International Journal of Pure and Applied Mathematics
Volume 118 No. 9 2018, 505-509
ISSN: 1311-8080 (printed version); ISSN: 1314-3395 (on-line version)
url: http://www.ijpam.eu
Special Issue

ijpam.eu

Smart Factories: An Indian Scenario

Neethu Elizabeth Vaskenly
Department of Management, Kochi,
Amrita Vishwa Vidyapeetham
Kerala, India
neethuvaskenly@gmail.com

Dhanya M.
Department of Management, Kochi,
Amrita Vishwa Vidyapeetham
Kerala, India
dhanyamrajeev@gmail.com

***Abstract*—The manufacturing industries of the world are seen to head towards a more agile, flexible and interconnected manufacturing process, fusing technology, machine and man. Thus, smart factories are jump forward from the traditional automation to a fully connected system. The advancement towards a smart factory is already in progress in India, though it has not yet been seen is an immense scale. Also, researches relating to smart factory adoption in India is lacking. In this paper, researchers aim at reviewing the related studies and current initiatives of smart factories under an Indian scenario.**

Keywords— smart factory, networked, India, challenges

I. INTRODUCTION

Industry 4.0 allows components, machines, products, individuals, properties and systems to create a smart network in a complete value range [11]. Industry 4.0 is what results in smart factory and it includes the internet of things, cyber physical systems, cognitive computing and cloud computing. Smart factories are being promoted as the future of manufacturing. Smart factory is based on, logistics automation, process and equipment automation, factory automation, product development, factory energy management, supply chain management, collaborative information management system and enterprise resource planning (ERP) implements using information and communication technology [9]. The goal of smart factory is to make production system intelligent, optimized and efficient, thus reducing the manufacturing cost, raising manufacturing rate and realizing a manufacturing company that actively responds to customer demand in fast changing and advanced environment [9].

Industrial manufacturing (67%) and aerospace and defense (62%) are the biggest end-use application segments in the worldwide smart factory market [6]. The global average of smart factory implementation across geographies is 43% and in India the status is just 28% [6].

Although, developed countries (USA-54%, Germany-46%, France-44%) have taken the head in adopting automation in their factories, Asia Pacific remains a key region for smart factories with many influential companies having their manufacturing blocks in developing regions [3]. In the global market, Asia Pacific accounts for around 39 percent revenue share. Smart factory market is expected to grow at the fastest CAGR in the Middle East and Africa [3].

Soon it will not be enough for companies to extend services; it will have to give smart services [1]. Intelligence that is connectivity and awareness must be built in to products. In the smart service world, using the 'plug & use' approach, all the machines, factories and systems can be smoothly connected to the internet via digital platforms. This would permit the product's operating data, to be obtained from any location. Thus, smart services are based upon actual evidence(preemptive) that a machine is about to fail, that a shipment of items has been impeded, that a customer's store of consumables is about to be exhausted, and so on. Heidelberger Druckmaschinen, a German maker of high end printing press, has its devices communicating continuously over Internet, transmitting information about their status between printing shops and its regional and global technical supports [1]. The company has access to monitor and optimize the printing equipment performance remotely and much more cost effectively. The 'Make in India' initiative is spreading the wider adoption of Industry 4.0 [10]. 'Smart Cities Mission' under the Government of India, expects to build 100 smart cities across India and are the forerunners of Industry 4.0 in India environment [14].

In India too, the advancement of smart factories has been picking up pace but not yet in a large scale. One of the notable examples include India's first "self-aware" factory in set up at the Indian Institute of Science's Centre for Product Design and Manufacturing, Bengaluru with funding from the Boeing Company [8]. This factory is capable of thinking, working on its own and course-correcting. This factory facilitates data to be continuously gathered and monitored, from digitally connected wearables and sensor-fitted machines, thus providing real-time insights into every motion and process taking place on the shop floor. The data thus created is actively fed back into a talking network-enabled frame that allows the factory to function truly productively and autonomously. Smart factory has also been adopted by a few large corporates. Godrej and Welspun operates their shop floors with the assistance of an Intelligent Plant Framework. Tata Motors' factory in Pune and Mahindra & Mahindra's plant in Nashik possess robots that build car body frames.

Manjushri Technopak manufacturing factory in Bidadi, Bengaluru has dozens of its packaging machines coupled to a network that circulates monthly updates on maintenance problems. In its only multi-modal factory in India, General Electric has invested USD 200 million which is a case of a greenfield smart factory approach.

There has been an increasing interest in smart factory, but research relating to this in India is still scarce. The concept of smart factory is going to change the way India designs, manufactures and smartens up the products. The manufacturing firms across India, without consideration of their size or influence, should try adopting the factory of the future.

II. Attributes of smart factories

Cyber physical systems, Big Data Analytics, Internet of Things (IoT), cloud computing platforms, Artificial Intelligence and 3D printing are the technologies that contribute to smart factories [6].

A. Cyber physical systems (CPS)

CPS track physical process, generates a virtual copy of the physical world and forms decentralized decisions [2]. CPS cooperates and communicates with each other and humans, over the IoTs, in real time. They are regarded as the upcoming evolutionary step from existing embedded systems. This mechanism is monitored and controlled by computer based algorithms, which are tightly unified with users and Internet.

B. Big data analytics

A dataset that is varied, large and complex is called big data. Big data analytics examines this big data to uncover correlations, hidden patterns, customer preferences, market trends, etc. to help organizations make better-informed business decisions [19]. Various business advantages of big data analytics include more effective marketing, new revenue opportunities, improved operational efficiency, better customer service and competitive edge over rivals. Big data analytics is a kind of advanced analytics, that involves complex applications with items such as statistical algorithms, predictive models, and what-if analysis that are supported by high-performance analytics systems.

C. Internet of Things (IoT)

The Internet of Things as a surfacing global Internet-based intelligence architecture that assists the exchange of services and goods, to provide the right information at the right time to form the right decisions [18] [20]. IoT refers to the networked interconnection and interaction of everyday objects via embedded systems, which are often furnished with ever-present intelligence [22]. The objects can be controlled and sensed remotely across prevailing network infrastructure, thus allowing for more incorporation of the physical world with computer-based systems. This results in improved accuracy, economic benefit, efficiency, reduced human involvement [17].

D. Cloud computing

Cloud computing is a form of computing procedure where IT services are supplied by vast lower-cost computing units coupled by IP networks [21]. It removes the need for maintaining expensive computing hardware and provides prevalent access to shared resources of adaptable system resources and top-level services, through the application of virtualization [13]. Thus, economies of scale and coherence are achieved and as can be observed from Amazon's cloud computing.

E. Artificial Intelligence(AI)

The intelligence that are shown by machines is called artificial intelligence and that which is shown by humans is called natural intelligence. It is the ability of a computer controlled robot or a machine to accomplish cognitive tasks that are linked with intellectual beings. AI is not a psychology and is a subpart of computer science [12].

F. 3D Printing or Additive Manufacturing(AM)

3D printing is the process of creating a three-dimensional object from a digital design under computer control. With 3D printing, everyone can be their own manufacturer. This customized manufacturing of goods would be done locally thus resulting in reduced logistics costs and massive energy savings [15]. 3D printing also cuts down on waiting time for replacement of parts and reduces waste by recycling plastics [20].

III. Benefits of smart factory

Smart factories would provide benefits like:

A. Lower costs and enchanced revenue generation

The interlinked and networked gadgets, factory floors and manpower are enabled to self-correct and run smoothly, with lesser errors, thus helping businesses save money and time that would be spent on manual assessments. A good-quality process would mean a good-quality product, lowered maintenance costs and warranty [5].

B. Assset effeciency

Self-correction and self-optimization through continuous analysis produces greater asset efficiency which leads to optimized capacity, lower asset downtime and reduced conversion time [7].

C. Improvements in safety and sustainability

In a smart factory setting, people could use drones or robotic arms, to measure and transmit data which otherwise would require tall ladders. Thus, worker safety and accurate measurement can be ensured. The operational efficiencies that a smart factory can deliver would lead to a smaller environmental footprint and greater environmental sustainability, than a regular manufacturing process.

D. Mass Customisation and reduced energy consumption

Due to the interlinked and networked way in which manufacturing takes place in a smart factory, mass customization of intelligent commodities is possible [5]. Thus, manufacturers can meet an increasing demand from consumers to participate in every facet of the manufacturing process, thus assisting to further distinguish their brand worth. 3D printing helps in mass customization and reduced energy consumption, since goods can be manufactured and transported when required.

E. Knowledge transfer

When experienced employees retire, the virtual and augmented reality in a smart factory would help with the effective transfer of age-old experience and advice. This critical knowledge can be easily stored, shared or given across generations.

F. Quality

Smart factories through self-optimization can detect and predict quality flaw trends faster and can also help to recognize distinct human, environmental or machine related sources of poor quality. This lowers lead times, scrap rates, recalls and increases yield [16][7].

IV. Challenges of Smart factory implementation in India

1. India ranks high in the total size of its workforce, but there is a lack of adequate skill-sets. There is a dire need for a skilled manpower that is equipped and experienced to design and implement smart factories. In almost all sectors there is requirement for new kinds of workers who can control, program and maintain the new operations, robotics and software.
2. Many jobs have been lost due to IT-controlled and automatic processes, especially among lower educated parts of Indian society
3. In India, there is a lack of standards, regulations and forms of certifications. Every retailer has their own process of connecting, which poses a big obstacle in the adoption of smart factories.
4. With many control systems being installed for automation, a lot of irrelevant data is being generated and this needs to be sorted to be acted on. Also, there is a question of how data can be collected, securely stored, examined and then made ready for use
5. There is a reluctance of stakeholders, senior leadership, and investors to invest in new technologies. They show a hesitation towards change.
6. Stability and Reliability are needed for crucial machine-to-machine communication (M2M), including very stable and short latency times.
7. There is a need to tackle the dread of IT security breaches and unclear legal issues that could take place in any part of the entire value chain of production because it is interconnected, open and networked. India's national security architecture is subject to digital intrusions like cybercrime, attacks that are intended to disrupt systems and services for a temporary period etc.

V. Managing the challenges and proposed agenda

1. First, the business structure should be reviewed, and evolution milestones must be defined for the journey of smart manufacturing.
2. An established roadmap should be present to monitor the progression of smart factory initiatives in India. Specifying and measuring the progress could be on an established set of key performance indicators. The benefits could be tracked at regular intervals to fine tune procedure of smart factory adoption.
3. Investments should be provided in data collecting capabilities, data integration and data analytics. Investment in IoT and greater allocations in R&D should be present.
4. So, as to address the skill gap of employees, emphasis on upskilling and reskilling the labor force in India should be given. A workforce that can build hardware, firmware and software; those who can design robotics and automation should be nurtured.
5. Augmented reality solutions can be used for remote assistance, which would allow individuals in different places around the world to link in a live view and troubleshoot together. Thus, an engineer in India could seek advice from an engineer in the U.S. on a technical glitch and receive response in real time leading to fast track problem solving and reduced travel costs.
6. The Indian IT infrastructure should be evolved. Cybersecurity can be augmented if IT security resources are shared, backed or integrated with Operation Technology personnel's, to plan and execute an intimately interconnected IT/OT security.
7. Government can try to incentivize the adoption of Iot for smart manufacturing and facilitate networks that assist IoT devices, like the LORA network. This can chip in significantly in enhancing India's economy",
8. The governing committees and leadership people should have some defined decision-making processes
9. Partnerships could be built to support the vision of complete implementation of smart manufacturing.
10. Implementing 3D manufacturing in India, where around 60% people live in rural areas, would help produce electric vehicles for rural mobility and thus reduce energy consumption to transport goods.

VI. Conclusion

With the trend seen, within a decade beginning now, smart factories would turn out to be an all-pervasive in the world. Thus, India cannot shy away from adopting smart factories and green technologies in all its enterprises, and thus to increasing the manufacturing share in GDP. Given the thrust

that connected manufacturing is getting all over the world and the pronounced advantages it guarantees to bring, corporate leaders across industries would be inspired to welcome the smart factory. A change to smart manufacturing will conserve a firm's money and translate into more jobs, greater profits, and a healthier economy. As machines move into a more complex age, so do the products and workers, thus marking the start of in a new era of production. To make it a reality, Indian industries will have to think outside the box, emphasize substantial investments in technology and R&D, concentrate on reskilling and upskilling of the workforce, thus ensuring that Indian manufacturing doesn't simply exist in the new world but vigorously thrives.

References

[1] Allmendinger, G. and Lombreglia, R., 2005. Four strategies for the age of smart services. Harvard business review, 83(10), p.131.

[2] Baheti, R., & Gill, H. (2011). Cyber-physical systems. The impact of control technology, 12, 161-166.

[3] Budholiya, A. (2016). 5 key trends in the global smart factory market. [online] Embedded-computing.com. Available at: http://www.embeddedcomputing.com/embedded-computing-design/5-key-trends-in-the-global-smart-factory-market.

[4] Chakraborty, P. (2017). Industry 4.0: Towards Smart Manufacturing. [online] BW Business world. Available at: http://businessworld.in/article/Industry-4-0-Towards-Smart-Manufacturing/26-05-2017-118968/ [Accessed 24 Nov. 2017].

[5] Christoph Jan Bartodziej, The Concept Industry 4.0: An Empirical Analysis of Technologies and Applications in Production Logistics (Springer Fachmedien Wiesbaden GmbH, 2017)

[6] Columbus, L. (2017). Forbes Welcome. [online] Smart Factories Will Deliver $500B In Value By 2022. Available at:https://www.forbes.com/sites/louiscolumbus/2017/07/30/smart-factories-will-deliver-500b-in-value-by-2022/#634b9b6e2d22.

[7] Dupress.deloitte.com. (2017). The smart factory: Responsive, adaptive, connected manufacturing. [online]Available at: https://dupress.deloitte.com/content/dam/dup-us-en/articles/4051_The-smart-factory/DUP_The-smart-factory.pdf.

[8] Forbes India. (2017). Making connected factories a reality in India | Forbes India Blog. [online] Available at: http://www.forbesindia.com/blog/technology/making-connected-factories-a-reality-in-india/.

[9] Kang, T.G. and Kim, Y.R., 2016. An Empirical Study on Factors Affecting Smart Factory Introduction Performance from a BSC Perspective: Focus on Manufacturing Firms. Indian Journal of Science and Technology, 9(S1).

[10] Makeinindia.com. (2017). Towards Smart Manufacturing: Industry 4.O and India - Make in India. [online] Available at: http://www.makeinindia.com/article/-/v/towards-smart-manufacturing-industry-4-0-and-india

[11] Mrugalska, B., & Wyrwicka, M. K. (2017). Towards Lean Production in Industry 4.0. Procedia Engineering, 182, 466-473.

[12] Nilsson, N. J. (2014). Principles of artificial intelligence. Morgan Kaufmann.

[13] Ostermann, S., Iosup, A., Yigitbasi, N., Prodan, R., Fahringer, T., & Epema, D. (2009, October). A performance analysis of EC2 cloud computing services for scientific computing. In International Conference on Cloud Computing (pp. 115-131). Springer, Berlin, Heidelberg.

[14] Rajvanshi, A. (2016). India Can Gain by Leapfrogging into Fourth Industrial Revolution. [online] The Quint. Available at:https://www.thequint.com/news/business/india-can-gain-by-leapfrogging-into-fourth-industrial-revolution.

[15] Rifkin, J. (2012). The third industrial revolution: How the internet, green electricity, and 3-d printing are ushering in a sustainable era of distributed capitalism. World Financial Review, 1, 4052-4057.

[16] ROI, Inside the smart factory: How the Internet of Things is transforming manufacturing, http://www.roi-international.com/fileadmin/ROI_DIALOG/ab_DIALOG_44/EN-ROI-DIALOG-49_web.pdf, accessed November 18, 2017.

[17] Vermesan, Ovidiu; Friess, Peter (2013). Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems (PDF). Aalborg, Denmark: River Publishers. ISBN 978-87-92982-96-4.

[18] Weber, R. H., & Weber, R. (2010). Internet of things (Vol. 12). New York, NY, USA: Springer.

[19] Srinivasa, S., & Bhatnagar, V. (2012). Big data analytics. In Proceedings of the First International Conference on Big Data Analytics BDA (pp. 24-26).

[20] World Economic Forum. (2017). 5 trends for the future of manufacturing.[online] Available at: https://www.weforum.org/agenda/2017/06/what-s-going-on-with-manufacturing-b013f435-1746-4bce-ac75-05c642652d42/

[21] Qian, L., Luo, Z., Du, Y., & Guo, L. (2009). Cloud computing: An overview. Cloud computing, 626-631.

[22] Xia, F., Yang, L. T., Wang, L., & Vinel, A. (2012). Internet of things. International Journal of Communication Systems, 25(9), 1101.