Part of project (LITD0110) sponsored by BIS

Cover Letter

Dear Sir/Madam,

We are conducting a research study titled "Use Case Compilation for Smart Manufacturing in India", sponsored by the Bureau of Indian Standards (BIS). This project is led by the Department of Production & Industrial Engineering at the National Institute of Technology, Jamshedpur. The aim is to explore the integration of advanced manufacturing technologies across various sectors within the Indian industry.

This research seeks to understand the implementation, challenges, and efficiencies driven by Industry 4.0 technologies. By documenting diverse use cases, this study intends to contribute significantly to the national repository, aiding policy makers and industry stakeholders in decision-making processes.

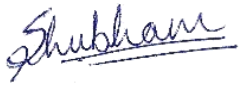
We invite your esteemed organization to participate in this survey. Attached to this letter, you will find a questionnaire specifically designed to collect information on your experiences with smart manufacturing technologies. Your responses will be invaluable to our study and to broader efforts aimed at enhancing India's manufacturing landscape.

Rest assured, confidentiality and anonymity of the information provided will be strictly maintained, and data will be used solely for research purposes. No sensitive company-specific information will be disclosed without prior consent.

Please complete and return the questionnaire by [due date]. Should you need any further information or have any queries, feel free to contact us at the provided contact details. We hope to conduct a digital/ physical interview to get a better understanding of Smart manufacturing application. Please provide a suitable date in response to the mail request.

Thank you for considering this request for your participation. We look forward to your valuable input, which will undoubtedly contribute to the success of this important national initiative.

Yours sincerely,



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Questionnaire: Smart Manufacturing in Indian Scenario

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Section A: General Questions

1. Please State the name of your company?

2. Name of the person filling the questionnaire.

3. Designation of the person filling the questionnaire.

4. Area of expertise/ key roles of the person filling the questionnaire.

5. E mail address/ contact number for communication.

6. Are you willing to have a further discussion on implementation of Smart Manufacturing Systems **(SMS)** in industry one digital / personal Interview? (Y/N)

Note: There are several descriptive questions intended to get a better understanding of SMS in Industry. We hope to discuss these questions over digital / personal Interview to get a comprehensive understanding and to structure that interview, we hope to get brief insights from the questionnaire itself. In case you are not available for an interview, we encourage you to write detailed answers for our understanding. These questions are marked with superscript I (^{I}).

Section B: Demographic Questions

1. State the year of establishment of your company.

2. Which manufacturing sector does your company specialise in?

3. State the major products produced by your company?

4. Does your company have multiple operational locations? If yes, please list the locations.

5. Please state the number of facilities dedicated to manufacturing operations in your company?

6. State the size in terms of total number of employees in the company

7. What was your company's annual revenue for the last fiscal year?

8. Please state the type of ownership:

    a. Private limited company
    b. Limited Liability Company
    c. One Person Company
    d. Sole proprietorship
    e. Private company limited by shares
    f. Partnership
    g. Public limited company
    h. Government company
    i. Subsidiary
    j. Foreign corporation
    k. Unlimited liability company

9. Type of company based on Investment in Plant & Machinery/equipment and Annual Turnover

    a. Micro (Investment in Plant and Machinery or Equipment:Not more than Rs.1 crore and Annual Turnover ; not more than Rs. 5 crore)
    b. Small (Investment in Plant and Machinery or Equipment: Not more than Rs.10 crore and Annual Turnover ; not more than Rs. 50 crore)
    c. Medium (Investment in Plant and Machinery or Equipment: Not more than Rs.50 crore and Annual Turnover ; not more than Rs. 250 crore
    d. Large scale industry

10. Please name a few market competitors.

Section C: Technology Specific understanding of SMS

11. What types of smart manufacturing technologies are currently implemented in your industry?

    a. Internet of Things (IoT) Devices, Industrial internet of things, RFID
    b. Sensor based data collection and monitoring
    c. Supervisory Control and Data Acquisition (SCADA)
    d. Cyber-Physical Systems (CPS)/ Cyber physical production systems (CPPS)
    e. Digital Twin
    f. Additive Manufacturing (3D Printing)
    g. Artificial Intelligence (AI)
    h. Machine Learning (ML)
    i. Big Data Analytics
    j. Real time computing/ analytics
    k. Simulation
    l. Cloud manufacturing
    m. Cloud Computing
    n. Intelligent Robotics, Cobotics
    o. Blockchain Technology
    p. Augmented Reality (AR)
    q. Virtual Reality (VR)
    r. Mixed reality (MR)
    s. Machine to machine communication (M2M)
    t. Cybersecurity
    u. 5 G Communication
    v. Enterprise Resource Planning (ERP) Systems
    w. Other, Please state ___

12. How much did your company invest in new technologies, like SMSs, in the last fiscal year?

13. What percentage of your revenue is invested in R&D?

14. How has integrating these technologies changed your facility's workflow or production line? (Select all that apply and indicate metric)

    a. Increased Efficiency of machines and equipment

        i. Percentage increase in efficiency reported

        ii. Other metrics used and quantifiable observations to observe change

iii. Observed but not quantified

b. Enhanced Productivity of machines and workers

i. Percentage increase in productivity reported

ii. Other metrics used and quantifiable observations to observe change

iii. Observed but not quantified

c. Improved Quality of products and services

i. Metrics used and quantifiable observations to observe change

ii. Observed but not quantified

d. Reduction in defects

i. Percentage decrease in defects reported

ii. Other metrics used and quantifiable observations to observe the change

iii. Observed but not quantified

e. Enhanced customer satisfaction with agility, customization, and responsiveness

i. Metrics used and quantifiable observations to observe change
ii. Observed but not quantified

f. Cost Reduction due to lower labour costs due to automation

i. Reduction in percentage w.r.t. total labour cost

ii. Other metrics used and quantifiable observations to observe the change

iii. Observed but not quantified

g. Cost Reduction due to decreased maintenance costs with prognostics

i. Reduction in percentage w.r.t. total maintenance costs

ii. Other metrics used and quantifiable observations to observe the change

iii. Observed but not quantified

h. Cost Reduction due to reduced waste and lower material costs

i. Reduction in percentage w.r.t. total material cost

ii. Other metrics used and quantifiable observations to observe the change

iii. Observed but not quantified

i. Enhanced Data-Driven Decision Making

i. Metrics used and quantifiable observations to observe change
ii. Observed but not quantified

j. Improved responsiveness to supply chain risk

i. Percentage improvement in response time

ii. Other metrics used and quantifiable observations to observe the change

iii. Observed but not quantified

k. Increased Flexibility of production systems

i. Metrics used and quantifiable observations to observe change
ii. Observed but not quantified

l. Improved Worker Safety

i. Metrics used and quantifiable observations to observe change
ii. Observed but not quantified

m. Enhanced Compliance

i. Metrics used and quantifiable observations to observe change
ii. Observed but not quantified

n. Improved tracking and tracing

i. Percentage reduction in time taken w.r.t total time for tracking and tracing

ii. Other metrics used and quantifiable observations to observe change

iii. Observed but not quantified

o. Improved use of energy and raw materials

i. Percentage reduction in energy consumption

ii. Percentage reduction in raw materials consumption

iii. Other metrics used and quantifiable observations to observe change

iv. Observed but not quantified

p. Lower emissions and waste generation

   i. Percentage reduction in emissions generated

   ii. Percentage reduction in waste generated

   iii. Other metrics used and quantifiable observations to observe change

   iv. Observed but not quantified

q. Enhanced sustainability practices

   i. Metrics used and quantifiable observations to observe change
   ii. Observed but not quantified

r. Improved Collaboration and Communication between departments

   i. Metrics used and quantifiable observations to observe change
   ii. Observed but not quantified

s. Enhanced communication with suppliers/ service providers and other stakeholders

   i. Metrics used and quantifiable observations to observe change
   ii. Observed but not quantified

t. [I]Any other quantifiable improvements observed?

15. How would you describe the existence of Smart manufacturing implementation strategy?
    a. No strategy exists
    b. Pilot initiatives launched for individual technology specific implementation
    c. Pilot initiatives launched for individual process specific transformation
    d. Strategy in development with focus on identified technologies individually
    e. Strategy in development with focus on individual process enhancement
    f. Strategy in development with focus on overall operational transformation specific to individual departments
    g. Strategy in development with focus on overall operational transformation of factory/plant.
    h. Strategy formulated with focus on identified technologies individually
    i. Strategy formulated with focus on individual process enhancement
    j. Strategy formulated with focus on overall operational transformation specific to individual departments
    k. Strategy formulated with focus on overall operational transformation of factory/plant.
    l. Strategy in implementation phases for technology specific solution
    m. Strategy in implementation phases for individual process transformation
    n. Strategy in implementation phases for individual departments
    o. Strategy in implementation phases for entire factory/plant
    p. Strategy implemented

16. [I]How was the smart technology implemented in your facility? Please select all that apply:

    a. In-house Development and R&D
    b. Collaboration with External Consultants
    c. Outsourced Implementation (third-party vendor)
    d. Government-Sponsored Programs
    e. Collaboration with Universities/Research Institutes
    f. Pilot Projects with Tech Providers
    g. Partnership with Industry Peers
    h. Public-Private Partnerships (PPP)
    i. Use a mix of internal R&D and external consultancy to implement the smart technology.
    j. Integration Through Joint Ventures
    k. No Formal Process

17. [I]Do you use indicators to track the implementation status of your Smart Manufacturing strategy?

    a. Yes, we have a well-defined system of indicators and their evaluation methods in practice.
    b. Yes, we have a system of indicators that gives us qualitative estimate but no quantifiable measures are in place.
    c. The implementation monitoring indicators are not separately defined but process efficiency indicators are used as implementation milestones.
    d. The implementation process is not being tracked with indicators.

18. [I]Please state the key performance indicators used to evaluate success of implementation of SMSs.

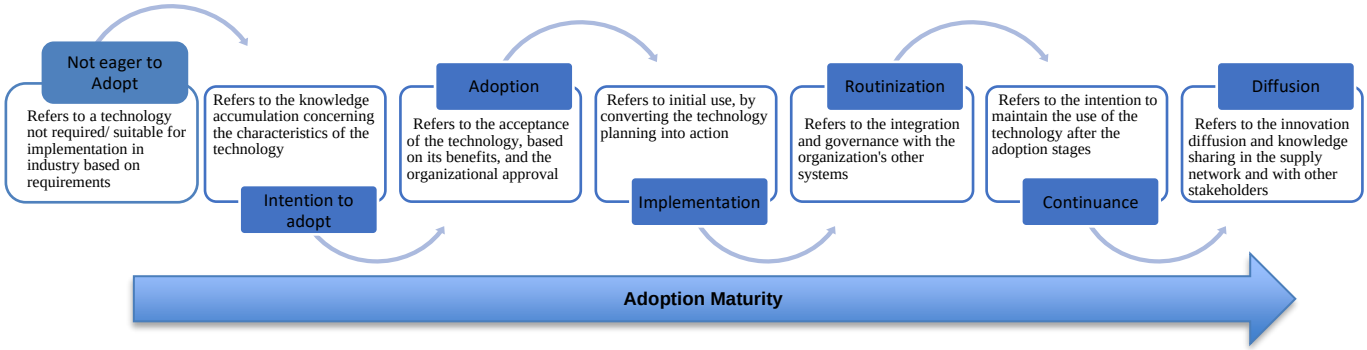
19. [I]What are/ were the challenges encountered in implementing Smart technologies?

    a. Data related issues as inability to collect and process data, insufficient data or fear of data security
    b. Lack of standards and reference architecture to implement SMSs
    c. Lack of understanding and awareness about SMS and visualisation of new processes
    d. Absence of IT and R&D department
    e. Lack of research and collaboration with academia
    f. Lack of capable human resource and skillset in employees
    g. Unjustified business case to justify ROI and difficulties in altering business models
    h. Failure of systems to deliver immediate achievements and desired outcomes
    i. High initial investment / high cost of SMS related technology

j. Low maturity or rapidly evolving levels of technology related to SMSs
k. Outdated infrastructure and machinery leading to Complexity in integrating systems
l. Lack of integration/ support from employees and OEMs/supplier industries
m. Cybersecurity and IPR threats
n. Resistance to evolve organisation culture
o. Fear of loss of employment
p. Reluctance of top management to evolve
q. Insufficient sense of urgency
r. Regulatory and legal issues
s. Unclear legal framework particularly relating to infringement of privacy and hazards caused by automated systems

20. [I]Please state the strategies adopted to overcome challenges and implement SMSs.

21. The following chart presents adoption stage of technology along with brief description. On a scale of 0 to 5 please enter the level achieved concerning the adoption stage of technology relevant to your industry. [**0-Hesitant; 1- Very low; 2- Low; 3-Moderate; 4-High; 5-Very High**]



Technology Related	Adoption Stage						
	Not eager to adopt	Intention to adopt	Adoption	Implementation	Routinization	Continuance	Diffusion
Internet of Things (IoT) Devices, Industrial internet of things, RFID							
Sensor based data collection and monitoring							
Cyber-Physical Systems (CPS)/ Cyber physical production systems (CPPS)							
Digital Twin							
Additive Manufacturing (3D Printing)							

Artificial Intelligence (AI)							
Machine Learning (ML)							
Big Data Analytics							
Real time computing/ analytics							
Simulation							
Cloud manufacturing							
Cloud Computing							
Intelligent Robotics, cobotics							
Blockchain Technology							
Cybersecurity							
Augmented Reality (AR)							
Virtual Reality (VR)							
Mixed reality (MR)							
Machine to machine communication							
5 G Communication							
Enterprise Resource Planning (ERP) Systems							

22. [I]Please state the techniques/ methods used to integrate Smart Manufacturing solutions with existing systems and processes within the organisation.

23. [I]Is your Industry member of Industrial Consortia related to SMS application and standardization? Please state the names of Industrial Consortia associated with?

24. [I]What role do these Industrial Consortia play in implementation of SMS?

(Respond in case of multiple operational facilities and the answers relating to a particular facility)

25. In which state and city is your factory/ plant/ facility located?

26. State the year of Establishment of your factory/ plant/ facility.

27. State the size in terms of total number of employees in the factory/ plant/ facility.

Section D: Process based understanding

28. In which parts/functions of your company have you invested or plan to invest resources in the implementation of technologies related to smart manufacturing:

Process/ Functions	Investment in past 2 to 3 years		Investment plant for next 3 to 5 years		Long term plans for implementation and investment in place	No plans
	Pilot projects	Strategic implementation plans	Pilot projects	Strategic implementation plans		
Product development						
Product Design						
Procurement						
Supplier selection						
Supplier integration						
Production Planning						
Process optimization						
Production monitoring						
Manufacturing control						
Product routing						
Quality control						
Inspection						
Production asset performance tracking						
Maintenance						
Inbound Logistics						
Intra-facility Logistics						
Outbound logistics						
Product Distribution						
Point of Sales						

Product recovery/ recycle						
Product usage						
Research and development						
Supply Chain Planning						
Energy management						
Process Automation						

29. The transformation to smart manufacturing is characterised by following features:
    a. *Digitalization/Virtualization:* Refers to the virtualization and digitalization of all assets (physical and others) and generation, storage and communication of information over digital platforms. This involves machinery upgrade with sensors and installation of embedded equipment. All resources are visible to industry control via a platform. Eg. IoT embedded machines, digital twin representations of industry etc.
    b. *Integration, connectivity, visibility*: Refers to the visibility and transparency across departments and stakeholders for assets and products and integrative capability to perform collaborative actions and take decisions in response to changes across supply chain. Eg. Collaborative product development/design, response to demand/ inventory/ equipment changes.
    c. *Predictive and context aware analytical decision making*: Refers to the ability of system to analyse past data available along with real time changes to predict future states of the system and further assist in decision making for enhanced performance. Eg. Prognostics, anomaly detection, risk mitigation.
    d. *Perceptive and Adaptive to Environment:* Refers to a manufacturing system that is self-aware of its environment and has cognitive decision-making capabilities along with actuations to make changes to manufacturing in response to environment changes without human involvement. Eg. Agile manufacturing,

Please Identify the stage of smart manufacturing capabilities your processes/ functions identify with:

Process/ Functions	Digitalization/Virtualization	Integration, connectivity, visibility	Predictive and context aware analytical decision	Perceptive adaptive Environment	[1]Any other
Product development					
Product Design					
Procurement					
Supplier selection					

Supplier integration					
Production Planning					
Process optimization					
Production monitoring					
Manufacturing control					
Product routing					
Quality control					
Inspection					
Production asset performance tracking					
Maintenance					
Inbound Logistics					
Intra-facility Logistics					
Outbound logistics					
Product Distribution					
Point of Sales					
Product recovery/ recycle					
Product usage					
Research and development					
Supply Chain Planning					
Energy management					
Process Automation					

Section E: Feature based understanding

30. Does your company have production processes that respond autonomously/automatically in real time to changes in production conditions?
    a. Yes, cross-enterprise
    b. Yes, but only in selected areas
    c. Yes, but only in the test and pilot phase
    d. No
31. How is customer feedback integrated into your product development cycle?
    a. Not collected
    b. Collected but not used in product development
    c. Directly integrated into the design of future models
    d. Used to make real-time adjustments to current designs
    e. Analysed for predictive engineering
32. How is historical data utilized in your product development strategy?
    a. It is not utilized

b. To guide initial design phases
c. Integrated into simulations for predictive outcomes
d. Central to continuous improvement processes

33. How are operators allocated and scheduled in your manufacturing processes?
    a. Manually
    b. Using digital scheduling tools
    c. With assistance from AI
    d. mobile applications
34. How are human workers and robots integrated on the shop floor?
    a. Separate operations of both
    b. Collaborative robots assisting human workers (Cobots)
    c. Autonomous robots with human oversight
    d. Fully autonomous robotic operations with minimal human interaction
35. How is process control data utilized to manage manufacturing execution?
    a. Not Collected
    b. Stored for record-keeping without further analysis
    c. Actively used to optimize ongoing production processes
    d. Integrated into a continuous improvement feedback loop
    e. Used for predictive maintenance
36. How is product quality monitored during manufacturing?
    a. End-of-line inspections only
    b. Random sampling during production
    c. Continuous inline monitoring
    d. AI-driven anomaly detection
37. How is data from the inspection process utilized?

    a. For immediate pass/fail decisions only
    b. Stored for record-keeping without further analysis
    c. Analysed for trends and recurring issues
    d. Integrated into a continuous improvement program
    e. Used in predictive maintenance

38. How is predictive maintenance applied in your factory's operations?

    a. use data analytics to predict and prevent machine failures before they occur.
    b. Maintenance schedules are automatically adjusted based on real-time machine performance data.
    c. Sensors on equipment trigger maintenance alerts when anomalies are detected
    d. Machine learning algorithms analyse historical operation data to improve maintenance protocols.
    e. Maintenance is conducted at regular intervals regardless of machine condition or data insights

Section F: Regulations and compliance

39. Does your company use a common vulnerability scoring system (CVSS) to assess and prioritize cybersecurity threats? Yes / No
40. What type of cybersecurity measures does your company employ to protect against data breaches?

    a. Firewalls and Encryption
    b. Intrusion Detection Systems (IDS)
    c. Multi-factor Authentication (MFA)
    d. Regular Software Updates and Patch Management
    e. Data Loss Prevention (DLP) Technologies
    f. Security Information and Event Management (SIEM)
    g. Endpoint Protection Platforms
    h. Cloud Security Controls
    i. Employee Training and Awareness Programs
    j. Incident Response Plan
    k. Network Segmentation
    l. VPN (Virtual Private Network)
    m. Zero Trust Architecture

41. Does your company's packaging system include indicators for real-time monitoring of product quality? Yes / No
42. What type of smart sensor is integrated into your packaging to monitor the quality of items?

    a. Time-Temperature Indicators (TTIs)
    b. Gas sensors
    c. pH indicators
    d. Humidity sensors
    e. Conductivity sensors
    f. Biological sensors
    g. Freshness indicators - Biochemical sensors that react to the breakdown products of food spoilage, changing color to indicate loss of freshness.
    h. Ripeness indicators
    i. Thermal sensors

43. Which of the following intelligent packaging features does your company employ to communicate product quality directly to consumers?

    a. Colour-changing labels indicating temperature abuse
    b. RFID tags for tracking and logging environmental conditions
    c. QR codes linking to a webpage with detailed product handling instructions
    d. NFC tags that provide real-time data when scanned with a smartphone

44. The industries data assessment unit collects the following information for the data analysis of customers:

    a. Passwords
    b. Financial information, including information relating to bank accounts, credit cards, debit cards, and other payment instrument details
    c. Physical, physiological, and mental health conditions
    d. Sexual orientation
    e. Medical records and history
    f. Biometric information
    g. Other form of customer-data.

45. To deal with the DPDPA Act 2005, the organization has appointed officers/persons for the following roles:
    a. Chief Compliance Officer;
    b. Nodal Contact Person
    c. Grievance Officer
    d. The physical contact address in India of the appointed officers (I, II, and III) is available on its website, and/or mobile app, to receive communications.
    e. The appointed officers (I, II, and III) are the resident Indian employees.

46. For the following purposes, the industry has appointed a Data Protection Officer (DPO)

    a. The DPO is appointed to ensure regulated data transmission.
    b. The DPO has the authority to protect personal data/ sensitive customer data or industrial data.
    c. The data transmission/data flow outside can not be performed before DPO recommendation/assigning.
    d. The DPO is responsible for ensuring the DPDPA regulation
    e. The DPO will be responsible for the DPDPA rules violation

47. The industry is using UAVs for their industrial project applications of the following categories:
    a. Nano: Less than or equal to 250 grams
    b. Micro: From 250 grams to 2kg
    c. Small: From 2kg to 25kg
    d. Medium: From 25kg to 150kg
    e. Large: Greater than 150kg
    f. Some other relevant categories.

48. The industry has adhered to the following DGCA regulations for the industrial applications of UAV.:
    a. The UAV has a Unique Identification Number (UIN)
    b. The industry has permitted fly zones.
    c. The industry has obtained a unique Air Defense Clearance (ADC)/Flight Information Center (FIC) number.
    d. The industry has permission to use India's Digital Sky Platform

49. Kindly provide the certification and standardization of the collaborative robotics (integrating humans and robots) that are currently being used by the industry.
    a. ISO 10218-2
    b. ISO/TS15066
    c. Some other standardization. Please state.
50. In regards to the safety concerns of workers who are working with collaborative robots safety, what resources is the industry offering?
    a. The industry has provided sufficient working distance between the workers and COBOTS.
    b. The industry has adequate space for operating the COBOTS.
    c. The industry has skilled workers to work with COBOTS.
    d. The industry has its training facility for safe and productive working with COBOTS.
    e. The industry has skill assessment mechanisms to opt the suitable workers that can work with Robotic integration.

Case Study for use case compilation of Smart manufacturing

1. Name of Industry
2. Tool/ Technology
3. Brief description of Application
4. Need/ idea for application
5. Baseline requirement of smart manufacturing tool
6. Mode of application integration
7. Details of application integration
8. Investment required
9. Equipment/ software acquired
10. Changes in product/ process/functions
11. (Re)Training of employees or special skillset personnel hired
12. Challenges encountered (Internal and External)
13. Strategy applied to overcome challenges
14. Enhancements reported
15. Returns on Investment reported/expected (Time-frame and amount)
16. Scalability and applicability to other sector/industries.

TERMS OF REFERENCE FOR THE R&D (PROJECT 2 - LITD 34)

(*Refer to the Guidelines on R&D Projects issued vide note SCMD/R&D dated 09-09-2023*)

1. **Title of the Project**: Use case compilation for Smart manufacturing in India.

2. **Background:**
   a) Smart manufacturing refers to the use of advanced technologies and data-driven intelligence to enhance and optimize the entire manufacturing process. It involves the integration of cutting-edge technologies, such as the Internet of Things (IoT), artificial intelligence (AI), machine learning, data analytics, and automation, into traditional manufacturing systems. The goal of smart manufacturing is to create more efficient, agile, and adaptable production processes that can respond quickly to changes in demand and market conditions.
   b) India, with its diverse industrial landscape, is poised to leverage Smart Manufacturing technologies to enhance efficiency, productivity, and global competitiveness. Recognizing the potential benefits and challenges of this technological transition, there is a growing need to systematically document and analyze real-world use cases within the Indian manufacturing context. The absence of a centralized repository hampers the dissemination of best practices, lessons learned, and insights gained from implementing Smart Manufacturing solutions across different sectors.
   c) This project endeavors to capture a spectrum of use cases, ranging from small and medium enterprises to large-scale manufacturing units, across various domains such as automotive, electronics, pharmaceuticals, and more. By compiling and categorizing these use cases, the repository will serve as a valuable resource for industry stakeholders, policymakers, researchers, and technology providers seeking to understand, replicate, and advance Smart Manufacturing practices in the Indian context.
   d) The repository will also help in identification of aspects of smart manufacturing which require standardization on priority.

3. **Objective:** To collect technical data, assess the landscape, and create a use-case repository for smart manufacturing in the context of Indian industries.

4. **Scope**:
   a) Study and comparative analysis of existing literature which would include use-case repositories created by countries, consortiums, industries etc., Study of these repositories may be done specifically to assess the suitability of use-case for utilization in Indian context.
   b) Collection of following data regarding industries where Smart manufacturing practices have been implemented in India in addition to the parameters mentioned in the template provided by BIS:
      a. Clear and detailed descriptions of the use case.
      b. Categorization of use cases based on industry sectors, such as automotive, electronics, pharmaceuticals, etc.

c. Detailed information on the technologies and solutions employed in each use case, including IoT, AI, robotics, data analytics, and automation.
d. Identification and documentation of challenges encountered during the implementation of Smart Manufacturing solutions in each use case.
e. Strategies and innovative approaches adopted to overcome challenges and ensure successful implementation.
f. Quantifiable data on the operational impact of Smart Manufacturing, including improvements in efficiency, productivity, cost savings, and sustainability.
g. Measurement of performance indicators used to evaluate the success of Smart Manufacturing initiatives in each use case.
h. Insights and lessons learned from each use case, including what worked well and what could be improved for future implementations.
i. Assessment of the scalability and replicability of the Smart Manufacturing solutions, considering factors like company size, industry type, and geographic location.
j. Details on how Smart Manufacturing solutions were integrated with existing systems and processes within the organizations.
k. Information on how each use case adhered to regulatory standards and compliance requirements (if any applicable).
l. Documentation of collaborations and partnerships that played a role in the success of the Smart Manufacturing initiatives.
m. Evaluation of the costs associated with implementation versus the benefits achieved in terms of increased efficiency and ROI.
n. Inclusion of visuals, such as diagrams, photos, or videos, to enhance understanding and showcase the practical application of Smart Manufacturing technologies.
o. Insights into the future plans and roadmaps for Smart Manufacturing within each organization, highlighting potential expansions, upgrades, or additional use cases.

c) Feedback and testimonials from end-users, operators, and other stakeholders involved in the Smart Manufacturing processes.

5. Research Methodology:

a) Review and analyze the literature as per the details mentioned scope.
b) Collect feedback/information through circulation of structured questionnaire.
c) During the visit to smart manufacturing industries and solution providers:
    a. Observe the facilities/solutions for collection of data.
    b. Conduct focused group discussion in a structured format.

6. Sampling Plan:

a) At-least 50 use-cases should be compiled.
b) Three large, medium and small scale each industry shall be visited where smart manufacturing practices have been implemented.
c) Atleast two smart manufacturing solution providers should be visited.
d) Feedback from at-least five users shall be sought.

7. **Deliverables**: The following should be submitted in hard copy and digital format to BIS:

a) Study report covering all the aspects mentioned in the scope.
b) Questionnaire and response received to them.

8. **Requirement for the CVs:** CVs of the following members to be shared by the organization conducting the research:

a) Project leader for the R&D project.
b) Team members to be engaged for the project.

9. **Timeline and Method of Progress Review:**

a) The timeframe for completing the study and submission of the final report is 4 months from the date of award of the project.
a) Mid-term review of the project: Mid-term report covering the review of the literature, industries, solution providers identified to be visited and survey conducted to be submitted within 45 days from the date of award of the project.
b) Draft report: To be submitted with 90 days from the date of award of the project.
c) In case of delay in submission of final draft report, the justification shall be given by the project proposer for consideration by the Sectional Committee.
d) d) The proposer shall comply to the provisions given in the BIS guidelines for Research & Development Projects for Formulation and Review of Standards, i.e., **doc no. SCMD/R&D Guidelines/20230909.**
e) e) The proposer taking up the project shall clear all doubts on provisions of research including ToR and BIS guidelines before acceptance of the project and signing agreement.

10. **Support BIS will Provide:** Following will be provided by BIS on request

a) Any national/international standard relevant to the project.
b) Assistance by introducing researchers to third parties wherever suitable.
c) Template for use-case compilation (to assist in data compilation in addition to the details mentioned in the scope)

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