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# Table Top Smart Factory (Industry 4.0) I4.0

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**Abstract -** *Novel digital technologies linked to the Internet of Things, as well as advances in artificial intelligence and automation, are allowing a new generation of industrial innovation. "Smart factories" will utilize industrial equipment that connects with users and other machines, automated processes, and mechanisms to enable real-time communication between the factory and the market, allowing for dynamic adaptability and efficiency maximization. Smart factories may provide a variety of benefits, including better process efficiency, product quality, sustainability, and safety, as well as cost savings. Companies, however, confront enormous obstacles in establishing smart factories due to the large-scale, systemic transformation required. We assess these issues and highlight the critical steps required to execute the smart factory idea using data acquired from in-depth examinations of five plants at two large car manufacturers. Based on our findings, we propose a preliminary maturity model for smart factory deployment based on three guiding principles: developing digital people, implementing agile processes, and designing modular technology.*

**Keywords**: Smart Factory, Industry 4.0, Table Top Factory, Smart Manufacturing

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## 1. Introduction

The advancement of novel digital technologies linked to the Internet of Things, as well as improvements in artificial intelligence and automation, is allowing a new generation of industrial innovation. Dynamic process innovations are being generated by industrial equipment that communicates with users and other machines, automated processes that require little or no human interaction, and even technologies that permit real-time communication between the factory floor and the market. The result is what we call a smart factory: a connected and flexible manufacturing system that learns and adapts to new needs using a constant stream of data from linked operations and production systems. According to some observers, smart factories will usher in a new industrial revolution that will substantially upset existing firms. Manufacturers must accept and adapt to new technology in order to remain competitive [2].

Leading manufacturers are answering the call and embarking on the road toward smart factory implementation. Tesla has built a smart factory in which a network of gadgets, sensors, and robots collaborate inside an integrated system to produce vehicles and batteries more effectively. Scania, a Swedish truck manufacturer that has traditionally kept its competitiveness by innovating in its manufacturing processes (for example, by being among the first to integrate industrial robotics, programmable logic controllers [PLCs], CAD/CAM, and Lean management techniques), is now attempting to transform its operations through smart factory technology [5].

## 2. Industry 4.0: Overview

The development of the industrial sector has transformed our lives since the 18$^{th}$ century. The inventions that resulted are known as the first industrial revolution. As a result, breakthroughs through the mid-nineteenth century, particularly the introduction of the electrical technical production system, defined the second industrial revolution and revolutionized the industry by enabling mass manufacturing. The development of the Programmable Logical Controller (PLC) in 1969 provided synergy between information technology and electronics, allowing for a rise in industrial automation that is still ongoing today. This progression is known as the third industrial revolution [4].

Today's manufacturing organizations confront several problems, including a shorter innovation and technology life cycle, as well as a need for specialized goods at the expense of large-scale production. Furthermore, the

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existence of industry in emerging nations has increased global market competition. Such industrial enterprises have the ability for technical absorption and present as low-cost manufacturing companies, which will shift the market away from developed countries (i.e., Germany, the US, and Italy). The government and industry industries, particularly in Germany, are seeking to win market dominance through inventions geared toward the fourth industrial revolution, or I4.0. I4.0 will build on current breakthroughs in information technology, communications, automation, and other fields to usher in a new industrial era. The objective is to develop a national industrial sector capable of competing in the global market by developing high-value-added goods and services via product and service innovation. Companies will be empowered by innovations that provide them with a distinct competitive edge in terms of enhanced efficiency, resource utilization, and responsiveness to the requirements of both consumers and society.

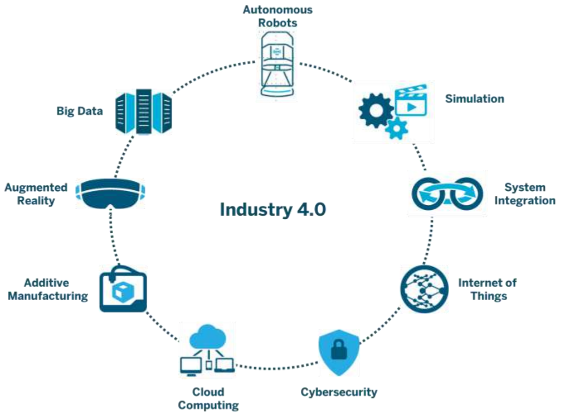


Fig.1: Various steps to finalize data in Industry 4.0

Other nations are aware of the aforementioned difficulties, and some of them share I4.0's goal. Fabricca Intelligence in Italy, Flanders Make in Belgium, the Smart Manufacturing Leadership Coalition in the United States, Made in China in China, and Made in India in India are examples of such concepts [3].

## 3. The Advantages of Smart Factory Implementation

The adoption of smart factories is a difficult task that necessitates a consistent commitment to developing organizational maturity and competence. However, the effort may result in significant advantages; our study indicates four major outcomes as companies advance to greater degrees of smart factory maturity [4].

- Continuous analysis of operational data facilitates the discovery of process-performance bottlenecks that may be addressed, resulting in increased process efficiency. As one Curie production supervisor put it, "many notifications in production that were previously hidden are now exposed, bringing tiny bottlenecks to the surface." Such self-correction, which improves process efficiency, distinguishes smart factories from standard industrial automation. According to our interviews, process efficiency translates into decreased equipment downtime, maximized capacity, and reduced mean time to repair, to mention a few possible advantages.

- Lowering operating costs is accomplished by process optimization, which allows for more cost-effective resource usage. According to a Franklin automation engineer, "resources may be distributed more wisely and based on facts as KPIs are obtained." As sources of cost reductions in this context, respondents indicated more predictable inventory requirements and supplier management, more effective personnel decisions, and lower process variability.
- Increased product quality is accomplished through the smart factory's real-time monitoring and continual optimization. Improved predictive and investigative tactics enable quality issues to be identified sooner rather than later. "The new smart traceability and stop system decreased the quantity of quality deviations in my area of responsibility from 20/day to 0-1/day," said a Curie supervisor. Furthermore, the system can help identify the fundamental causes of faults, whether they are human, mechanical, or environmental. Decreased scrap rates and lead times, as well as a lower frequency of product faults and recalls, were mentioned as advantages by interviewees.
- Increased safety and sustainability are attained through operational efficiency, which minimize the factory's environmental imprint when compared to traditional production procedures. Furthermore, increased process autonomy may lessen the possibility of human mistake, including industrial accidents, for example, sensors can identify an operator or assembler in a machine cell or other restricted area and halt the activity. Finally, monotonous and exhausting work activities can be substituted with more fulfilling jobs that provide more job satisfaction, lowering injuries and employee turnover. As one Einstein team leader put it, "unnecessary manual lifts may be eliminated by utilizing modern and clever technologies" [7].

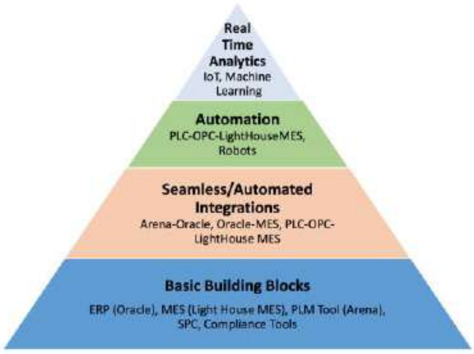


Fig.2: The pillar of basic building block

### 3.1 Approaches in a Smart Factory

This section examines the references in the eight categories, attempting to provide additional information about the proposed requirements and current works in each area.

1. **Surveys -**This category contains publications that propose reviews, surveys, and tutorials regarding smart manufacturing systems or one of its enablers. This category of references investigates and analyses existing works that attempt to give solutions for the smart manufacturing system. Table 2 analyses these references in relation to the criteria of a smart factory. The requirements for modular machine tools, standard infrastructure, standard communication and CPS, decentralized control architecture, and service orientations received the greatest attention in the literature [7].
2. **Perspectives –** This category is devoted to sources that provide their viewpoint on how the smart factory should be. They endeavored to design the smart factory of the future. The resources in this category explore reasons for developing technological enablers, software structure, and tactics to accomplish smart factory implementation. Such arguments inspire academics and manufacturers to help shape the future of the smart manufacturing system. Examine these references in light of the indicated needs. According to the chart, the needs for standard communication and CPS, modular and decentralized control architecture, and service orientation received the most attention. On the other side, specifications for modular material handling systems, reconfigurable fixtures, reconfigurable tools, recording actual manufacturing data, and standardized virtual modelling language have been established.
3. **System Design -**This category covers references that are concerned with system engineering. References in this category give mechanical, electrical, mechatronic, computer, and control engineering solutions that enable the smart factory's technological needs. Requirements improve not just system flexibility and reconfigurability, but also system component modularity. The capacity to modify the layout of the shop floor and adapt process operations is referred to as reconfigurability. A module, which is an autonomous machine tool, workstation, or material handling equipment that can perform a set of tasks, is the core component of the smart factory. A module is loosely connected and may be relocated, added, or withdrawn from the system as needed [2].
4. **Workforce -** This category is devoted to works that examine the role of the human worker in the smart production system. This category's references suggest tutorials or software tools that assist workers in integrating into the system. A classic specialized production line requires a defined and repeated activity from the labor,

and high-level competence is not required. Machines and robots replace workers in a flexible production system when high automation is appropriate. The smart factory system presents a new notion of the workforce's involvement in the manufacturing system. Workers must be highly competent not just to deal with renewable goods and processes, but also to be able to supervise and solve problems on their own. Workers in smart factories integrate with the system, have access to product and process information, and have the programming and mechatronics abilities to troubleshoot software and technical issues. The majority of inventive ideas for improving processes and products originate from the worker, who is the system's foremost expert.

5. **Communication-** The evaluated study on communication issues focuses on proposing ways to facilitate data sharing between system internal parts and CM. The field of CPS has received the most interest in several categories. They want to create systems that can combine compute, networking, and physical processes. Such systems do not yet exist, but the ideas proposed offer pathways for such systems [5].

## 4. Conclusion

Developing and implementing smart factories may be a challenging and hazardous endeavor, but our evidence shows to multiple benefits. Companies that deploy smart factories successfully may boost value creation by cutting manufacturing costs, enhancing quality and flexibility, and decreasing time to market. Finally, a robust smart factory implementation provides the potential of enhanced sales growth, market penetration, and firm profitability. To reap these benefits, businesses must design their smart factory implementation with three guiding concepts in mind: nurture digital people, adopt Agile procedures, and setup modular technology to maximize productivity. The model we presented gives practical assistance for establishing the smart factory and carrying out a digitally driven transformation of production processes, paving the way for the next step. The model we've proposed offers practical assistance for adopting the smart factory and delivering a digitally driven transformation of production processes, paving the way for the next generation of process innovation.

## References

[1] H. Gaub, (2016), "Customization of mass-produced parts by Combining Injection Molding and Additive Manufacturing with Industry 4.0 Technologies", Rein. Plast. **60**, pp.401-404.

[2] A. Schumacher, S. Erol, W. A. Sihn, (2016) "Maturity Model for Assessing Industry 4.0 Readiness and Maturity of Manufacturing Enterprises", Procedia CIRP, **52**, pp.161-166.

[3] A. Quik, (2016) "Examination of the Moderating Effect of Country Cultura l-Dimensions on the Relation between Board Gender Diversity and Firm Financial Performance", Master's Thesis, Radboud University, Nijmegen, Netherlands.

[4] G. Adamson, L. Wang, P. Moore, (2017) "Feature-based control and information framework for adaptive and distributed manufacturing in cyber physical systems", J. Manuf. Syst., **43**, pp.305-315.

[5] J. Lee, (2015) "Smart Factory System", Informatik Spektrum, **38**, 230–235.

[6] X. F. Liu, M. R. Shahriar, S. M. N. Al Sunny, M. C. Leu, L. Hu, (2017) "Cyber-Physical Manufacturing Cloud: Architecture, virtualization, Communication, and Test Bed", J. Manuf. Syst. **43**, pp.352-364.

[7] Y. Lu, (2017) "Industry 4.0: A survey on Technologies, Applications and open Research Issues", J. Ind. Inf. Integ. **6**, pp.1-10.

[8] D. C. Mowery and N. Rosenberg, (1989), Technology and the Pursuit of Economic Growth, Cambridge University Press, New York, USA.