



TSINGHUA UNIVERSITY

INNOVATING EDUCATION AND ENTREPRENEURSHIP

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INNOVATING MANUFACTURING OPERATIONS WITH AI



TEAM MEMBERS



PANGOU GOMA
FRED RAGIVE (Leader)



HOSSAN AMIR



SIMUKOKO JAMES



SANON WILFRIED
YVAN MAX



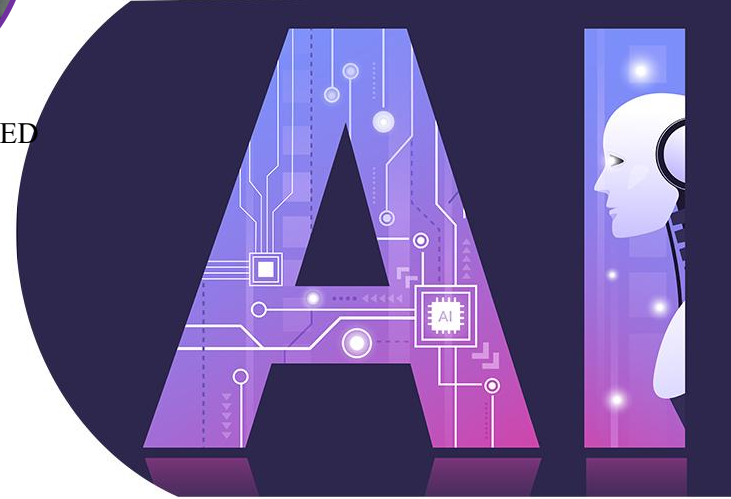
MD YEASIN ARAFAT



SAMRAT HASAN
RUBEL



TAN NING JIE



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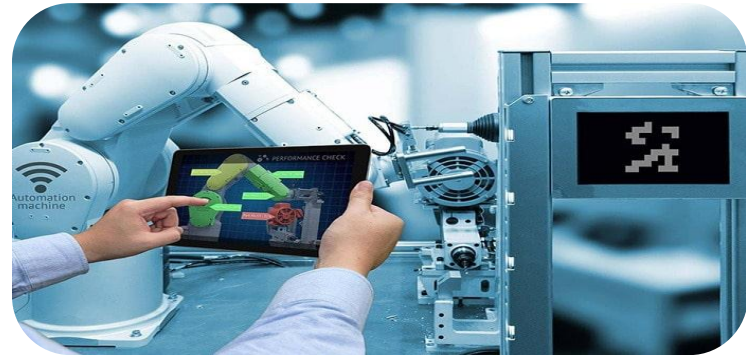
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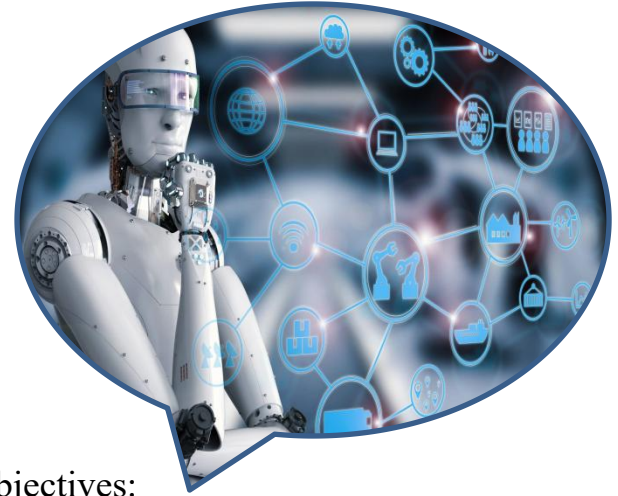
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01 Background and Purpose

Manufacturing is the process of transforming raw materials or components into finished products through various methods such as additive manufacturing, subtractive manufacturing, forming, molding, and assembly. Manufacturing operations enhanced by artificial intelligence (AI) integrate advanced technologies to optimize processes, increase efficiency, and improve quality control. AI algorithms analyze vast amounts of data to predict maintenance needs, optimize production schedules, and enhance resource utilization. Robotics and automation powered by AI streamline repetitive tasks, while machine learning algorithms refine operations over time by identifying patterns and making real-time adjustments.



01 Background and Purpose



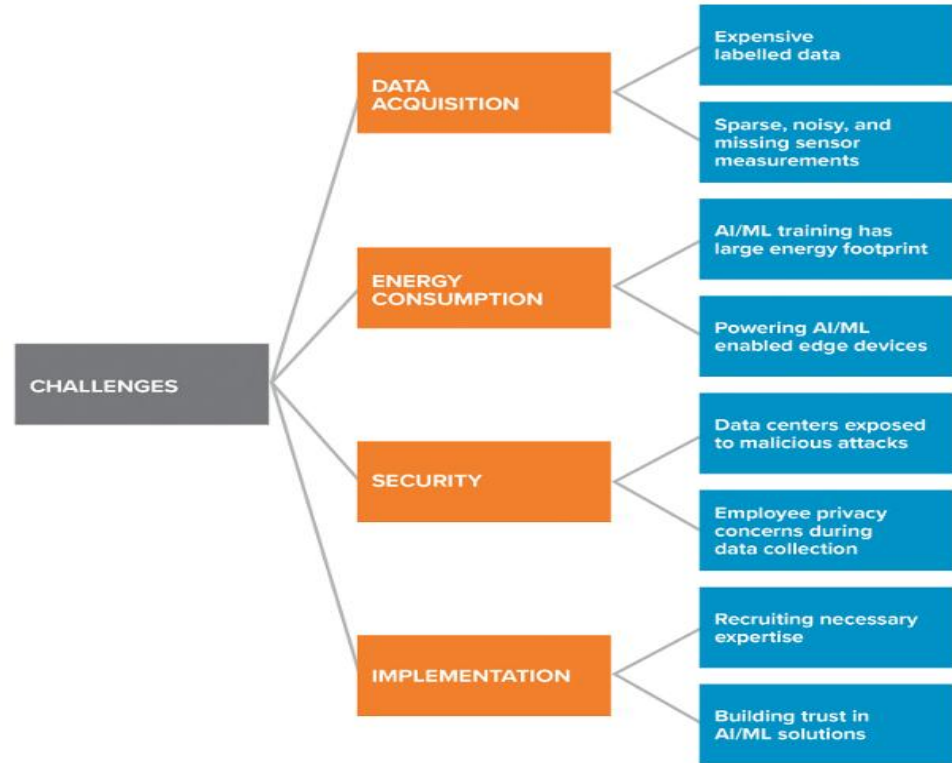
The objectives:

- Providing latest AI-based challenges in manufacturing operations,
- Proposed solutions addressing the challenges,
- Objective analysis and future research opportunities



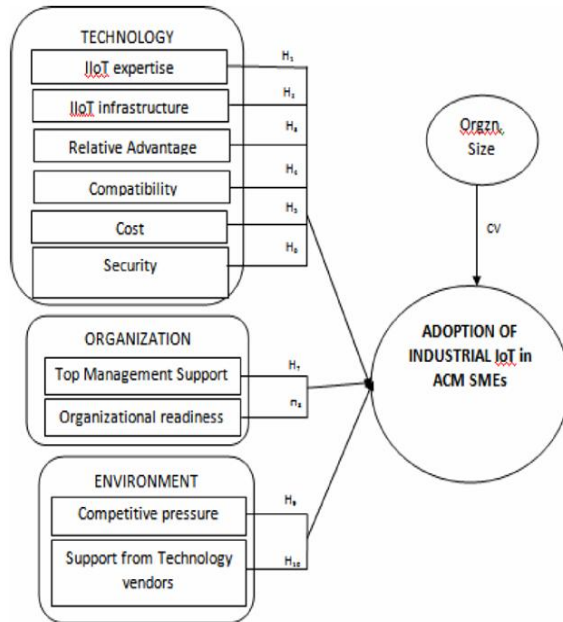
02 Challenges

Manufacturing operations are essential for meeting consumer needs across industries, requiring efficiency, innovation, and adaptability. In a rapidly evolving landscape shaped by technology, globalization, and sustainability concerns, success demands adept resource management, technological integration, skilled talent retention, and compliance with regulations. Understanding these dynamics is crucial for navigating the complexities of modern manufacturing and ensuring long-term viability in competitive markets.



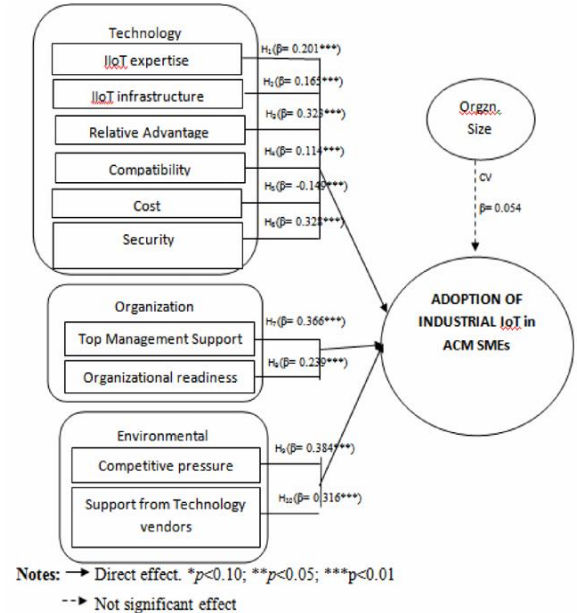
03 Innovations in data collection

Figure 1. Conceptual framework



- ❖ A survey was conducted with ICT officers, managers, and owners of 320 ACM SMEs in India using a structured questionnaire.
- ❖ Factors such as IIoT expertise, infrastructure, relative advantage, compatibility, cost, security, organizational readiness, top management support, competitive pressure, and support from technology vendors were found to affect the adoption of IIoT.
- ❖ Organization size was considered as a control variable but was found to have no significant effect on the adoption of IIoT.

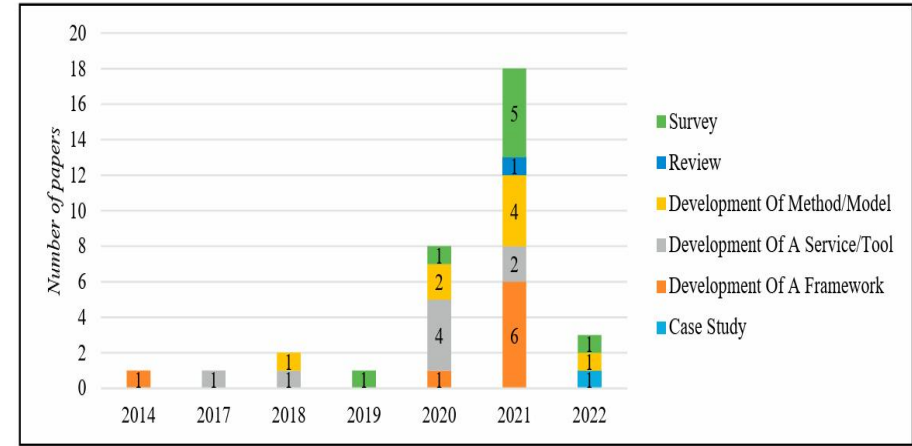
Figure 2. Results of PLS-SEM model



03 Innovations in data collection

- ❑ RQ1: Which types of problems can be solved by implementing of AI/ML in manufacturing MSMEs?
- ❑ RQ2: What are the main limitations and challenges associated with the use of AI/ML techniques in manufacturing MSMEs? The search was carried out using the relevant scientific database Scopus and the search strategy was defined coherently with the RQs already defined. A set of keywords were initially identified, as reported in Table below.

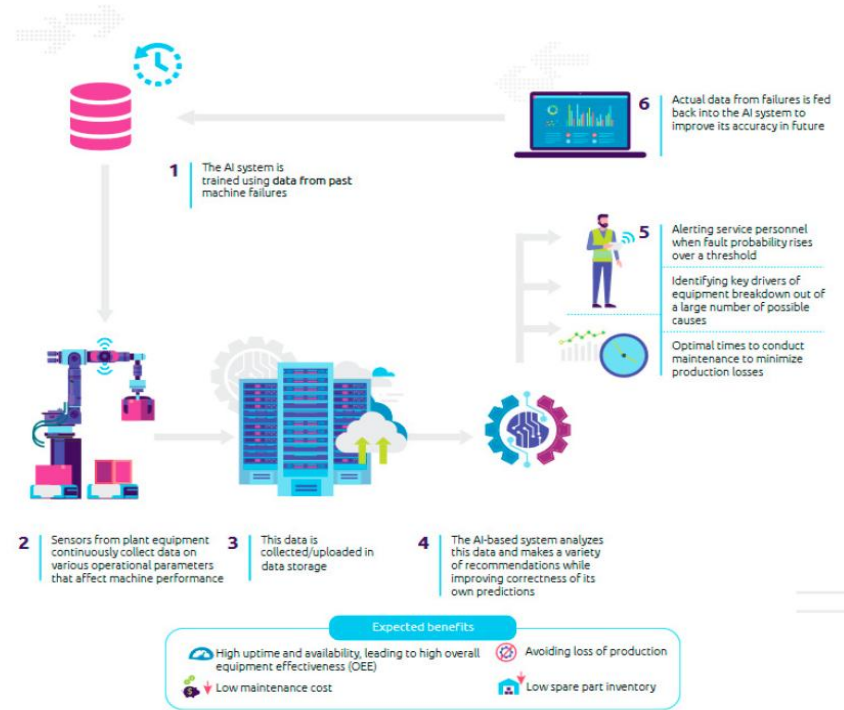
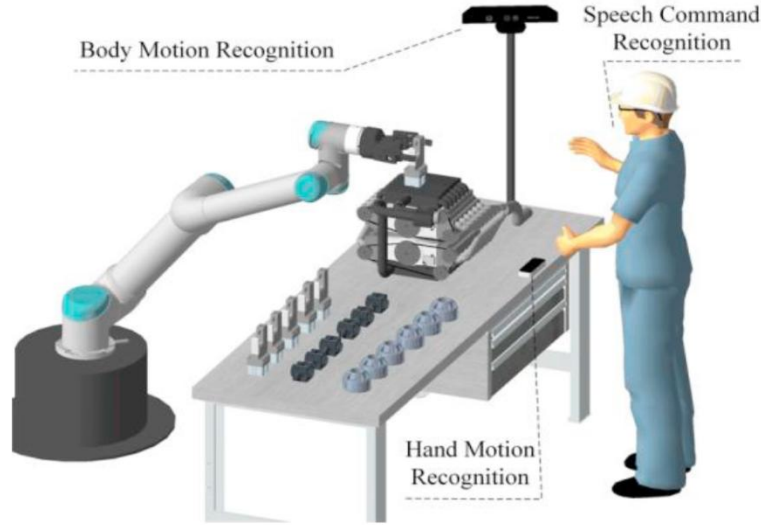
Innovating manufacturing operations with AI



MSMEs	Investigated Technology	Context
micro, small and medium enterprise; micro, small and medium-sized enterprise; small and medium-sized enterprise; small and medium enterprise; micro* enterprise; small* enterprise; medium* enterprise	Artificial Intelligence; Machine Learning	manufactur*; industr*; production



04 Execution enhancement

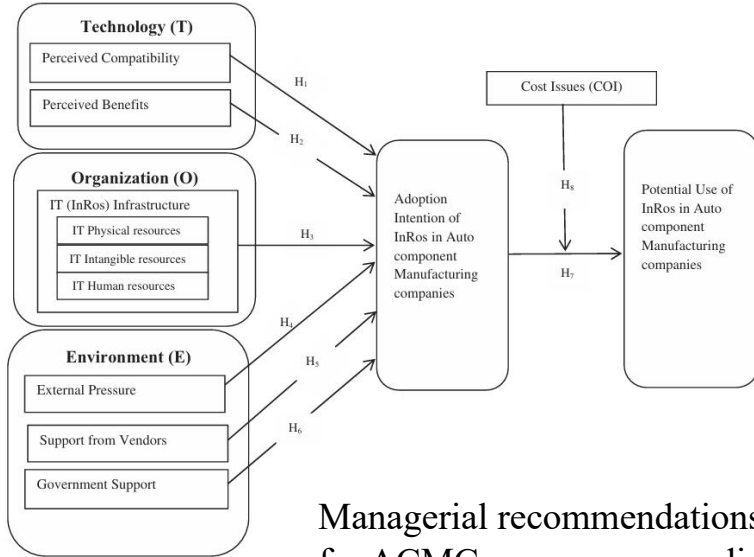


The focus here is the application of such AI systems in the manufacturing and purchasing and supply management processes in factories, leading to concepts like smart factory and smart manufacturing, and the restructuring and digitalization on the production floor, dominated till to now by the human workforce. Also how preventative maintenance could be useful, with capability for predicting when a mechanical part may require replacing

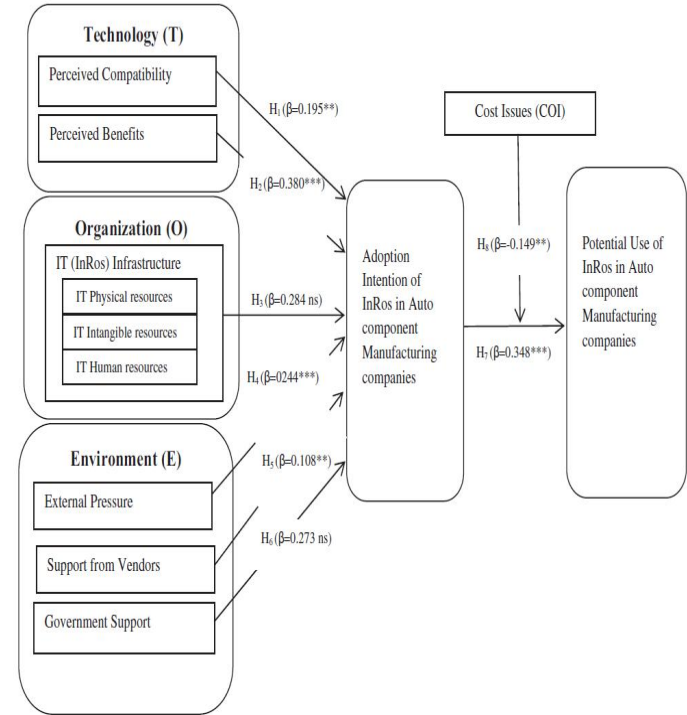


04 Execution enhancement

The adoption of AI-empowered Industrial Robots (InRos) in Auto Component Manufacturing Companies (ACMCs) is examined.



Managerial recommendations are provided for ACMC managers regarding the adoption intention and potential use of InRos in a country where InRos adoption is in a nascent stage.

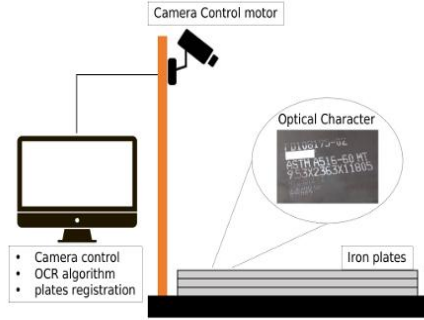


04 Execution enhancement

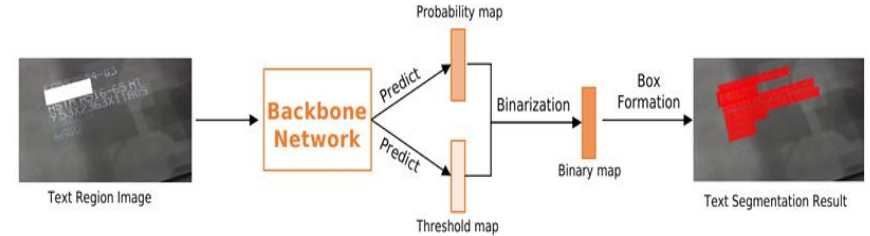
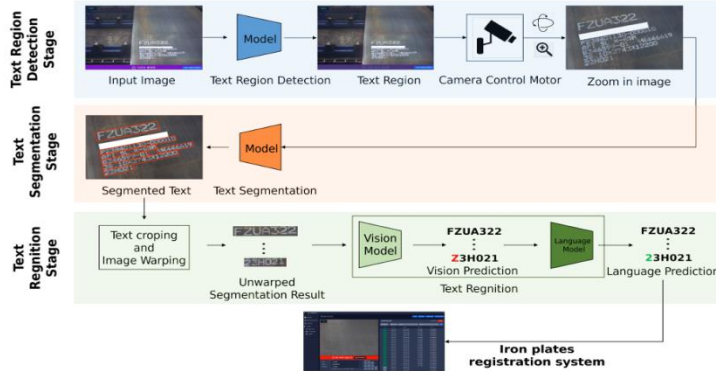
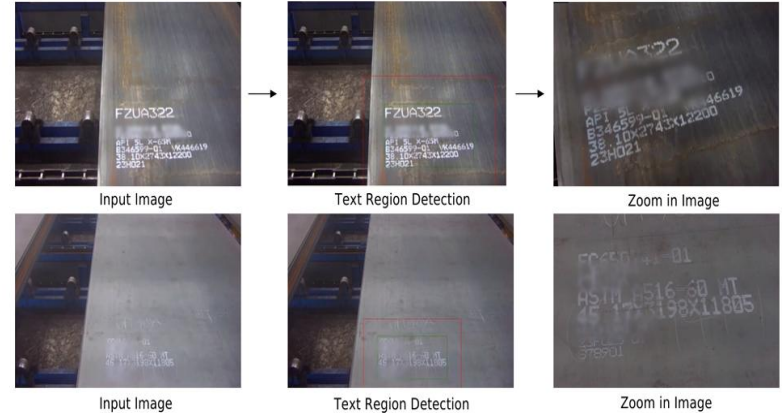
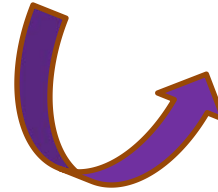
Innovating manufacturing operations with AI



(a) on site photos



(b) schematic of iron plates registration system

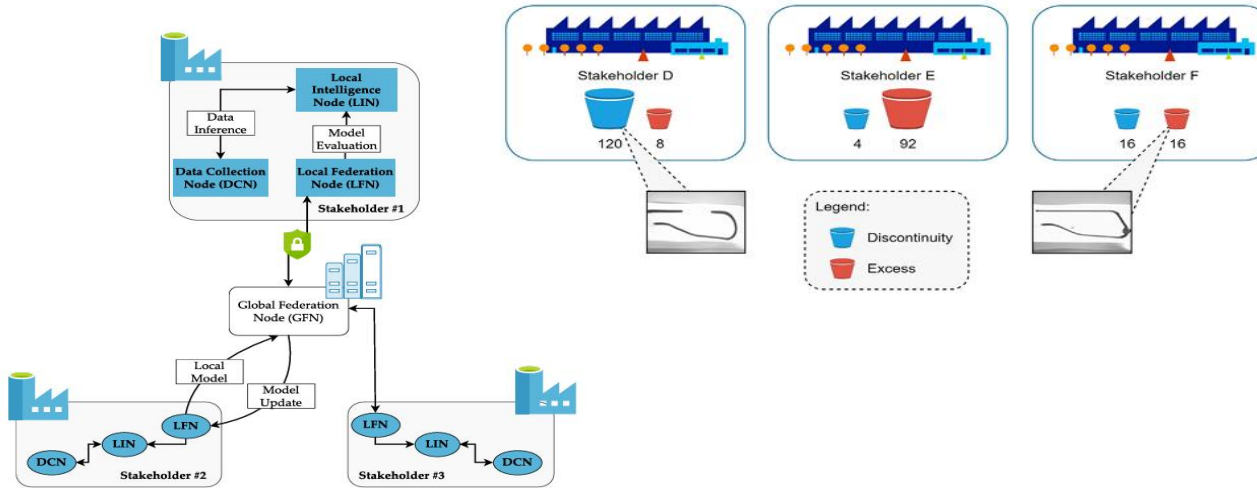


The cycle time are delayed and increased in the harsh industrial environments. There is also high potential to increase human error when using traditional manual methods continuously especially the workers are tired.



05 Strengthening safety and privacy

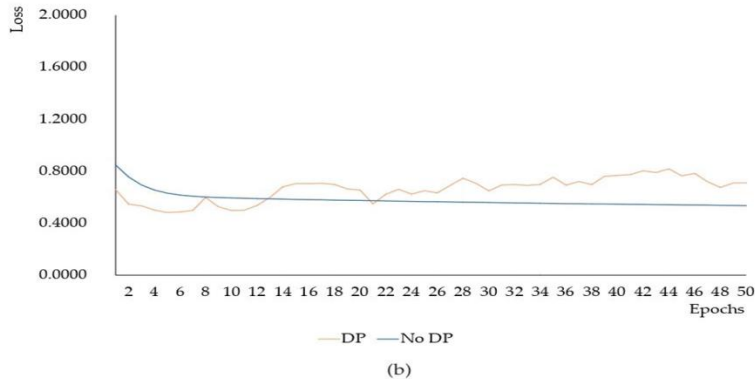
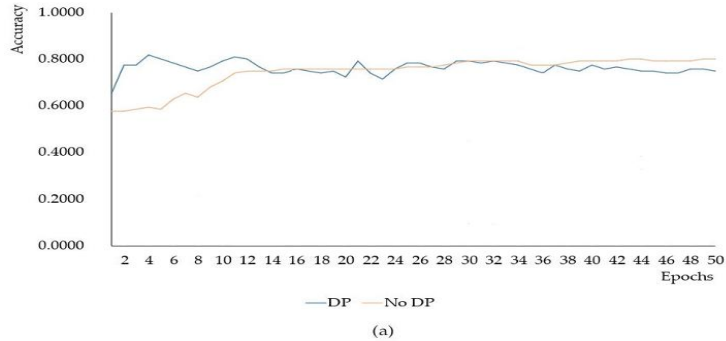
Collaborative Industrial AI, with a focus on automated quality inspection using Federated Learning in smart manufacturing, has been explored. Key challenges including data privacy, ownership, and cybersecurity were addressed through a conceptual framework. An initial FL system implementation for automated quality inspection was presented, with insightful discussions on its potential impact and parameters. These findings contribute significantly to the advancement of this field.



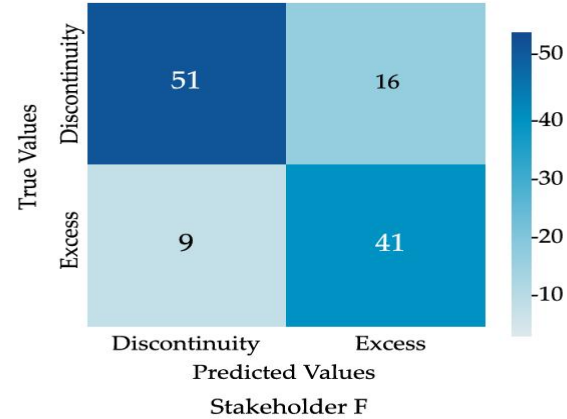
		Algorithm							
		FedAvg				FedOpt			
Noise Level		1.2	2	5	10	1.2	2	5	10
Learning rate	0.0015	0.7759	0.5776	0.5776	0.5776	0.7845	0.7931	0.7672	0.7500
	0.1500	0.8017	0.7500	0.7500	0.6034	0.8017	0.7414	0.7069	0.6983



05 Strengthening safety and privacy



Innovating manufacturing operations with AI



Even though FL represents a large step-up in terms of addressing critical issues of data privacy and security when compared to more traditional ML approaches, by itself it is still not sufficient to ensure full privacy as it has been shown to be vulnerable to for instance reverse-engineering attacks that can extract sensitive information about the data directly from the model.



06 Conclusion

In conclusion, the integration of AI into manufacturing operations holds significant promise for revolutionizing efficiency and competitiveness. While challenges such as data acquisition and security persist, proposed solutions offer avenues for overcoming these obstacles. Embracing technological advancements is crucial for navigating a dynamic global landscape and achieving success in the manufacturing industry.



THANKS FOR
WATCHING

