 | 3.25% | 2016 |
| Dynalec Controls Pvt. Ltd. | 0.8 | 0.60% | 1.2 | 0.91% | 132.5 | 282.48 | -11.51% | 2016 |
| Efcee Global Ship Recycling Pvt. Ltd. | 0 | 0.00% | 26.8 | 2.42% | 1106 | 228.63 | 1.98% | 2016 |

| Company Name | ICT Investment (MN INR) | ICT Investment per sales (in %) | Short-term borrowings (MN INR) | Short-term borrowings per sales (in %) | Sales (MN INR) | Gross working capital cycle (days) | ROA (in %) | Financial Year |
|---|---|---|---|---|---|---|---|---|
| Elysium Pharmaceuticals Ltd. | 1.3 | 0.23% | 195.8 | 34.86% | 561.7 | 212.81 | 3.52% | 2016 |
| Fenasia Ltd. | 0.2 | 0.05% | 61.1 | 13.87% | 440.6 | 212.08 | 2.31% | 2016 |
| Filtron Engineers Ltd. | 0 | 0.00% | 30.2 | 1438.10 % | 2.1 | 2247.88 | -33.72% | 2016 |
| Govind Poy Oxygen Ltd. | 0 | 0.00% | 1.9 | 2.58% | 73.7 | 88.16 | 3.33% | 2016 |
| Kaveri Ginning Mills Pvt. Ltd. | 0.4 | 0.03% | 169.5 | 14.47% | 1171.4 | 78.36 | 2.92% | 2016 |
| M K Shipping & Allied Inds. Pvt. Ltd. | 0 | 0.00% | 191.2 | 37.10% | 515.3 | 527.26 | 1.78% | 2016 |
| Maco Pvt. Ltd. | 0.7 | 0.35% | 53.3 | 26.62% | 200.2 | 609.34 | 0.58% | 2016 |
| B M D Chemicals Pvt. Ltd. | 0 | 0.00% | 11.2 | 4.02% | 278.4 | 133.81 | -2.75% | 2017 |
| Containe Technologies Ltd. | -0.1 | -0.38% | 19.6 | 74.81% | 26.2 | 263.75 | 2.02% | 2017 |
| Dynalec Controls Pvt. Ltd. | 0.8 | 0.44% | 3.6 | 1.96% | 183.6 | 206.74 | 3.97% | 2017 |
| Efcee Global Ship Recycling Pvt. Ltd. | 0 | 0.00% | 109.1 | 7.95% | 1371.8 | 206.51 | 1.03% | 2017 |
| Elysium Pharmaceuticals Ltd. | 1.2 | 0.39% | 160.1 | 52.53% | 304.8 | 316.87 | 2.87% | 2017 |
| Fenasia Ltd. | 0.1 | 0.02% | 81.1 | 20.12% | 403.1 | 531.22 | 0.62% | 2017 |
| Filtron Engineers Ltd. | 0 | 0.00% | 13.9 | 4633.33 % | 0.3 | 30360.85 | -19.56% | 2017 |
| Govind Poy Oxygen Ltd. | 0 | 0.00% | 1.4 | 1.96% | 71.5 | 99.48 | 3.58% | 2017 |
| Kaveri Ginning Mills Pvt. Ltd. | 0.5 | 0.05% | 193 | 19.91% | 969.3 | 89.18 | 3.03% | 2017 |
| Maco Pvt. Ltd. | 0.7 | 0.23% | 52.7 | 17.25% | 305.5 | 351.6 | 0.53% | 2017 |
| B M D Chemicals Pvt. Ltd. | 0 | 0.00% | 4.7 | 1.56% | 302 | 111.67 | -3.04% | 2018 |
| Containe Technologies Ltd. | -0.1 | -2.94% | 12.5 | 367.65 % | 3.4 | 1616.84 | -5.37% | 2018 |
| Dynalec Controls Pvt. Ltd. | 1.2 | 0.62% | 8.6 | 4.47% | 192.2 | 217.7 | 4.56% | 2018 |

| Company Name | ICT Investment (MN INR) | ICT Investment per sales (in %) | Short-term borrowings (MN INR) | Short-term borrowings per sales (in %) | Sales (MN INR) | Gross working capital cycle (days) | ROA (in %) | Financial Year |
|---|---|---|---|---|---|---|---|---|
| Efcee Global Ship Recycling Pvt. Ltd. | 0.1 | 0.01% | 85.8 | 8.66% | 990.6 | 216.08 | 0.43% | 2018 |
| Elysium Pharmaceuticals Ltd. | 1.4 | 0.34% | 156.8 | 38.45% | 407.8 | 219.06 | 3.66% | 2018 |
| Fenasia Ltd. | 0.1 | 0.03% | 76.3 | 19.71% | 387.2 | 347.79 | -1.45% | 2018 |
| Filtron Engineers Ltd. | 0.2 | 2.15% | 12.9 | 138.71 % | 9.3 | 1248.94 | -12.75% | 2018 |
| Kaveri Ginning Mills Pvt. Ltd. | 0.4 | 0.03% | 107.6 | 8.19% | 1314.2 | 63.94 | 2.16% | 2018 |
| M K Shipping & Allied Inds. Pvt. Ltd. | 0.1 | 0.03% | 167.8 | 43.93% | 382 | 680.6 | 0.52% | 2018 |
| Maco Pvt. Ltd. | 0.8 | 0.21% | 46.5 | 11.98% | 388.2 | 258.46 | 1.87% | 2018 |
| B M D Chemicals Pvt. Ltd. | 0.1 | 0.03% | 22.2 | 6.14% | 361.6 |  | -0.53% | 2019 |
| Containe Technologies Ltd. | 0.1 | 1.08% | 7.1 | 76.34% | 9.3 | 395.48 | -9.21% | 2019 |
| Dynalec Controls Pvt. Ltd. | 0.9 | 0.34% | 17.3 | 6.50% | 266.3 | 146.81 | 13.24% | 2019 |
| Efcee Global Ship Recycling Pvt. Ltd. | 0.3 | 0.32% | 82.6 | 88.44% | 93.4 | 1271.71 | 0.20% | 2019 |
| Elysium Pharmaceuticals Ltd. | 0.5 | 0.12% | 123.1 | 28.81% | 427.3 | 185.04 | 3.83% | 2019 |
| Fenasia Ltd. | 0.2 | 0.05% | 61.9 | 15.31% | 404.4 | 329.49 | -1.88% | 2019 |
| Filtron Engineers Ltd. | 0.3 | 0.80% | 24.6 | 65.25% | 37.7 | 318.16 | -8.82% | 2019 |
| Govind Poy Oxygen Ltd. | 0.3 | 0.43% | 7.2 | 10.24% | 70.3 | 121.69 | 1.13% | 2019 |
| Kaveri Ginning Mills Pvt. Ltd. | 0.4 | 0.04% | 138.8 | 14.92% | 930.5 | 98.68 | 2.39% | 2019 |
| M K Shipping & Allied Inds. Pvt. Ltd. | 0.1 | 0.01% | 1127.8 | 135.13 % | 834.6 | 180.39 | 0.61% | 2019 |
| Maco Pvt. Ltd. | 0.7 | 0.21% | 37.5 | 11.39% | 329.2 | 257.35 | 1.12% | 2019 |

**b. Sample data –DURING COVID**

| Company Name | ICT Investment (MN INR) | ICT Investment per sales (in %) | Short-term borrowings (MN INR) | Short-term borrowings per sales (in %) | Sales (MN INR) | Gross working capital cycle (days) | ROA (in %) | Financial Year |
|---|---|---|---|---|---|---|---|---|
| B M D Chemicals Pvt. Ltd. | 0.1 | 0.02% | 33.1 | 7.22% | 458.2 | 99.41 | 4.26% | 2020 |
| Containe Technologies Ltd. | 0.3 | 1.45% | 4 | 19.32% | 20.7 | 3787.3 | 0.25% | 2020 |
| Dynalec Controls Pvt. Ltd. | 0.9 | 0.39% | 70.4 | 30.15% | 233.5 | 583.7 | 0.52% | 2020 |
| Efcee Global Ship Recycling Pvt. Ltd. | 0 | 0.00% | 48.9 | 2.36% | 2072.8 | 254.08 | 3.38% | 2020 |
| Elysium Pharmaceuticals Ltd. | 29.3 | 1.54% | 583.3 | 30.67% | 1901.6 | 216.92 | 13.27 % | 2020 |
| Fenasia Ltd. | 0 | 0.00% | 67.6 | 20.15% | 335.5 | 167.36 | 0.00% | 2020 |
| Filtron Engineers Ltd. | 0 | 0.00% | 4.6 | 0.00% | 0 | 796.83 | 25.13 % | 2020 |
| Govind Poy Oxygen Ltd. | 0 | 0.00% | 6.2 | 6.62% | 93.6 | 84.32 | 1.98% | 2020 |
| Kaveri Ginning Mills Pvt. Ltd. | 0.2 | 0.02% | 106 | 10.56% | 1004.1 | 85.08 | 2.42% | 2020 |
| M K Shipping & Allied Inds. Pvt. Ltd. | 0 | 0.00% | 1.9 | 0.39% | 487.5 | 281.08 | 13.79 % | 2020 |
| Maco Pvt. Ltd. | 0.2 | 0.08% | 53.3 | 21.24% | 251 | 395.05 | 0.53% | 2020 |
| B M D Chemicals Pvt. Ltd. | 0.1 | 0.04% | 34.4 | 13.30% | 258.7 | 188.87 | 1.95% | 2021 |
| Containe Technologies Ltd. | 1 | 16.95% | 52.6 | 891.53% | 5.9 | 338209.4 | 0.14% | 2021 |
| Dynalec Controls Pvt. Ltd. | 1.2 | 0.49% | 39 | 15.80% | 246.8 | 474.69 | 0.24% | 2021 |
| Efcee Global Ship Recycling Pvt. Ltd. | 0.1 | 0.01% | 0 | 0.00% | 1329.2 | 262.98 | 2.17% | 2021 |
| Elysium Pharmaceuticals Ltd. | 33.1 | 2.06% | 356.6 | 22.21% | 1605.5 | 163.04 | 15.49 % | 2021 |
| Fenasia Ltd. | 0.3 | 0.10% | 63.9 | 21.79% | 293.3 | 192.94 | -0.09% | 2021 |
| Filtron Engineers Ltd. | 0 | 0.00% | 3.4 | 0.00% | 0 | 639.27 | -12.44 % | 2021 |
| Govind Poy Oxygen Ltd. | 0 | 0.00% | 7.4 | 11.60% | 63.8 | 110.02 | -6.39% | 2021 |
| Kaveri Ginning Mills Pvt. Ltd. | 0.2 | 0.03% | 152.8 | 24.29% | 629.1 | 123.25 | 1.72% | 2021 |

| Company Name | ICT Investment (MN INR) | ICT Investment per sales (in %) | Short-term borrowings (MN INR) | Short-term borrowings per sales (in %) | Sales (MN INR) | Gross working capital cycle (days) | ROA (in %) | Financial Year |
|---|---|---|---|---|---|---|---|---|
| M K Shipping & Allied Inds. Pvt. Ltd. | 0 | 0.00% | 561.7 | 126.57% | 443.8 | 443.68 | 1.27% | 2021 |
| Maco Pvt. Ltd. | 0.3 | 0.14% | 45.5 | 20.83% | 218.4 | 485.73 | 0.32% | 2021 |
| B M D Chemicals Pvt. Ltd. | 0.1 | 0.04% | 16.7 | 6.09% | 274.3 | 147.74 | 0.67% | 2022 |
| Containe Technologies Ltd. | 1.1 | 3.77% | 41.5 | 142.12% | 29.2 | 469.79 | 1.00% | 2022 |
| Dynalec Controls Pvt. Ltd. | 1.7 | 0.36% | 6.4 | 1.34% | 477.8 | 178.2 | -0.53% | 2022 |
| Efcee Global Ship Recycling Pvt. Ltd. | 0.2 | 0.01% | 140.9 | 8.17% | 1725.5 | 160.93 | 2.89% | 2022 |
| Elysium Pharmaceuticals Ltd. | 3 | 0.36% | 267.8 | 31.97% | 837.7 | 192.95 | 6.52% | 2022 |
| Fenasia Ltd. | 0.1 | 0.03% | 61 | 16.58% | 368 | 170.9 | -0.04% | 2022 |
| Filtron Engineers Ltd. | 0 | 0.00% | 3 | 0.00% | 0 | 669.53 | -8.44% | 2022 |
| Govind Poy Oxygen Ltd. | 0 | 0.00% | 5.1 | 6.85% | 74.4 | 97.39 | -1.56% | 2022 |
| Kaveri Ginning Mills Pvt. Ltd. | 0.1 | 0.01% | 95.2 | 13.11% | 726 | 95.77 | 2.26% | 2022 |
| M K Shipping & Allied Inds. Pvt. Ltd. | 0 | 0.00% | 3.1 | 0.58% | 539 | 285.16 | 0.75% | 2022 |
| Maco Pvt. Ltd. | 0.4 | 0.22% | 49.8 | 27.39% | 181.8 | 666.32 | 0.25% | 2022 |