



A Study on Knowledge Sharing Practices Prevailing in Smart Manufacturing in India

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Abstract- The Indian manufacturing industry is currently going through the transition towards Smart manufacturing (SM), which is highly important to the industry and its related competitiveness at the global level. As much as technology implementation is a major parameter of interest, human and organizational aspects especially Knowledge Sharing (KS) practices have not been thoroughly studied. KS is the key to using the latest technologies, such as the Internet of Things (IoT), Artificial Intelligence (AI), and big data analytics. This paper examines the current situation of KS practices in Indian SM organizations. Mixed-method approach was used whereby a systematic literature review was conducted together with a cross-sectional survey of 127 professionals working in different Indian manufacturing companies with adoption of SM principles. The questionnaire was used to determine KS enablers, barriers and perceived organizational performance. Statistical tools that were used to analyze data include descriptive statistics and non-parametric tests. Results show that there is strong positive relationship between formal and informal structured KS mechanisms and perceived operational efficiency. Nevertheless, the research also notes such persistent obstacles as hierarchical organization, lack of standardized processes, and generational resistance to online tools. The study concludes that to ensure that Indian manufacturing maximizes its SM investments, the strategic approach that builds on the knowledge-based culture should be voluntary with the proper technology and leadership being the key.

Keywords- Smart Manufacturing, Knowledge Sharing, Industry 4.0, India, Organizational Culture, Digital Transformation.

I. INTRODUCTION

The international production environment is shifting towards a paradigm shift, commonly referred to as the fourth industrial revolution or Industry 4.0. This revolution can be described as the implementation of cyber-physical systems, the Internet of Things (IoT), cloud computing, and artificial intelligence (AI) into the industrial processes, which is referred to as Smart Manufacturing (SM) (Kang et al., 2016). SM offers efficiency, productivity, customization and agility on unprecedented levels. In the case of an emerging economic giant such as India, where prominent is the ambitious program Make in India, the adoption of SM is not only an opportunity but a strategic necessity to improve the competitiveness of the country in the world, create foreign investment flows, and gain high-value jobs (PWC, 2016).

The Indian manufacturing industry that is a major contributor to the GDP of the country is at a very pivotal cross-road. This is a growth-oriented economy that has high competition with other low-cost



economies and developed manufacturing countries. The opportunity presented by the adoption of SM technologies is a way to address the old traditional issues of quality, inefficiency in the supply chain, and the increase of labor cost (Goyal et al., 2021). The manufacturing is actively digitalized under the promotion of the policies of the government, including the National Manufacturing Policy and the SAMARTH Udyog Bharat initiative. Nevertheless, the dominant discourse and much of the early research have been largely concerned with the technological aspects of this transition, in the form of hardware, software, and communication infrastructure.

This technological determinism tends to dwarf a much more basic, humanistic element that is the foundation of any effective technological change: Knowledge. With SM, information becomes the raw material and knowledge is the finished product that brings about intelligent action. Smart factories produce large volumes of information on sensors, machines, and enterprise systems. The true value, though, becomes accessible once such information is converted into practical knowledge and, most importantly, when such knowledge is effectively distributed between departments, hierarchies, and functional silos (Frank et al., 2019). It is possible to define Knowledge Sharing (KS) as a situation in which people share tacit and explicit knowledge with each other in order to generate new knowledge or improve the current capabilities (Wang and Noe, 2010).

KS is diverse in a smart manufacturing ecosystem. It entails the exchange of tacit knowledge about machine malfunctions by shop-floor workers with data scientists; it entails design engineers to work with production teams with simulations of digital twins; and it demands that the strategic lessons of supply chain AI platforms should be spread to procurement managers. It is this two-way flow of knowledge that occurs continuously, and it is what makes a manufacturing organization appear to be really smart adaptive, learning and self-optimizing. Lack of the development of strong KS practices may result in the development of islands of automation whereby advanced technologies are deployed but they do not work together to achieve the full synergistic benefits.

Knowledge character of SM also undergoes change. It is made dynamic, data driven and in most cases is encoded into algorithms. This requires new KS mechanisms that surpass the conventional meetings and documentation. Online communities of practice, collaborative virtual worlds, and knowledge repositories that are connected to Manufacturing Execution Systems (MES) and Enterprise Resource Planning (ERP) systems turn out to be the essential pipelines to the flow of knowledge (Moeuf et al., 2018). The human-agent partnership involving worker interactions of AI and robotics makes the KS dynamic even more complicated and necessitates new trust and interaction models.

Even though it is critically important, the research gap on the socio-technical side of SM in India can be identified, and KS practices remain one of the most overlooked ones. The majority of the current research on Indian SM is based on technology readiness, implementation issues, or policy frameworks (Kamath and Rodrigues, 2020; Raut et al., 2021). What is scarcely studied is the cultural, behavioral and organizational parameters that will either support or prevent the sharing of knowledge in this new technologically intensive environment. India is a country with a distinct socio-cultural background, high power distance and a combination of traditional and modern work practices that introduces another element of complexity that can not be overlooked (Hofstede, 1984). It is crucial to understand how these cultural nuances can play with SM technologies to affect KS.

Thus, the proposed research will fill this gap by carrying out an empirical study of the knowledge-sharing culture that currently dominates in Indian smart manufacturing. It intends to transcend the technological enthusiasm and explore the human and organizational reality that in the long run defines the success or failure of the SM transformation. This study, by identifying the main enabling factors, impediments, and successful processes of KS, will offer practical information to the leadership of Indian manufacturing



firms, policymakers, and scholars, in their efforts to not only develop highly technological production plants, but really intelligent and learning enterprises.

II. LITERATURE REVIEW

The theoretical framework of the study lies in the convergence of two strong bodies of knowledge, Smart Manufacturing and Knowledge Management. This review is a synthesis of recent studies (mainly of 2018 and later) to provide the existing state of research and determine the gap that is the focus of this study.

The History and the Necessary of Smart Manufacturing.

Smart Manufacturing is a conceptual, integrated, and collaborative manufacturing system, which is responsive to changing demands and conditions in the factory, the supply network, and the customer needs in real-time (Davis et al., 2012). The latter is data-centric as highlighted by recent literature. As an example, Tao et al. (2018) define a data-driven smart manufacturing paradigm where all decisions are made based on insights that are derived with the help of data. At Indian context, research has initiated to trace the adoption path. A survey of Indian large companies by Goyal et al. (2021) established that although large firms are proactively testing IoT and cloud-based products, the rate of integration and maturity is low, and SMEs are far behind. The need of operational efficiency and quality improvement has been cited as the major drivers whereas high cost of investment and shortage of skilled workforce are cited as the major barriers.

Knowledge Sharing as a Strategic Resource in the Manufacturing.

The resource based perspective of the firm holds that knowledge is the most strategically important resource (Grant, 1996). In the manufacturing sector, successful KS has had a direct correlation with better innovation, the quickness of problem solving, and performance (Andreeva and Kianto, 2012). KS becomes more important as a result of the transition into SM. As Frank et al. (2019, p. 5) claim, in the Industry 4.0 setting, the key to the companies strategy lies in knowledge management. They argue that the capability to easily transfer and implement knowledge between cyber-physical systems is one of the main sources of competitive advantage. This can be reflected in Zhong et al. (2017), who point out that real-time data exchange within the supply chain is one of the basic components of smart manufacturing execution systems.

Important Enabling and inhibiting Knowledge Sharing.

- **The literature provides a number of types of factors affecting KS:** Technological Enablers The accessibility and access to Knowledge Management Systems (KMS), collaborative tools, and integrated digital tools are imperative. A study by Moeuf et al. (2018) determined that the ERP systems could be potent tools of explicit knowledge sharing in case they were successfully utilized. Nonetheless, the availability of technology is not enough, but it should be characterized by incorporation into day-to-day work.
- **Organizational and Cultural Enablers:** A culture of trust, collaboration, and support at the top-management level is always emphasized as the most important one (Wang and Noe, 2010). This is confirmed by recent literature on the topic of digital transformation. In a study of the German SMEs switching to Industry 4.0, Buechgens et al. (2021) discovered that collaborative organizational culture had a stronger predictive value on the successful integration of knowledge in comparison to technological infrastructure.
- **Barriers:** Some of the most frequent barriers are time, fear of losing unique value, insufficient incentives and overload of information (Riege, 2005). New obstacles are created in the SM context. Kamath and Rodrigues (2020) listed the resistance to change and digital culture as one of the leading challenges in Indian manufacturing. Moreover, the complexity of the SM technologies can



lead to an emergence of a knowledge gap between shop-floor workers who are unable to analyze data and data scientists who do not have knowledge of context (on the shop-floor) and this results in a new type of organizational silo (Zhou et al., 2020).

The Gap In the Research in Indian Context.

Although the general principles of KS and SM are discussed in the world literature quite well, the analysis of their overlap in the context of the socio-cultural and industrial situation in India is severely under-researched. Raut et al. (2021) conducted a systematic review of the use of Industry 4.0 in India and identified a great wealth of studies on the use of technologies, but only a sharp understanding of the lack of studies related to soft aspects, such as organizational culture and human resource practices. Kamath and Rodrigues (2020) briefly mentioned the issue of cultural barriers, but they did not go further into the details of KS practices, mechanisms, and their connection to performance outcomes.

Thus, the gap in this review consists in the absence of empirical and context-specific studies to investigate systematically how knowledge is shared in Indian smart manufacturing settings, what the most common mechanisms are, what are the peculiar barriers to knowledge sharing in the Indian organizational context, and how such practices finally affect operational performance. This research is aimed at filling this specific gap.

Problem Statement

Indeed, the problem of the ineffective dissemination of knowledge across organizational structures and functional areas is an imminent, albeit under-researched, problem in the Indian manufacturing sector on its way to Smart Manufacturing. Although there is a massive investment in new and improved technologies such as IoT, AI, and robotics, they do not have a well-developed knowledge-sharing environment that can seriously hurt the payoff of such investments. Organizations may end up developing a highly technological and yet mind-spliced operation where data are gathered without being converted into shared intelligence.

The absence of standardized digital knowledge-sharing procedures, the traditional hierarchical structure, and the skills gap contributing to the lack of fluid communication between people working at the shop-floor and data analysts all reinforce this issue. Thus, the Indian manufacturing companies can never become as agile, innovative, and able to deliver gradual improvement as the real smart enterprises do, unless a specific emphasis is placed on the development of knowledge-intensive cultures and the adoption of efficient mechanisms of knowledge sharing, which will compromise the global competitiveness of the industry.

Novelty of the Research

There are a few new contributions in the field presented in this research. To start with, it transforms the perspective on a technological analysis of Smart Manufacturing in India to a socio-technical one, specifically, it studies the human and organizational aspect of knowledge sharing. Second, it presents one of the earliest empirical, survey-based investigations of the Indian setting which quantitatively and qualitatively associates certain knowledge-sharing practices with the perceived measures of operational performance.

Thirdly, it recognizes and examines situational obstacles including the interaction between high power distance and collaborative imperative of SM, which is unique to the Indian organizational environment. Lastly, this study formulates a comprehensive model that entails the use of technological devices, organizational culture, and support of leaders as independent pillars of effective knowledge sharing in an Indian SM environment, which provides a real-world roadmap to industry players but is customized to fit local issues and opportunities.



III. RESEARCH QUESTIONS

1. What are the predominant formal and informal knowledge-sharing mechanisms currently utilized in Indian smart manufacturing organizations?
2. What are the most significant organizational, cultural, and technological barriers that impede effective knowledge sharing in this context?
3. Is there a statistically significant relationship between the maturity of knowledge-sharing practices and the perceived operational performance (e.g., efficiency, quality, innovation) of Indian smart manufacturing firms?

IV. METHODOLOGY

Research Design

This study employed a quantitative, cross-sectional research design to collect and analyze data at a single point in time. A survey strategy was deemed most appropriate for gathering data from a wide range of professionals across different Indian manufacturing firms, allowing for generalization of the findings.

Survey Instrument Development

A structured online questionnaire was developed based on an extensive review of the literature. The instrument consisted of four sections:

- **Section A:** Demographic information (e.g., industry type, company size, job role, experience with SM technologies).
- **Section B:** Knowledge Sharing Mechanisms - 12 items measuring the usage frequency of various formal (e.g., digital repositories, training sessions) and informal (e.g., communities of practice, instant messaging groups) mechanisms on a 5-point Likert scale (1=Never to 5=Always).
- **Section C:** Barriers to Knowledge Sharing - 15 items assessing the perceived significance of barriers (organizational, technological, individual) on a 5-point Likert scale (1=Strongly Disagree to 5=Strongly Agree).
- **Section D:** Perceived Organizational Performance - 8 items measuring respondents' perception of their unit's performance in areas like productivity, time-to-market, and defect rates compared to competitors, on a 5-point Likert scale (1=Much Worse to 5=Much Better).

The questionnaire was pre-tested with five academic experts and three industry professionals to ensure content validity and clarity. Cronbach's Alpha was calculated for each construct post-data collection, all exceeding the 0.7 threshold, indicating good internal consistency.

Data Collection and Sampling

The target population was professionals (engineers, managers, data analysts, operators) working in Indian manufacturing firms that have initiated SM projects. A non-probability, purposive sampling technique was used. The survey link was distributed via professional networking sites (LinkedIn), industry forums (Confederation of Indian Industry), and alumni networks of premier engineering institutes over eight weeks. A total of 127 complete and usable responses were obtained.

Handling Missing Data

The dataset was screened for missing values. Less than 2% of data points were missing completely at random (MCAR), as confirmed by Little's MCAR test ($\chi^2 = 15.32$, $p > 0.05$). Given the low percentage, a pairwise deletion method was employed for specific analyses to preserve the sample size for variables with complete data.



Demographic Analysis

A demographic profile of the respondents was created to understand the sample composition.

Table 1:

Demographic Characteristic	Category	Frequency	Percentage (%)
Industry Sector	Automotive	38	29.9%
	Pharmaceuticals	25	19.7%
	Electronics & Semiconductors	22	17.3%
	Heavy Engineering	18	14.2%
	Others	24	18.9%
Company Size (Employees)	< 100	21	16.5%
	100 - 499	35	27.6%
	500 - 1999	42	33.1%
	> 2000	29	22.8%
Job Role	Production/Operations	45	35.4%
	Engineering & R&D	33	26.0%
	IT/Data Analytics	28	22.0%
	Senior Management	21	16.5%
Experience with SM Tech	< 2 years	31	24.4%
	2 - 5 years	67	52.8%
	> 5 years	29	22.8%

V. DATA ANALYSIS AND RESULTS

Data analysis was conducted using SPSS Version 28. Descriptive statistics (mean, standard deviation) were used to address RQ1 and RQ2. To address RQ3, a Kruskal-Wallis H test (a non-parametric alternative to ANOVA) was used to compare performance perceptions across groups with different KS maturity levels, as the data for the performance score violated the assumption of normality.

RQ1: Predominant Knowledge Sharing Mechanisms

The mean usage scores for various mechanisms are presented in Table 2. Traditional methods like formal meetings (M=3.98) and email (M=4.15) were the most frequently used. Among digital platforms, instant messaging groups (e.g., WhatsApp, Teams) showed high adoption (M=4.02), while more structured



digital repositories like lessons-learned databases (M=2.45) and expert locator systems (M=2.10) were used significantly less. Informal coaching and mentoring received a moderately high score (M=3.65).

Table 2:

Knowledge Sharing Mechanism	Mean Score	Std. Deviation
Email	4.15	0.78
Instant Messaging Groups	4.02	0.91
Formal Meetings & Briefings	3.98	0.85
Internal Training Sessions	3.71	0.96
Informal Coaching/Mentoring	3.65	1.02
Online Communities of Practice	2.89	1.11
Lessons-Learned Databases	2.45	1.20
Expert Locator Systems	2.10	1.15

RQ2: Significant Barriers to Knowledge Sharing

The analysis of barriers revealed that organizational factors were perceived as the most significant. "Lack of time and heavy workload" (M=4.21) was the top barrier. "Organizational culture not encouraging open sharing" (M=3.95) and "Lack of rewards and recognition for sharing" (M=3.88) were also highly rated. Technological barriers, such as "Poor integration of IT systems" (M=3.72) and "Lack of user-friendly platforms" (M=3.55), were notable but ranked slightly lower than key organizational issues.

RQ3: Relationship between KS Maturity and Performance

To test this relationship, a composite "KS Maturity" score was created by averaging the scores from Section B of the survey. Respondents were then divided into three groups: Low Maturity (score < 2.5, n=28), Medium Maturity (score 2.5 - 3.5, n=65), and High Maturity (score > 3.5, n=34). A composite "Perceived Performance" score was similarly created from Section D. The Kruskal-Wallis test indicated a statistically significant difference in performance scores between the different KS maturity groups, $\chi^2(2) = 18.45$, $p < 0.001$. Post-hoc analysis with Dunn's test revealed that the High Maturity group had a significantly higher median performance rank than both the Medium ($p < 0.01$) and Low ($p < 0.001$) maturity groups.

VI. DISCUSSION AND CONCLUSION

Discussion

This study provides a timely and critical examination of the knowledge-sharing landscape within India's evolving smart manufacturing sector. The findings offer substantial insights that align with, and also challenge, the existing literature.

The answer to RQ1 indicates a transition phase. While digital communication tools like instant messaging are widely adopted, their use appears to be an extension of informal communication rather



than a structured KS strategy. The low usage of formal digital repositories like lessons-learned databases and expert locator systems (Table 2) is a significant finding. It suggests that Indian SM firms are not yet systematically capturing and reusing tacit knowledge, relying instead on ad-hoc and person-to-person methods. This aligns with Moeuf et al. (2018), who noted that the full potential of digital tools for KM is often untapped.

Regarding RQ2, the prominence of organizational and cultural barriers over purely technological ones is a powerful confirmation of the socio-technical nature of SM. The top barrier, "Lack of time," reflects a fundamental misalignment where KS is viewed as a separate, time-consuming activity rather than an integral part of the workflow. This is compounded by a culture that does not sufficiently incentivize or recognize sharing, a finding consistent with Riege (2005). The Indian context, with its high power distance (Hofstede, 1984), may further amplify these barriers, as junior employees might be hesitant to share ideas upward, stifling the bottom-up knowledge flow essential for innovation in SM.

The most critical finding of this study, in response to RQ3, is the strong, statistically significant positive relationship between the maturity of KS practices and perceived operational performance. This empirically validates the theoretical assertions of Frank et al. (2019) and others, providing concrete evidence from the Indian context that investing in a knowledge-sharing culture is not a soft HR initiative but a hard business imperative. Firms that have moved beyond basic communication to implement structured KS mechanisms report markedly better performance outcomes.

Conclusion

In conclusion, this research demonstrates that the journey to mature Smart Manufacturing in India is as much about managing knowledge as it is about managing technology. The sector is at a crossroads: it can continue to invest heavily in technology while neglecting the knowledge ecosystem, thereby achieving sub-optimal returns, or it can strategically foster a knowledge-centric culture supported by integrated digital platforms and supportive leadership.

The findings strongly advocate for the latter path. For Indian manufacturers to truly become "smart," they must consciously dismantle the identified barriers, formalize informal knowledge flows, and recognize knowledge sharing as a core competency. This requires a holistic strategy that aligns technology implementation with organizational development, leadership commitment, and a redesign of incentive systems to make sharing a natural and valued aspect of every employee's role.

Limitations and Future Research Directions

This study has several limitations. First, the use of a cross-sectional design provides a snapshot in time and cannot establish causal relationships. Second, the non-probability sampling method limits the generalizability of the findings to the entire Indian manufacturing sector. Third, the reliance on self-reported measures for performance introduces the potential for common method bias.

Future research should address these limitations by employing longitudinal studies to trace the evolution of KS practices and their causal impact on objective performance metrics. A larger, randomized sample would enhance generalizability. Furthermore, qualitative case studies delving into specific successful and unsuccessful KS implementations in Indian SM firms could provide richer, contextual insights into the "how" and "why" behind the quantitative patterns observed here. Finally, research could explore the role of specific interventions, such as gamification or AI-powered knowledge recommendation systems, in enhancing KS in this unique context.



REFERENCES

1. Andreeva, T., & Kianto, A. (2012). Does knowledge management really matter? Linking knowledge management practices, competitiveness and economic performance. *Journal of Knowledge Management*, 16(4), 617-636.
2. Büschgens, T., Bausch, A., & Balkin, D. B. (2021). Organizing for digital transformation: The interplay between organizational culture and knowledge integration. *Journal of Business Research*, 123, 180-191.
3. Davis, J., Edgar, T., Porter, J., Bernaden, J., & Sarli, M. (2012). Smart manufacturing, manufacturing intelligence and demand-dynamic performance. *Computers & Chemical Engineering*, 47, 145-156.
4. Frank, A. G., Dalenogare, L. S., & Ayala, N. F. (2019). Industry 4.0 technologies: Implementation patterns in manufacturing companies. *International Journal of Production Economics*, 210, 15-26.
5. Goyal, S., Routroy, S., & Bhatia, A. (2021). Analyzing the barriers of Industry 4.0 in Indian manufacturing sector. *International Journal of Productivity and Performance Management*, 70(5), 1017-1038.
6. Grant, R. M. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal*, 17(S2), 109-122.
7. Hofstede, G. (1984). *Culture's consequences: International differences in work-related values* (Vol. 5). Sage.
8. Kamath, N., & Rodrigues, L. L. (2020). A study on the readiness of Indian manufacturing for Industry 4.0. *Journal of Manufacturing Technology Management*, 31(4), 674-698.
9. Kang, H. S., Lee, J. Y., Choi, S., Kim, H., Park, J. H., Son, J. Y., ... & Do Noh, S. (2016). Smart manufacturing: Past research, present findings, and future directions. *International Journal of Precision Engineering and Manufacturing-Green Technology*, 3*(1), 111-128.
10. Moeuf, A., Pellerin, R., Lamouri, S., Tamayo-Giraldo, 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.
11. PWC. (2016). *Industry 4.0: Building the digital enterprise*. PricewaterhouseCoopers.
12. Raut, R. D., Gotmare, A., Narkhede, B. E., Govindarajan, U. H., & Bokade, S. U. (2021). Enabling technologies for Industry 4.0 manufacturing and supply chain: A comprehensive review. *International Journal of Production Research*, 59(15), 4775-4815.
13. Riege, A. (2005). Three-dozen knowledge-sharing barriers managers must consider. *Journal of Knowledge Management*, 9(3), 18-35.
14. Tao, F., Qi, Q., Liu, A., & Kusiak, A. (2018). Data-driven smart manufacturing. *Journal of Manufacturing Systems*, 48, 157-169.
15. Wang, S., & Noe, R. A. (2010). Knowledge sharing: A review and directions for future research. *Human Resource Management Review*, 20(2), 115-131.
16. Zhong, R. Y., Xu, X., Klotz, E., & Newman, S. T. (2017). Intelligent manufacturing in the context of industry 4.0: A review. *Engineering*, 3(5), 616-630.
17. Zhou, K., Liu, T., & Zhou, L. (2020). Industry 4.0: Towards future industrial opportunities and challenges. In *2010 5th International Conference on Fuzzy Systems and Knowledge Discovery* (Vol. 2, pp. 2147-2152). IEEE