TERMS OF REFERENCE FOR THE R&D PROJECT 1 (LITD 34)

1. **Title of the Project**: Study of Reference architecture for Smart Manufacturing in India

2. **Background:**

a) A reference architecture is a standardized framework or blueprint that provides a structured and comprehensive design for the implementation of any system. It serves as a guide, offering a set of best practices, principles, and specifications to design and deploy integrated solutions in the context of any modern manufacturing processes.

b) 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.

c) A reference architecture for smart manufacturing would be essential as it would provide a standardized framework and set of guidelines for the design and implementation of interconnected and intelligent manufacturing systems. This would not only facilitate seamless integration of technologies but also streamline the development process, reduce implementation risks, and accelerate innovation. Additionally, a reference architecture would serve as a common language for industry stakeholders, enabling effective communication and collaboration.

d) This research project intends to review the existing reference architectures for smart manufacturing developed by various consortiums and countries. It further aims to assess the current status of implementation of smart manufacturing across various sectors of industry of varied scales and assess the suitability of implementation of the existing reference architectures on Indian industry.

3. **Objective:** To gather technical data, assess the landscape, and create a structure of a reference architecture for smart manufacturing the context of Indian industries.

4. **Scope**:

a) Study and comparative analysis of existing literature which includes international standards such as standards published by IEC, DIN/DKE etc., research papers, SOPs/instruction/guidelines/laws applicable to smart manufacturing, any other study report available. Study of international standards may be done specifically keeping in view their suitability for implementation in Indian context.

b) Collection of the following data regarding industries where Smart manufacturing practices have been implemented in India. Similar discussion and assessment should be done with smart manufacturing solution providers in India:

i. Current state of smart manufacturing: Overview of the existing smart manufacturing landscape in India and adoption rates and maturity of smart manufacturing technologies.
ii. Industry-Specific Requirements: Analysis of specific needs and requirements across different industries and customization of reference architecture required to accommodate industry-specific challenges and opportunities.
iii. Technology Stack: Examination of the technologies involved, including IoT, AI, machine learning, data analytics, and automation. Also assess compatibility and integration of various technologies within the reference architecture.
iv. Identification and evaluation of interoperability standards for seamless communication between different components of smart manufacturing systems currently being implemented.
v. Assessment of security measures within the reference architecture to protect sensitive data.
vi. Evaluation of the existing reference architectures reviewed under literature survey for scalability to accommodate growth and changing demands and flexibility to adapt to evolving technologies and industry requirements.
vii. Identification of potential challenges and obstacles in implementing smart manufacturing reference architecture in the Indian context. Also suggest, strategies to overcome these challenges.
viii. Assessment of the economic impact of adopting smart manufacturing reference architecture, including potential cost savings, increased productivity, and job creation.
ix. Analysis of the availability of skilled professionals to implement and manage smart manufacturing systems.
x. Strategies and plans for disaster recovery, Business continuity measures in place.
xi. Development of a roadmap for the future evolution of smart manufacturing reference architecture in India.
xii. Collection of feedback from industries that have adopted smart manufacturing reference architecture.

c) Feedback from users of smart manufacturing solutions in India.

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) Two large, medium and small scale each industry shall be visited where smart manufacturing practices have been implemented.
b) Atleast two smart manufacturing solution providers should be visited for in depth-review.
c) Feedback from atleast 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 3 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 and survey conducted to be submitted within 45 days from the date of award of the project.
b) Draft report: To be submitted with 75 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.

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