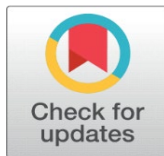
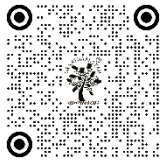


# DESIGN THINKING AND USER EXPERIENCE IN MANUFACTURING MSMEs: A SYSTEMATIC LITERATURE REVIEW AND RESEARCH GAP ANALYSIS

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## ABSTRACT

Design Thinking (DT) and User Experience (UX) are poised to create a transformative opportunity for the manufacturing sector in the context of Micro, Small and Medium Enterprises (MSMEs) in India. Although MSMEs account for more than 94% of the industrial units in India with an estimated share of about 40% in Indian industrial output, they are very limited in their use of human-centred design methodologies. This paper aims to carry out a systematic literature review (SLR) on the existing literature across the fields of Design Thinking, UX methodologies, and innovation frameworks with regards to small and medium manufacturing enterprises (SMEs). This review, based on the published literature found in Scopus, Web of Science, and Google Scholar database (2010-2024), critically examines the state of knowledge, key theories, and important research gaps. The study shows that although DT is being used in technology and service industries, there is still limited research and literature available that applies Design Thinking in resource-challenged manufacturing MSMEs, especially in India. Likewise, the tenets of UX - which are most often seen in digital products - have not been applied to a manufacturing setting as often. According to the paper, there is a gap in the literature that is a lack of an integrated framework bringing DT and UX together which is specifically applicable to Indian manufacturing MSMEs. The general foundation and rationale for the development of such a framework is given in this gap analysis, which forms the main contribution of the larger doctoral research programme. Academic, practitioner and policy implications are discussed.

**Keywords:** Design Thinking, User Experience, MSMEs, Manufacturing, Innovation Framework, India, Human-Centred Design, Systematic Literature Review

## 1. INTRODUCTION

The Micro, Small and Medium Enterprise (MSME) sector is also considered to be one of the pillars of the Indian economy, contributing to over 110 million jobs and over 7,500 categories of products (Ministry of MSME, 2023). The manufacturing sub-sector is the most vital sector as MSMEs contribute to about 45% of manufacturing output and 40% of export in the sector. However, these contributions notwithstanding, there is a significant productivity gap between the Indian manufacturing MSMEs and the MSMEs from other nations, which is increasingly being blamed on the lack of structured innovation and human-centred design practices (Mehta, 2014; Roy & Modak, 2026).

Design Thinking (DT) is a problem-solving process that focuses on the empathy, ideation, prototyping and iteration aspects, and has been proven to have transformative effects in a variety of fields from healthcare to education, and digital technology (Brown, 2008; IDEO, 2015). At the same time, User Experience (UX) research has evolved from the digital realm to the usability of products, worker ergonomics, and industrial human-machine interaction (Weiss and Huber, 2016; Li et al., 2022). For those companies with limited resources, the synergy between these two disciplines can be a formidable means of adding value to the product, optimizing processes and providing a competitive edge.

But, a thorough search of published literature shows there is a large research gap in the existing literature on the subject, especially on the field of DT, UX, and Indian manufacturing MSMEs. The majority of the current set of frameworks to support DT in SMEs are based on western industrial contexts and are primarily concentrated on software, services or large-scale manufacturing, which makes their direct application limited to Indian MSMEs (Müller & Thoring, 2012; Liedtka, 2015). In order to address this gap, this paper presents a systematic literature review that brings the theoretical landscape to the fore and highlights the areas of scant knowledge.

## 1.1. RESEARCH OBJECTIVES OF THIS PAPER

The aim of this literature review paper is to achieve the following specific objectives:

- 1) To map and synthesize existing literature on Design Thinking, UX and MSMEs from the key academic databases.
- 2) To analyse the current innovation systems and their suitability to manufacturing MSMEs in India.
- 3) To define and explain the gaps in research that warrant the creation of an integrated DT–UX framework.
- 4) To provide a theoretical underpinning to the extended doctoral research programme.

## 1.2. PAPER STRUCTURE

This paper is organized as follows: In Section 2, the methodology for the systematic literature review is described. Section 3 presents a review of the evolution, models and application of Design Thinking in SMEs. Section 4 looks at UX research in manufacturing and industrial settings. In section 5, the current innovation frameworks and their shortcomings are discussed. Section 6 is a synthesis of findings and maps research gaps. Conclusions and future research directions are given in section 7.

## 2. METHODOLOGY: SYSTEMATIC LITERATURE REVIEW

The research method employed in this study is Systematic Literature Review (SLR) that uses PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines published by Moher et al. (2009). The SLR approach was selected because it is transparent, easily reproducible and allows to reduce selection bias when mapping a broad interdisciplinary literature landscape.

### 2.1. SEARCH STRATEGY AND DATABASES

The search was performed on three top academic databases: Scopus (Elsevier), Web of Science (Clarivate), and Google Scholar. The time period of the search was limited to 2010-2024 for relevance. The following boolean search strings were used:

- ("Design Thinking" AND "SME" OR "MSME" OR "Small Enterprise" AND "Manufacturing")
- ("User Experience" OR "UX" AND "Manufacturing" AND "SME")
- ("Innovation Framework" AND "MSME" AND "India")
- ("Human-Centred Design" AND "Manufacturing" AND "Developing Countries")
- ("Design Thinking" AND "UX" AND "Framework" AND "Product Development")

## 2.2. INCLUSION AND EXCLUSION CRITERIA

| Inclusion Criteria                                   | Exclusion Criteria                              |
|--|---|
| Peer-reviewed journal articles and conference papers | Non-peer-reviewed sources, blogs, reports       |
| Published between 2010 and 2024                      | Publications before 2010 (except seminal works) |
| Focus on DT, UX, SME/MSME, manufacturing, innovation | Unrelated domains (pure IT, medicine, arts)     |
| Written in English                                   | Non-English publications without translation    |
| Empirical, theoretical, or review papers             | Opinion pieces, editorials                      |
| Studies addressing developing economies or India     | Studies exclusively from large enterprises      |

## 2.3. SEARCH OUTCOMES

A first search in the databases resulted in 3,847 articles. Duplicate articles (n=612) and articles excluded due to title/abstract screening (n=2104) were excluded, leaving 1131 articles full text for evaluation. After the full text screening for inclusion criteria, 214 articles were included for detailed reading and themed synthesis. Of these, 89 were Design Thinking, 54 were UX in non-digital, 41 were innovation frameworks for SME and 30 were Indian MSME specific design research.

Figure 1

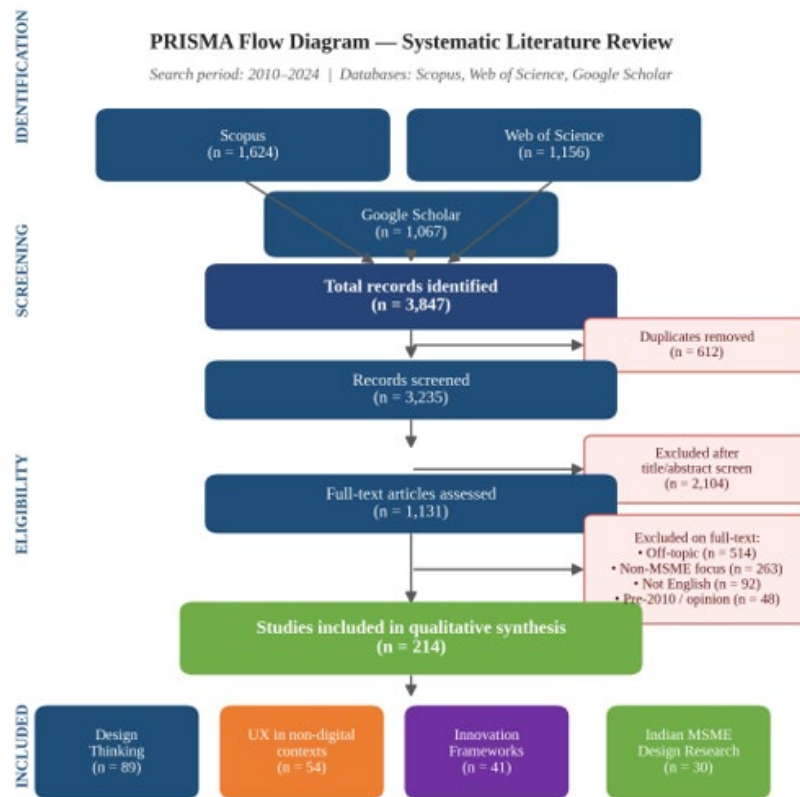


Figure 1 PRISMA Flow Diagram for the Systematic Literature Review- Of 3,847 Records Identified Across Three Databases (Scopus, Web of Science, Google Scholar), 214 Papers Were Retained for Thematic Synthesis. Adapted From Moher Et Al. (2009).

## 3. DESIGN THINKING: EVOLUTION, MODELS, AND SME APPLICATIONS

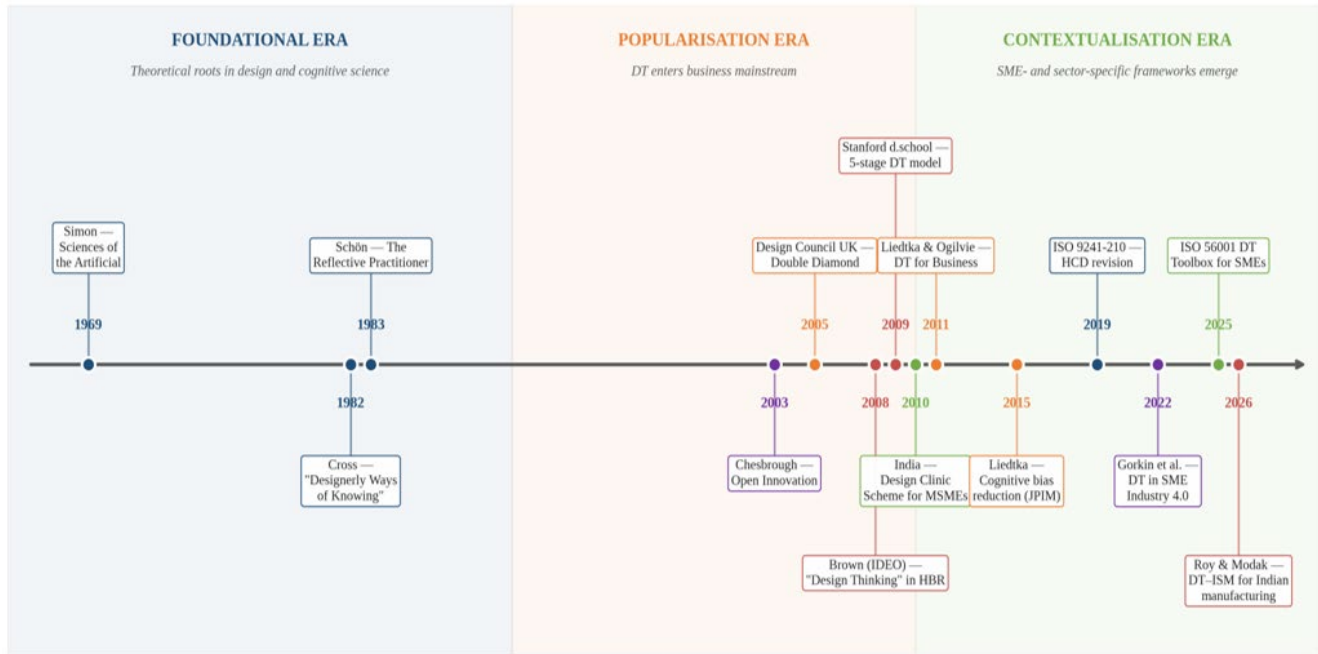
### 3.1. CONCEPTUAL ORIGINS AND EVOLUTION

The design processes of engineering and architecture in the 1960s and 1970s gave rise to Design Thinking as a formalized methodology, which was widely recognized in the academic community by Cross (1982), Schön (1983) and, later, Simon (1996). It is popularized, however, as a tool for business innovation by the global design consultancy, IDEO,

and the Stanford d.school, which formalized the five-stage methodology: Empathize, Define, Ideate, Prototype, Test (Brown, 2008; Plattner et al., 2009).

Since then there have been successive interpretations and extensions of DT. The Double Diamond model (2005) by the UK Design Council is a divergent-convergent process that unfolds in the stages of Discovery, Definition, Development, and Delivery. Liedtka and Ogilvie (2011) suggested a more formalized ten-step process, focused on business managers. Meineke and Leifer (2011) noted DT's iterative, non-linear process as its most salient feature. Recently, researchers have explored DT in organizations, social innovation, and public sector reform.

**Figure 2**



**Figure 2** Evolution of Design Thinking - Key Milestones (1969–2026)-Three Eras: Foundational (Theoretical Roots), Popularisation (Business Mainstream), And Contextualisation (SME- And Sector-Specific Frameworks).

### 3.2. DESIGN THINKING IN MANUFACTURING AND SME CONTEXTS

Design Thinking in manufacturing contexts has been increasingly, but not extensively, explored in the academic literature. Hekkert and van Dijk (2011) explored product innovation using the DT lenses, and Björgvinsson et al. (2012) discussed participatory design in the industrial field. In SMEs, the collaborative and iterative approach of DT is well suited to the flexible organizational structures of SMEs, but the implementation challenges lie in the resources, as pointed out by Müller and Thoring (2012).

A notable contribution is that of Roy and Modak (2026) who developed a methodology to rank the attributes of Design Thinking for product innovation in Indian manufacturing using Interpretive Structural Modelling (ISM) and identified empathy, visualization, and difference creation as the most critical attributes. Likewise, since 2010, the National Institute of Design (NID) has been running a Design Clinic Scheme for MSMEs, which has recorded more than 200 intervention programmes and illustrated how transformative design could be and the ongoing challenges to wider scale adoption of DT (Mehta, 2014).

More recently, Gorkin et al. (2022) showed how DT processes help manufacturing SMEs deal with the complexity of digitalisation in Industry 4.0, and in conclusion suggested that 'the potential value of design thinking in manufacturing SMEs needs to be further explored by analysing more cases and industries'. The present doctoral research directly confirms the research gap targeted in the work.

### 3.3. BARRIERS TO DESIGN THINKING ADOPTION IN INDIAN MSMEs

Although there is increasing awareness, there are significant challenges to embrace Design Thinking in Indian manufacturing MSMEs. Based on the literature reviewed the following challenges are identified for the study:

- Limited financial resources for hiring external consultants, training, and prototyping (Subrahmanya, 2015; Bahl et al., 2021).
- Awareness Deficit: Lack of awareness of DT methodologies among the MSME owners and managers (Mehta, 2014; Singh & Kumar, 2020).
- Skill Gaps: Lack of skilled design professionals in the MSMEs, especially in tier 2 and tier 3 cities (Ministry of MSME, 2022).
- Cultural Resistance: a predisposition to opt for tried and tested methods instead of exploring new ones that involve taking risks (Bloom et al., 2013).
- Limitation of Infrastructure: Lack of adequate prototyping facilities and digital infrastructure in MSME clusters (Das, 2007; Khurana et al., 2021).
- Policy Gaps: Lack of linkages between the government design promotion schemes and the requirements at ground level (Mehta, 2014).

## 4. USER EXPERIENCE IN MANUFACTURING AND INDUSTRIAL CONTEXTS

### 4.1. DEFINING UX BEYOND DIGITAL INTERFACES

According to ISO 9241-210:2019 (The ISO Standard) User Experience (UX) is defined as 'a person's perceptions and responses arising from the use and/or expected use of a product, system or service'. Since the 1990s, UX research has been primarily applied to digital products and software interfaces, but over the last few decades, there has been an increasing amount of literature that has started to apply UX to physical products, industrial systems, and workplace situations (Norman, 2013; Li et al., 2022).

On the other hand, Li et al. (2022) conducted a bibliometric analysis of 14,825 publications in UXD from 1999 to 2019, where they discovered that Computer Science and Engineering are the primary research domains with UX converging with manufacturing and industrial design as a new research frontier. Significantly, interdisciplinary UX research that crosses the engineering, management science and psychology disciplines is growing and receiving widespread acceptance, indicating uptake of UX scholarship for manufacturing..

### 4.2. UX IN INDUSTRIAL AND MANUFACTURING SETTINGS

In manufacturing contexts, UX research has mostly focused on three sub-domains: human-machine interface (HMI) design, worker ergonomics, and human-robot collaboration. Weiss and Huber (2016) carried out a groundbreaker study on UX of industrial robots in automotive assembly lines, which results were that 'UX aspects are crucial in the factory context, because they might affect the production process'. The results of their research showed that robotic systems with poor UX resulted in lower flexibility of workers and a lower productivity level.

As various technologies in the scope of Industry 4.0 are increasingly being integrated into manufacturing processes, UX's role in manufacturing has become even more significant. A 2026 systematic review of publications in the field of UI/UX in industrial context has found an increasing number of publications in the last two years (2022 and 2023), showing a steady rising trend of publications. Research has been conducted on visual ergonomics in control systems, touch screen systems on factory floors and augmented reality in assembly support, amongst others, and it has been proven that all of them can be measured and show a measurable decrease in error and increase in efficiency.

But a key takeaway from the literature reviewed is that there is a significant bias towards UX research in the context of large-scale, high-tech companies in manufacturing. The use of UX techniques in the manufacturing of MSMEs, especially in the developing world, where they are operated with limited resources and technology, is virtually non-existent in the academic literature. This is one of the biggest gaps noted in this review.

### 4.3. UX AS A BUSINESS VALUE DRIVER IN SMES

In the technology industry the business case for UX investment is clear, Forrester Research (2016) found that every dollar invested in UX would make up to 100 dollars come back. But, putting it into the context of manufacturing SMEs involves contextual adaptation. By defining how to leverage UX strategies to create product cycles, navigate design pitfalls, and enhance end user satisfaction within a B2B manufacturing environment, Bevan et al. (2016) and Roto et al. (2011) have provided research that further illustrates these points.

The opportunity for UX as a value driver in the Indian MSME landscape is even more intriguing, especially since the sector is striving to become a global player. Usability and aesthetic standards vary across the world, and products that fail to adhere to them have limited market penetration, if they do. Thus the integration of UX in the MSME product development pipeline becomes a competitive requirement as well as a great research opportunity.

## 5. INNOVATION MODELS AND THEIR LIMITATIONS FOR MANUFACTURING MSMEs

### 5.1. OVERVIEW OF EXISTING INNOVATION FRAMEWORKS

There is a plethora of innovation management and design frameworks in the literature, with different philosophies and logics of operation. This section discusses the most popular frameworks in the context of their relevance for manufacturing MSMEs.

**Table 1**

**Table 1 Comparative Analysis of Existing Innovation and Design Frameworks for Manufacturing MSMEs and Their Key Limitations**

| Framework                                 | Core Principles  | Limitations for MSMEs  |
|---|--|--|
| Stanford d.school Design Thinking         | Empathy-driven, 5-stage iterative process; human-centred problem-solving       | Requires trained facilitators; resource-intensive; not contextualized for manufacturing        |
| Lean Startup (Ries, 2011)                 | Build-Measure-Learn loop; MVP-based iteration; validated learning              | Primarily digital/service context; lacks design integration; not adapted for physical products |
| Agile Innovation                          | Iterative sprints; cross-functional teams; continuous delivery                 | Requires structured team infrastructure; limited applicability to shop-floor manufacturing     |
| Business Model Canvas (Osterwalder, 2010) | 9-building-block strategic visualization; value proposition centred            | Strategic tool only; no operational design guidance; minimal UX integration                    |
| Double Diamond (Design Council UK)        | Divergent-convergent thinking; 4D: Discover, Define, Develop, Deliver          | Western context; not validated for MSME or Indian manufacturing environments                   |
| Open Innovation (Chesbrough, 2003)        | External knowledge flows; collaboration with academia and industry             | Requires IP infrastructure; not suitable for informal-sector MSMEs                             |
| Design Clinic Scheme (NID, 2010)          | Government-facilitated design intervention; ergonomics and product improvement | Limited scalability; project-based; no sustained framework for MSME integration                |

### 5.2. CRITICAL ANALYSIS: WHY EXISTING FRAMEWORKS FALL SHORT

An in-depth study of the above discussed frameworks highlights five major constraints of the implementation of the above within Indian manufacturing MSMEs:

The first is contextual mismatch: almost all dominant schemes of innovation relate to and are designed for the Western/technology/large enterprise context. The non-alignment of their assumptions on available resources, sophistication of the organizations and market conditions with Indian MSMEs with informal management structure, low capital and low digital literacy is observed (Bloom et al., 2013; Singh & Kumar, 2020).

Secondly, no systematic integration of UX: none of the considered frameworks explicitly include UX as an integral part of the innovation process. Design Thinking focuses on user needs rather than user research, but it does not leverage the systematic user research toolbox (like personas, journey mapping, usability testing, and measuring experience) that can make a substantial contribution to the quality of a product.

Thirdly, manufacturing specificity: most innovation frameworks are sector-independent, or, if sector-dependent, focus on the digital product. There is a lack of recognition of the unique properties of physical manufacturing, such as material constraints, manufacturing processes, supply chain dynamics and interactions between workers and products.

Fourth, the issue of validation gaps: even frameworks that are supposedly applicable to SMEs like the recent Design Thinking Toolbox for SMEs aligned with ISO 56001:2024 (Enabling Innovation Capabilities, 2025) recognise the shortcoming of 'still no validated framework exists which combines design thinking with structured, standards based approach'. This validates the need for framework validation to be a critical need. Chougala and Angadi (2026)

Fifth, policy-practice disconnection: Government initiated programs like Design Clinic Scheme in India are beneficial but limited in their scope to projects and not institutions. Lack of theoretical backing and systematic evaluation for wider spread.

## 6. SYNTHESIS AND RESEARCH GAP ANALYSIS

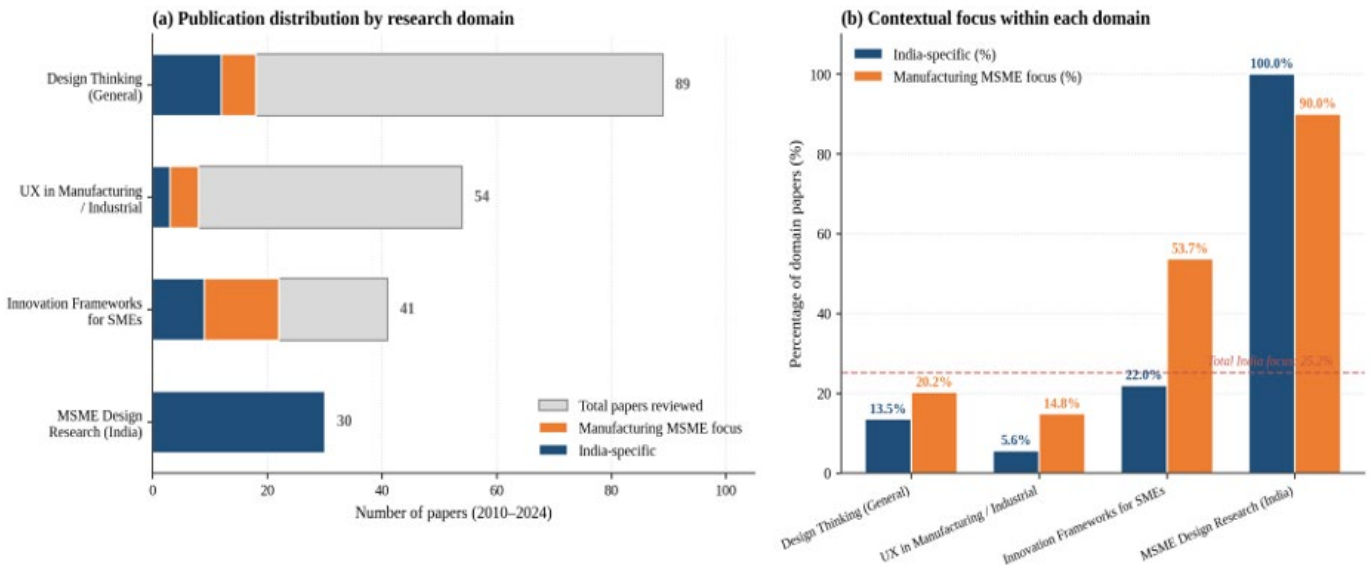
### 6.1. THEMATIC SYNTHESIS OF LITERATURE

This systematic review of 214 papers in the three areas of focus - Design Thinking, UX in manufacturing, and innovation frameworks for MSMEs - shows that the scholarly field is fragmented, with each of these areas developing more or less isolated. The publication rate and research focus by these areas are summarised in Table 2.

**Table 2**

| Table 2 Publication density across research domains (SLR findings, 2010–2024) |                 |                       |                          |
|---|-----------------|-----------------------|--------------------------|
| Research Domain   | Papers Reviewed | India-specific Papers | MSME Manufacturing Focus |
| Design Thinking (General)   | 89              | 12 (13.5%)            | 18 (20.2%)               |
| UX in Manufacturing/Industrial  | 54              | 3 (5.6%)              | 8 (14.8%)                |
| Innovation Frameworks for SMEs  | 41              | 9 (22.0%)             | 22 (53.7%)               |
| MSME Design Research (India)  | 30              | 30 (100%)             | 27 (90.0%)               |
| <b>Total</b>  | <b>214</b>      | <b>54 (25.2%)</b>     | <b>75 (35.0%)</b>        |

**Figure 3**

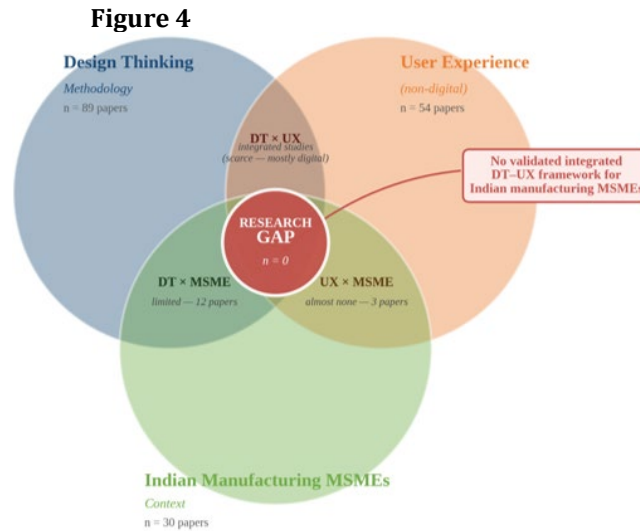


**Figure 3** Publication Distribution Across Research Domains (N = 214)-Panel (A) Shows Total Papers Reviewed, With India-Specific and Manufacturing-MSME-Focused Subsets Highlighted. Panel (B) Renders the Same Data as Proportions, Revealing the Systemic Underrepresentation of Indian And MSME-Specific Research

### 6.2. IDENTIFIED RESEARCH GAPS

The findings of a systematic literature review and thematic synthesis lead to the identification of six main gaps in the research. The results of the systematic literature review and thematic synthesis suggest six main research gaps that

are expressed below. Together these gaps form the academic rationale behind the integrated DT-UX framework of the overall doctoral research:



**Figure 4** Mapping The Research Gap-DT × UX × Indian Manufacturing Msmes Intersection-The Three Domains Overlap Pairwise But Produce Zero Validated Frameworks at the Three-Way Intersection (Highlighted In Red).

### Gap 1: Absence of an Integrated DT-UX Framework for Manufacturing MSMEs

There is no published study that has developed and validated a framework that fits Design Thinking methodology and User Experience principles for the context of manufacturing MSMEs. The current approaches only consider one dimension at a time, therefore failing to cover an important gap in theory and practice.

### Gap 2: Underrepresentation of Indian Manufacturing MSMEs in DT Research

Less than 14% (12 out of 89 papers) of the DT papers discussed Indian context, and fewer than half of these papers discussed manufacturing specifically. MSMEs in India are characterised by unique institutional, cultural, and economic features such as the cluster-based industrial organisation, informal management practices and policy dynamics of the government, which are under-theorized.

### Gap 3: Limited UX Research in Physical Manufacturing and Developing Economies

The field of UX research in manufacturing has manifested itself mostly in high-technology settings in developed countries such as Europe, North America, and East Asia. 3 of 54 papers in the UX-manufacturing collection covered UX situations in India or in developing economies, none of which specifically covered micro or small enterprises. The area of UX adaptation to low technology, resource-limited manufacturing is almost entirely unexplored.

### Gap 4: Lack of Validated Innovation Frameworks for Indian MSME Manufacturing

Although there are some innovation frameworks which state that they are applicable to the SMEs, there is little empirical evidence in Indian manufacturing MSMEs. Systematic work to adapt to local contextual factors such as dynamics of informal economy, caste and gender composition of workforce, characteristics of industrial clusters and policy ecosystems has not taken place.

### Gap 5: Insufficient Attention to DT-UX Synergies in Product Value Creation

There is a lack of articulation and empirical testing between DT's empathy-based approach to problem framing and UX's user research techniques (personas, journey mapping, heuristic evaluation) which can be used to improve the value of products in manufacturing contexts.

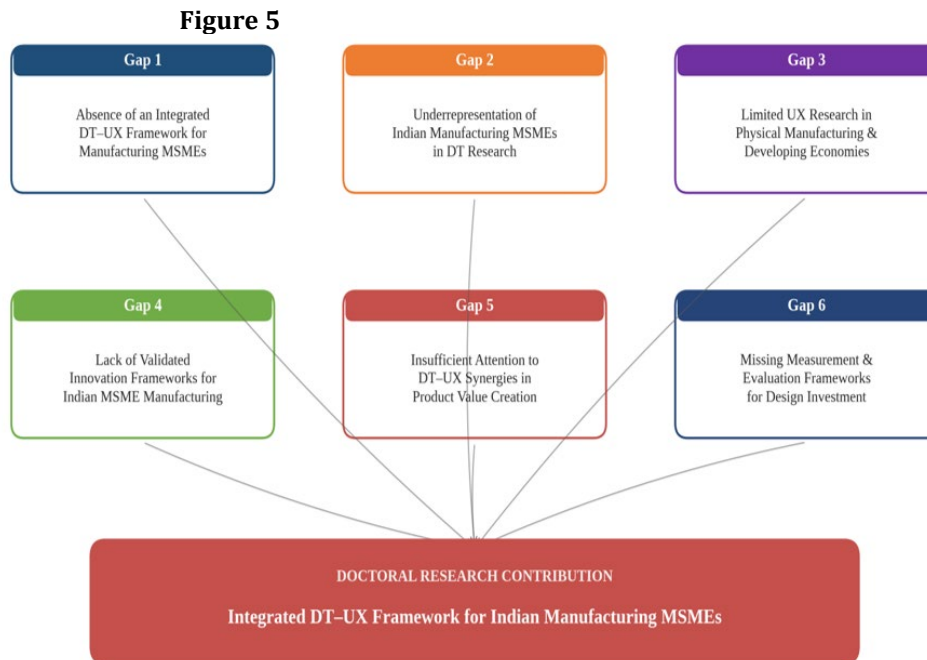
### Gap 6: Missing Measurement and Evaluation Frameworks

In those places where DT or UX is implemented in MSMEs, there is no strong framework to measure the effect of DT or UX on product quality, market performance, worker satisfaction, and organizational ability. This evaluation gap reduces the amount of evidence that can be used to make a compelling case to MSME stakeholders and policymakers regarding the importance of design investment.

### 6.3. POSITIONING OF THE PROPOSED DOCTORAL RESEARCH

All the research gaps identified above form a unique research niche-Development and validation of an integrated Design Thinking–User Experience framework for empowering Indian manufacturing MSMEs. This gap is not just theoretical, but practical for millions of MSME workers and entrepreneurs, for manufacturing competitiveness in India like 'Make in India' and 'Atmanirbhar Bharat', and for the world of knowledge and understanding about human-centred innovation in resource-constrained settings.

The proposed doctoral work covers all the six gaps with a mixed method approach including:(1) Empirical investigation of DT adoption challenges, (2) Exploratory study of the applicability of UX in MSME manufacturing, (3) Development of an expert panel framework and (4) Pilot validation of the integrated framework in selected MSME clusters in Delhi NCR, Ludhiana and Surat.



**Figure 5** Six Research Gaps Justifying the Doctoral Research Programme-Each Gap, Derived From the SLR, Provides Distinct Theoretical Justification for the Proposed Integrated DT–UX Framework for Indian Manufacturing Msmes.

## 7. CONCLUSIONS AND FUTURE RESEARCH DIRECTIONS

This systematic literature review has drawn a picture of how Design Thinking, User Experience, Innovation frameworks intersect in the context of manufacturing MSMEs in India. The review is an affirmation that although a lot of scholarship has been generated on each of these domains, a need to integrate them, especially in the MSME manufacturing context, is one of the critical research frontiers which has not been explored to a great extent.

The main conclusions of this review are: (a) Design Thinking has shown its potential to transform the innovation process in SMEs, but has been found to have significant adoption barriers in Indian manufacturing MSMEs; (b) UX research in manufacturing has been a growing activity, but it is limited to technologically advanced companies in developed economies; (c) Research on integrating DT and UX in manufacturing has yet to be adequately contextualized for the institutional, cultural and resource environment of MSMEs in India; and (d) There is no validated integrated DT–UX framework for manufacturing MSMEs in India.

These results provide a solid academic foundation for the doctoral research programme which aims to create and test this framework. The future research outcomes of this programme will be: Theoretical insights in the conceptual

framework of DT and UX; Measurement instruments proved in the respective sector; Adoption guidelines for DT and UX use in MSMEs; Policy recommendations for development of design ecosystem in manufacturing sector in India.

In this paper it offers an initial systematic and comprehensive mapping of the intersection of DT and UX-with the importance that it provides the first such mapping of the intersection of DT and UX; and that it is a replicable methodological model for future review studies in design research.

## CONFLICT OF INTERESTS

None.

## ACKNOWLEDGMENTS

None.

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