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An Industry-wise Comparative Study of Industry 4.0 Status of Indian Firms

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Abstract--- *Purpose - Industry 4.0 is reality. Indian firms must be at different stages of embracing Industry 4.0. This research paper tries to explore the status of Indian firms with regards to moving towards Industry 4.0. This paper also tries to capture the challenges companies are facing to call themselves Industry 4.0 ready. Approach –A virtual survey of Indian companies is carried out. Methodology is to survey companies by visiting their websites and other newspaper articles to collect data on various aspects of Industry 4.0 activities of top companies in two sectors. Findings – The research result shows that the two industries studied were much ahead in adopting Industry 4.0 relevant technologies. But there were other industries which were not even near totechnologies to be Industry 4.0 ready. Research Implications – The findings reveal there is huge scope in spreading awareness and thereby action required in several industries. Utility of the paper – Research paper definitely provides a basic understanding of status of companies in two industries with regards to Industry 4.0 readiness.*

Keywords *– Industry 4.0, Artificial Intelligence, Internet of Things, Smart Factory.*

I INTRODUCTION TO INDUSTRY 4.0

First industrial revolution brought in several changes and conventional production systems into this world for the first time with steam engine and mechanical equipment during later part of 18th century. This period can be called as Industry 1.0. Then came the era of automobiles – cars, assembly line and mass production during the early part of 20th century. This period can be marked as Industry 2.0. Later part of 20th century and early part of 21st century can be called as Industry 3.0 period which saw huge advancement of computers and their uses in almost everything in our daily life. The current industrial revolution is Industry 4.0. Industry 4.0, for the first time, was used by German government to release as a memo dealing with strategy to handle a manufacturing industry with advanced technology without human intervention. They called it 'Industrie 4.0'.

Here the smart factory has machines handled by robots and computers with machine learning capabilities, which over time can run machines making human intervention obsolete (Marr, 2016). For a factory to be called Industry 4.0, it should fulfil the following characteristic requirements:

- Interoperability: all the machines and men, devices and sensors should be able to communicate with each other. Industrial Internet of Things (IIOT) being one of the enablers of interoperability characteristic.
- Information generation, handling and dissemination: System should be capable of handling sensor data.

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- Technical assistance: machines, over period, must be assisting men in solving technical problems and also in decision making.
- Decentralized decision-making: machines should adapt to the environment, develop machine learning capabilities to self-diagnose and also to solve simple problems on their own.
- The benefits manufacturing companies can accrue on going Industry 4.0 are, as observed:
- Increased Productivity
- Improved Quality
- Increased Flexibility
- Decreased Cost
- Increased Speed

There are certain concerns or challenges of adopting Industry 4.0:

- Security and privacy aspects.
- Lack of skilled employees in this area.
- Implementation costs are high.
- Capital availability.

(Scalabre, n.d.) explains that there are basically nine fundamental building blocks of Industry 4.0, as shown in the Fig 1 below:

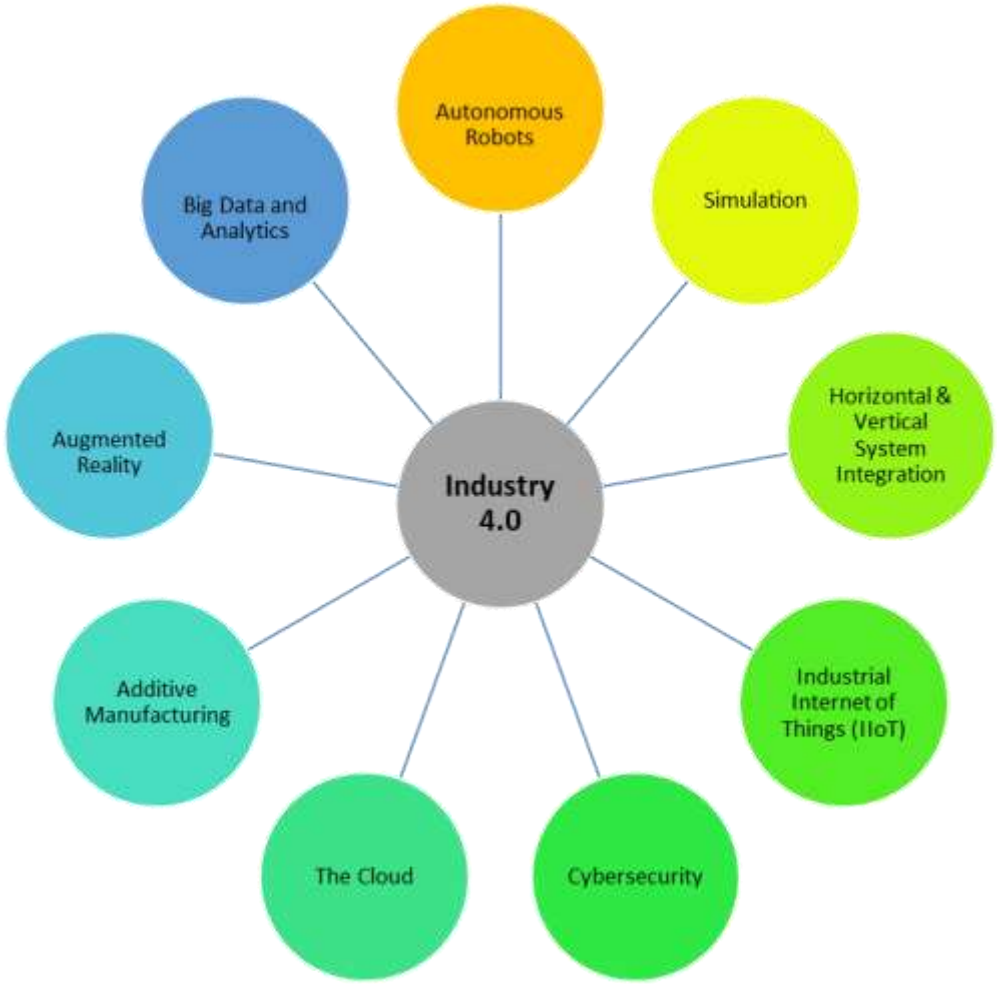

Figure 1: Nine fundamental building blocks

(Andreas Schumacher, 2016) have collected data from 23 different companies to study their maturity level using 9 different dimensions having overall around 62 maturity items. The 9 dimensions on which the companies were graded the maturity level are: Strategy, Leadership, Customers, Products, Operations, Culture, People, Governance and Technology. In this paper, an attempt has been made to assess the current status of Indian firms embracing Industry 4.0.

II LITERATURE REVIEW OF INDUSTRY 4.0 STATUS

Literature review was done to know how the status of Industry 4.0 has been gauged and measure by other scholars and researchers. The maturity models were also looked at for the literature review. Hoffman and Rusch (2017) have studied Industry 4.0 status in logistics management as this area would have an impact and huge repercussions of Industry 4.0. Authors have studied logistics with respect to all the 9 building blocks mentioned earlier. They have found that the opportunities would be for the companies to self-regulate, de-centralize and in improving efficiency. They have further suggested Kanban systems and Just-in-sequence systems for logistics companies adopting Industry 4.0 concepts.

Weyer et. al. (2015) have proposed a SmartFactory which is standardized, multi-vendor and highly modular production system for Industry 4.0 as a contribution to current status of Industry 4.0. This has been presented as a

substitute to proprietary production systems. Lee et. al (2014) have discussed the trends in manufacturing and services with reference to Industry 4.0. They have developed an advanced prediction model that help in informed decision making. The prediction tools make use of big data in order to arrive at better decisions. Sanders et. al. (2016) have discussed that companies trying to be Industry 4.0 compliant they will have to make lot of investment for the benefits which they are not sure about. Industry 4.0 being costly enough, the authors have explored if there is a chance to reduce cost and increase productivity through lean implementation. Authors have tried to investigate whether Industry 4.0 will be compatible with lean manufacturing. They have studied the barriers in implementing lean for Industry 4.0 and also the different ways of overcoming the barriers. Kolberg and Zuhlke (2015) have tried a different approach of combining automation technology and lean production system. They have later on tried to link lean automation with Industry 4.0. They have used an example of smart watches that were used with Andon system for Kanban production scheduling. Wan et. al (2016) have analyzed the IIoT architecture, physical layer, IWNs, smart terminals and industrial cloud. They have proposed IIoT which is software-defined and provides a platform for interaction between various parts for information sharing. They have also tried to foresee problems arising out of IIoT and have discussed the solutions to the problems that might arise.

Wang et. al. (2015) have discussed the current status of cyber-physical systems (CPS) for Industry 4.0 in detail. They have provided the definition of CPS, characteristics and its usage. They have also provided comparison between CPS and cloud manufacturing concept. They have also discussed the reasons for CPS being the future of manufacturing. Hermann et. al. (2016) have discussed various literature on IoT and Industry 4.0. The design principles of Industry 4.0 have been listed after extensive survey of literature and quantitative text analysis. They have also finally provided a case study how identified design principles can help practitioners identify Industry 4.0 activities. Scheuermann et at. (2015) have explained how companies have slowly transformed from meeting linear customized demand to a non-linear dynamic demand. They have discussed about Agile Factory prototype where customers should be allowed to change their requirements to get customer oriented, customized software products. Agile Factory prototype transfers agile software engineering techniques to assembly manufacturing domain. There is a customer feedback loop fed into assembly line to track the customer changes so that it can be incorporated during assembly process. Authors have created a Cyber-Physical System to allow integration of virtual and physical world so that factory worker can communicate with the customer. The literature on status of Industry 4.0 reveals that there is relatively less research work has been carried out with reference to Indian Industry and the status of Indian companies. This paper tries to explore how in reality Indian companies are moving to Industry 4.0 by integrating 9 building blocks of Industry 4.0 into their production process and also in other areas of management.

III METHODOLOGY

Three major companies from automobile industry and consumer durables industry have been studied with respect to their Industry 4.0 status. The status of Industry 4.0 is gauged from all the 9 building blocks shown in Figure 1. Status of Industry 4.0 is gauged to know what each of the three companies are doing in these 9 building blocks. Is there a pattern of using a technology or every company irrespective of industry uses a particular technology in a similar fashion? Is there a company which thinks differently and adopts a technology in a different manner?

Automobile Industry

	Big Data	Autonomous Robots	Augmented Reality (AR)	Additive Manufacturing	Cloud Computing	Cyber Security	Internet of Things (IoT)	System Integration	Simulation
Tata Motors (TM)	Tata Insights and Quants (Tata iQ) helps Tata Motors with Big Data Analytics for customer targeting mainly.	TAL BRABO robot manufactured by TAL Mfg Solutions (Tata Motors Subsidiary) is used by Tata Motors.	Tata Motors is using AR to showcase its products during Motor Show. Nexon App allows customers to experience car through AR and Virtual Reality.	Prototype Development with 3D Printing.	With the help of Amazon Web Services (AWS), Tata motors helps fleet owners to monitor all the vehicles in real-time. Tata Motors is using cloud to service the customers too.	Tata Motors has Senior Manager - Information Security Operations. Beyond this not much know about cyber-security aspect of Tata Motors.	TM has tied up with Microsoft to use their IoT expertise to enhance driving experience.	TM has collaborated with WABCO for several innovative products to enhance safety of commercial vehicles. Technologies like Advanced Driver Assistance Systems, Lane Departure Warning System.	TM uses simulation for several purposes like Virtual try-out facility and virtual weld shop feasibility study.
Mahindra & Mahindra	M&M is using Big Data and Data analytics for logistics network optimization and several other areas with the help of Tech Mahindra	M&M has developed autonomous tractors which run driverless. These tractors will help Indian farmers with their enormous intelligence.	M&M uses AR mainly for outdoor publicity like in Times Square and Melbourne show.	M&M has setup 'Factory of the Future' Center at B'lore. It has 3D printing facility to print auto parts in this center.	M&M's Mahindra Tech helps its automobile unit with its cloud computing technology through 'DiGiSENSE'.	Tech Mahindra opens Cyber Security Operations Center, first of its kind in India. M&M plans to take the help for its Defense Solutions and Armored vehicles.	M&M uses IoT in trucks and tractors to identify the breakdown and thus the loss of time for drivers.	M&M Defense wing has System Integration set-up to design land-vehicles for the military (Infantry Combat Vehicle).	Mahindra Racing team uses simulator with library of Formula 1 racing tracks.

Maruti Suzuki	Maruti has adopted Big Data as back as 2013. By 2016, they had experienced immense benefits from it. They had added above 1 lakh customers.	Fanuc Robotics is the company helping Maruti with C-Series robots in their assembly plant. 104 robots are being used just for welding Dzire cars.	On-stand kiosk and in autoshow, Maruti is taking help of Xenium Digital for VR and AR display of its cars.	STRATASYS is helping Maruti in prototying new designs and visualization of new products through their 3D printing technology.	Cloud ERP helps Maruti to connect with its major suppliers and also with their tier-II suppliers.	Maruti has started digital training center but not much on cyber security. Though it says cybersecurity was successful initiative in 2016-17.	Maruti is using IoT to integrate Android Auto and Apple's CarPlay into its cars where apps get mirrored.		Maruti Driving School uses driving simulator. In operations like

Consumer Durable Industry

	Big Data	**Autonomous Robots**	**Augmented Reality (AR)**	**Additive Manufacturing**	**Cloud Computing**	**Cyber Security**	**Internet of Things (IoT)**	**System Integration**	**Simulation**
Godrej	IBM is helping Godrej to meet real-time demand using data analytics and help them in market expansion.	Godrej Consoveyo Logistics Automation Ltd. is helping them in improving supply chain efficiency.	Godrej Interio showcased its products using AR in a LIFW fashion show.	CII Naoroji Godrej Center of Excellence has program on Advanced Manufacturing to make companies industry 4.0 including 3D printing.	Godrej Infotech Ltd. is partnering with MS Azure to help Godrej with their cloud computing, consulting, and IT solutions.	Godrej has robust cyber security processes setup. Data leakage prevention and security data on mobile platforms is one of their several IT Security initiatives.	IoT is another area Godrej has taken initiative for robust security architecture	Godrej & Boyce has expertise in SCADA, PC based Controls, NC and CNC systems. Also in integrating mechanical, electrical, hydraulic sub-systems, electronics.	Godrej believes in simulating several aspects like building simulation, energy simulation etc.

Samsung India	Samsung is trying to transform itself into big data company because of its leadership on memory chip market.	RoboCV Autonomous vehicles are used in Samsung factories and warehouses.	Samsung has released S9 mobile that has AR feature in it.	Samsung is quite ahead in 3D printing. It has patented for multi-color 3D printing technology.	Samsung cloud is the feature/facility provided to all its customers of mobile phones.	For Samsung mobiles, cyber security and privacy becomes major concerns. It follows 'Nothing gets in or out on our watch' motto.	Samsung ARTIK Internet of Things (IoT) is an integrated smart platform providing secure products.	Samsung is going beyond just system integration calling it service integration.	Samsung has released smart simulator for customers. Especially troubleshooting problems.
LG India	LG CNS's Advanced Analytics Center is an integrated organization that handles projects in Big Data.	From Seoul Olympics experience, LG has introduced whole range of robots for domestic chores.	LG Optimus phone has 3D AR.	LG Chem is one which makes the parts and components of durables. They have taken help of Stratsys to have ABS as material for 3D printing.	LG CNS provides cloud computing facility to LG Electronics along with other customers too.	LG has tied-up with Honeywell for automotive cybersecurity solutions and also for vehicle connectivity technology.	LG has obtained OneM2M IoT certification to integrate across IoT environment.	LG provides integrated smart solutions.	

IV CONCLUSION

From the virtual survey it appears that the top companies, in India, are quite ready for Industry 4.0 in certain industries only. But it is only at awareness, as per virtual survey, in several industries in India. It is high time for the companies to adopt and adapt Industry 4.0 technologies before they feel left out.

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There is huge scope to conduct research and help the companies and also SMEs to strive to become Industry 4.0 ready at the earliest or the consequences they will have to bear would be enormously high. The research restricted itself to only two industries due to lack of data about other industries related to Industry 4.0.

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