



# **Smart Maintenance Technologies in the Manufacturing Industry: Implementation, Challenges, Enablers and Benefits**

**San Giliyana**

Licentiate Thesis Defence



## Biography

**San Giliyana is a Industrial Doctoral Student in smart maintenance. His focus is on supporting the manufacturing industry in the implementation of smart maintenance technologies.**

**He has worked as a maintenance engineer at Volvo GTO in Sweden for almost four years and as a university lecturer in production, logistics, and maintenance at Mälardalen University, for almost four years.**

**He married and lives with his wife Saba and his child Gabriel in Eskilstuna, Sweden.**

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## Contact

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## Abstract

In Industry 4.0, production, Information Technology (IT), and the Internet are combined. The nine technologies of Industry 4.0, Artificial Intelligence (AI) and Cyber-Physical System (CPS), are changing machines, strategies, processes, and maintenance.

In the first generation of maintenance, machines were run to failure, which is related to Corrective Maintenance. Systems for planning and control were implemented in the second generation, related to Predetermined Maintenance. Condition Based Maintenance (CBM) was presented in the third maintenance generation. Industry 4.0 places new demands on maintenance and different maintenance approaches are presented in previous research, such as Maintenance 4.0, Smart Maintenance and Self-Maintenance.

This research focuses on smart maintenance technologies, using the nine technologies of Industry 4.0, such as Industrial Internet of Things (IIoT), and Big Data and Analytics, for machine connection, maintenance data collection, analysis of data, and making decisions using AI. CPS can be used to integrate the physical world, such as manufacturing machines, factory environment, material, people, and executions, with the cyber world, such as data analysis, apps, services, and decision-making.

Previous research presents several approaches to smart maintenance technologies. One problem is a lack of research regarding how smart maintenance technologies can be implemented to add benefits to the maintenance organization in line with company's goal. Furthermore, previous research presents that further research is needed to support the manufacturing industry in what step an organization should take to implement smart maintenance technologies.

In this research, four studies have been performed, which include literature reviews to obtain a clear overview of the research area of smart maintenance, as well as collected empirical data. The empirical data is collected from large companies and Small and Medium-sized Enterprises (SMEs), within the manufacturing industry, to obtain a clear overview of the manufacturing industry' situation. The studies show that the manufacturing industry faces several challenges when implementing smart maintenance technologies, despite the concept of Industry 4.0 has been discussed for more than ten years. In this research, a conceptual implementation process is proposed, including challenges and enablers to consider when implementing smart maintenance technologies, as well as benefits of using smart maintenance technologies.

# Opponent



Phillip Tretten  
Luleå University of Technology

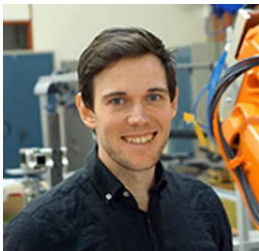
# Committee



Yvonne Lagrosen  
Mälardalen University



Carin Rösiö  
Jönköping University

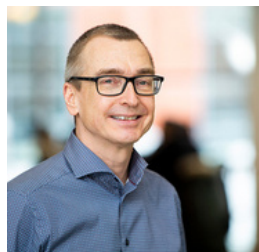


Jon Bokrantz  
Chalmers University of Technology

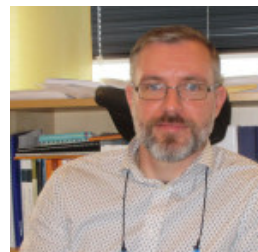


Konstantinos Kyprianidis  
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# Advisors



Antti Salonen  
Mälardalen University



Marcus Bengtsson  
Mälardalen University



Vincent Adoue  
Mälardalen Industrial Technology Center

# List of publications in the thesis

## Paper A:

Title: Perspectives on Smart Maintenance Technologies – A Case Study in Large Manufacturing Companies

Authors: San Giliyana, Antti Salonen, Marcus Bengtsson. *Advances in Transdisciplinary Engineering* / [ed] Amos H.C. Ng, Anna Syberfeldt, Dan Högberg, Magnus Holm, IOS Press, 2022, Vol. 21, p. 255-266

## Paper B

Title: Perspectives on Smart Maintenance Technologies – A Case Study in Small and Medium-Sized Enterprises (SMEs) Within Manufacturing Industry. Authors: San Giliyana, Marcus Bengtsson, Antti Salonen. In: *16th WCEAM Proceedings*, Springer Nature, 2023, p. 571-585

## Paper C

Title: A Testbed for Smart Maintenance Technologies. Authors: San Giliyana, Joakim Karlsson, Marcus Bengtsson, Vincent Adoue, Mikael Hedelind. *Manuscript (preprint)*

## Paper D

Title: A Conceptual Implementation Process for Smart Maintenance Technologies. Authors: San Giliyana, Antti Salonen, Marcus Bengtsson. *Manuscript (preprint)*

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