NAVIGATING THE FUTURE : UNVEILING THE DYNAMICS OF INDUSTRY 5.0

Editors

Dr.A.Mayil Murugan | Dr.S.Selvakumar | Dr.K.Hema Malini
Dr.Y.Natarajan | Dr.S.Chandrasekar | Dr.R.Vennila
Dr.A.Karuppusamy | Dr.S.Ramachandran | Dr.S.Krithika
Mrs.P.Jayalakshmi | Mrs G Sreedevi

PG & RESEARCH DEPARTMENT OF COMMERCE,
THE MADURA COLLEGE,
MADURAI

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Editor's Name:	**Dr.A.Mayil Murugan** **Dr.S.Selvakumar** **Dr.K.Hema Malini** **Dr.Y.Natarajan** **Dr.S.Chandrasekar** **Dr.R.Vennila** **Dr.A.Karuppusamy** **Dr.S.Ramachandran** **Dr.S.Krithika** **Mrs.P.Jayalakshmi** **Mrs G Sreedevi**
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PREFACE

In an era marked by technological revolutions, the concept of Industry 5.0 stands at the forefront, promising a paradigm shift in the way industries operate. As we navigate the ever-evolving landscape unravel the intricacies and possibilities that Industry 5.0 holds. "Navigating the Future" invites all attendees to be active contributors to the ongoing dialogue that shapes the future on industries, fostering a community of forward – thinkers and innovators who are well – equipped to drive positive change in the world of Industry 5.0

Industry 5.0 is regarded as a fifth industrial revolution in which consumers could satisfy their individual requirements as per the tastes and expectations. Although the repetitive tasks are done by robots in Industry 4.0 which is at the mass customization level, Industry 5.0 aims to perform mass personalization with help of Artificial Intelligence.

Industry 5.0 is expected to revolutionize the production process with higher autonomy to collaborative robots. Industry 5.0 is the futuristic industrial revolution which is expected to bring in more creativity and innovation in the products by allowing robots to perform repetitive tasks. It is expected to utilize the creative intellectual capability of human optimally. Moving from mass production to custom manufacturing techniques and production system digitization and intelligentization.

In the lines if above, the PG & Research Department of Commerce has organized two days Conference on the theme "Navigating the Future: Unveiling the Dynamics of Industry 5.0" with the following objectives, to understand and gain knowledge on the functional areas of Industry 5.0; to provide a holistic understanding of the multifaceted dynamics of Industry 5.0 and to enhance the research aptitude among the academicians, scholars towards dynamic changing environment.

To get more insights on the above theme, research articles were invited for presentation and publication. The Department has received fifty (50) articles on various sub-themes from Professors and research scholars of various colleges in Tamil Nadu, Kerala and Karnataka. The Editorial Board has reviewed and edited all the papers scrupulously and meticulously with plagiarism check.

The Editorial Board has recommended and forwarded all the articles in the form of Edited Book with ISBN Publication Number for disseminating the knowledge to all the stakeholders of Higher Education Institutions and Industry concerned.

This book is a comprehensive guide for understanding and utilizing on various themes to generate indepth knowledge on it and suitable for research scholars as well as corporates. We hope that you will find this book informative and inquisitive as much as we learnt it.

Editorial Board.

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INDUSTRY 5.0 APPLICATIONS FOR SUSTAINABILITY: A SYSTEMATIC REVIEW AND FUTURE RESEARCH DIRECTIONS

K.Naganandhini
Assistant professor
PG & Research Department of Commerce,
The Madura College, Madurai.

Abstract

Industry 5.0 has created innovative new prospects leading to the production of more environmentally friendly projects, services, and products. However, the available investigation of Industry 5.0 for sustainability is still in its early stages, with few systematic and scant findings. Therefore, the purpose of this study is to undertake a systematic review of industry 5.0 for sustainability in order to identify trends, categorize research themes, draw attention to research limitations, and suggest potential directions for future research.

Results showed that the research trend on the contributions of Industry 5.0 to sustainability has been remarkably growing worldwide. The internet of things, artificial intelligence, and collaborative robots were the most commonly used Industry 5.0 technologies for sustainability purposes. Subsequently, this study discussed the current studies under four main research themes, namely, robot advancement, higher education sustainability, human-centric, and ecosystem advancement. It has been found that human centric is the most popular theme. The identification of themes and sub sub-themes in this study can help researchers identify gaps and inspire further exploration based on the existing knowledge. This study can support the decision-making process regarding the effective implementation of Industry 5.0 solutions to enhance sustainability practices in organizations. This study discusses the current state of Industry 5.0 technologies for sustainability and provides insights into future researchdirections. This can motivate researchers, policymakers, and industry professionals to explore and develop innovative Industry 5.0 solutions.

Keywords : *Industry 5.0, Industry 4.0, Digitalization, Sustainable development, Resilience, Human-centricity, Environmental sustainability, Social sustainability*

Introduction

The present study addresses this knowledge gap by developing an architectural design for Industry 5.0, which involves exploring and describing this phenomenon's technological constituents, techno-functional principles, components, and the scope of impact (intended values) that collectively contribute to the new human-centric, sustainable, and resilient manufacturing economy. To this purpose, the study conducts a content-centric review of Industry 5.0 academic literature and draws on evidence mapping to identify how Industry 5.0.Various advancements in technology help us to achieve a significant increase in industrial output. This significant increase in industrial output create a chain reaction in industries and businesses. New products in large quantities become available. Supply and demand relations in many products and services change. New businesses are born. Existing businesses adapt. New industries are born and some become obsolete. Changes in inter- and intra-industrial relations are observed. Science and technology research receive funding for further research. All these changes affect the society in many ways. Therefore, we call this an industrial revolution. There were three industrial revolutions in history. According to many, we are at the dawn of a new industrial revolution. This fourth

revolution is called "Industry 4.0". The concept was recently introduced in 2011. "Smart Manufacturing" or "Smart Factories" are at the core of Industry 4.0. Since the introduction, there were many talks, discussions, conferences, seminars, and scientific research into the concept. However, while there is a remarkable support for Industry 4.0, there is also some criticism from various experts and scholars. One of the basic critique related to Industry 4.0 is that it is not a revolution but the same old IT-supported manufacturing. Furthermore, we have yet to see the changes previously observed in earlier industrial revolutions.

Industry 5.0

An Industry 5.0 research paper would likely explore the integration of advanced technologies with human ingenuity in industrial settings, emphasizing personalization, sustainability, and collaboration. It would delve into how this new paradigm fosters a synergistic relationship between human creativity and machine efficiency, aiming to enhance not just productivity but also worker satisfaction and environmental responsibility. The paper would examine case studies and emerging trends, showcasing how businesses are adopting Industry 5.0 principles to create more resilient, adaptive, and sustainable operations. Furthermore, it would address the implications of this shift for workforce development, ethical considerations, and potential societal impacts, outlining strategies for navigating the challenges and maximizing the benefits of this transition

Another vision for Industry 5.0 is set forth by Michael Rada (Rada, 2015; Rada, 2017). Rada states that the priority of Industry 5.0 is "to utilize efficiently workforce of machines and people, in synergywith the environment. It goes back from a virtual environment to a real one." He also provided a definition for industry 5.0 (Rada, 2017). The theme of this vision is Industrial Upcycling. This visionfocuses on waste prevention. Furthermore, Rada points out that we need to turn to human element in the manufacturing process. He criticizes the current digitization trend that is the effort to embed 1s and 0s into any living organism (Rada, 2015).

According to Rada, Industry 5.0 includes 6R methodology andThe 6R are:

1. **Recognize:** First, we need to recognize the opportunities offered by Industrial Upcycling. An awareness is the first required step.
2. **Reconsider:** We need to evaluate and reconsider our business and manufacturing processes. A redesign of processes to realize the benefits of Industrial Upcycling is an essential step
3. **Realize:** After recognition of the opportunities and reconsideration of business processes, we need to realize the business process improvement or innovation.
4. **Reduce:** Reducing the use of resources to achieve efficient outcomes is the essence of themethodology.
5. **Reuse:** Reusing the materials considered as useable prior to process improvement is also at the centre of the methodology.
6. **Recycle:** Recycling as much as possible is one of main expected outcomes of the Industrial Products.

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Industry 4.0

The goal of Industry 4.0 is not different from the previous industrial revolutions. It is basically achieving mass production with the help of new technologies. Obviously, in this sense, technology is the fuel for an industrial revolution. This is in fact a cyclic development. Technology helps industries and industries create a need for technology. Furthermore, the path for achieving efficiency and effectiveness in industries sets goals and creates a necessity for technology.Smart production is at the core of Industry 4.0 (Erkollar and Oberer, 2016). The motto set by Germany Trade and Invest (GTAI) for Indutries4.0 is "Smart Manufacturing for the Future" (Germany Trade and Invest, 2014). According to the policy document (Indutrie 4.0 - Smart Manufacturing for the Future), smart industry or "Industries4.0" is the technological evolution from embedded systems to cyber-physical systems. It also makes way to a paradigm shift from centralized to decentralized production. Naturally, Industry 4.0 benefits from various trend technologies. These trend technologiesare in fact information technologies (IT) not originally developed and intended for Industry 4.0. These trends are

- Internet of Things (IoT)
- Cloud Computing
- Big Data
- Robotics and Artificial Intelligence (AI) These technologies are commonly accepted as the core technologies supporting Industry 4.0. There are also various other technologies such as 3D printing. European Union and especially Germany is pushing forward the Industry 4.0. Germany is one the most important manufacturers of the world and leader in many aspects related to manufacturing. Much has written about Industry 4.0 and its promises.

Industry 5.0 contains three core values, including sustainability, resilience, technology and human centric.

Sustainability means. It is also related to sustainableeconomic processes for improving the use of materials, reducing waste, and environmental impact. Industry 5.0 has some boundaries for environmental sustainability.

The focus of industry 5.0 is on sustainability, and the production process is also related to creative human touch and Cobots.

Resilience represents the need for developing a system having higher robustness in the manufacturing process, precautions against disruptions, and providing and supporting critical infrastructure for crisis management. Industry 5.0 promises that future industries will be resilient to manage natural emergencies and significant political shifts.

Technology is under the control of human factors to serve society, as manufacturing technology is adaptive to the diversity of industrial workers and the needs of society . Traditional manufacturing paradigms may be developed with new robots empowering line workers to provide further flexibility in the production area. Industry 5.0 enables cooperation betweentechnology, humans, and machines with technological advances'

economic, social, and environmental impacts. Industry 5.0 proposes that the next generation will see cleaner, smarter, and more resilient industries.

Human-centric approach to emerging technologies proposes combining sustainability and competitiveness with emerging tools, including artificial intelligence, cobots, and big data techniques. The human-centric paradigm focuses on core human interests and needs in the production process, being a more human-focused and society-driven approach rather than technology-driven progress

Challenges and Responses for Industry 5.0

Industry 5.0 approach posits some unique challenges and responses, including measurement of social and environmental value generation, social heterogeneity of values and acceptance, system complexity and inter-discipline research, integration from value chains of customers in SMEs, agile, outcome-oriented, and ecosystem-based innovation policy. Significant investments and productivity are required (Xu et al., 2021). Also, the European Commission (EC) initiated some policies to promote Industry 5.0 (European Commission, 2022). Also, Industry 5.0 needs substantial investment from various government agencies. Industry 5.0's future depends on the abovementioned core values of resilience: human-centricity and sustainability. Thus, Industry 5.0 has become a major driving force for Society 5.O

Conclusion:

Industry 4.0 is still in its early stages. It is officially introduced in the beginning of 2010s. In only afew years, various visionaries started discussing Industry 5.0. Moreover, these visionaries also pointout the inadequacies of Industry 4.0 and propose Industry 5.0 to overcome the shortcomings of Industry4.0. One logical conclusion is that Industry 4.0 was introduced without adequate vision. Previousindustrial revolutions occurred naturally unlike Industry 4.0, which is formally defined and forcedupon the industry. It is possible to argue that this artificial revolution start is premature and proposedwithout adequate maturity. To call a concept an industrial revolution, we need to observe a widespreadchange both in industries, businesses, and society. Currently, with its current definition, Industry 4.0should actually be a proposal.Smart mass production seems to be the goal of Industry 4.0. Sustainability is main theme in Industry 5.0 proposals. Actually, they are both inadequate by themselves. Note that sustainability and mass production are not mutually exclusive. Therefore, combining these two goals or themes and redefining the next industrial revolution may be a better approach. As a result, the motto of the next industrial should at least be "sustainable smart production".

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