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Role of IIoT Technology in Indian Cement Industries

Multan Singh Bhati[1], Dr. Jayshree Jain[2]

[1]*Research Scholar, Pacific University, Udaipur, Rajasthan, India*

[2]*Professor, Pacific University, Udaipur, Rajasthan, India*

ABSTRACT- *Cement is mainly used in infrastructure works. Civil infrastructures are sign of development in any country. As India is developing country, its cement industry is one of major industrial sector. Cement industry of India has seen many technological advancement and still incorporates any kind of changes to meet Indian demands. Out of many changes one of the major technological changes was to shift cement industry from wet process to dry process. Uses of automation technology was second major change for Indian cement industry. Currently Indian cement industry is witnessing uses of cyber-physical system which is also known as Industry 4.0. Or Industrial Internet of Things (IIoT). Cyber-physical system has significantly improved cement production, quality, cost, delivery and safety. This paper focused on role of IIoT technology in Indian cement industries.*

Keywords: *Indian cement industry, Industrial IIoT, Automation, cement, Industry 4.0.*

1. INTRODUCTION

In cement production and cement consumption, India comes to 2nd place in the entire world. Indian cement industry is one of the oldest cement industry and can be traced to early 1900s.Indian cement industry is also one of the fastest growing sectors in India and accounted for around 1.5% of GDP [1]. Cement industries generates huge revenue for governments. In India, cement industry is one of top employment generator industry.Total production capacity of Indian cement industrywas around 550 MTPA in 2020, while production was around 329 and consumption was 327 MTPA [2]. Industries use various technologies for automation of process, operation, and management of supply chain. One of the automation technologies is machine to machine communication which came into existence in 1968, when caller line id inventor "Theodore paraskevakos" introduced machine to machine communication concept. Later, Internet of Things (IoT) concept came in 1999, when "Kevin Ashton", introduced IoT term.General Electric in late 2012,introduced term "Industrial Internet". "Industrial Internet of Things" and "Industry 4.0" are synonyms of "Industrial Internet" [3].Gartner analytics predicted, around 526 million manufacturing devices will be connected using industrial internet of things technology, among them 90 million devices related to mining only [1].

2. DEFINITION

Although Industrial Internet of Things term is new one, but it's enabling technologies are quite old. To understand IIoT technology, it is necessary to first understand its ancestor technologies M2M and IoT. There are many groups, researchers and organizations are available, those have definedM2M, IoT and IIoT, some of discussed here. According to ETSI, M2M communication happens between two or more devices without direct human interference [4].Some example of M2M technology could be rain-sensing wipers of cars, communication of PLCs etc. According to IEEE, IoT is "A network of items- each embedded with sensors- which are connected

to the Internet" [5]. Simple examples of IoT technology are smart watch, smart TV, heath monitors etc. According to IoT agenda, "IIoT is the use of smart sensors and actuators to enhance manufacturing and industrial processes" [6].Level and temperature sensors are simple example of IIoT technology. In general, when IoT technology implemented in industries, it is known as IIoT.

3. ARCHITECTURE

There is no unique architectural model is available for industrial internet of things, but the general concept is the same in every architectural model. Some of popular IIoT architecture models are discussed here.

3.1 General Concept –

In General, IIoT architecture can be understood as a layered architecture, it may contain edge layer (sensors and applications), fog layer (network, server) and cloud layer (big data, analytics and enterprise).

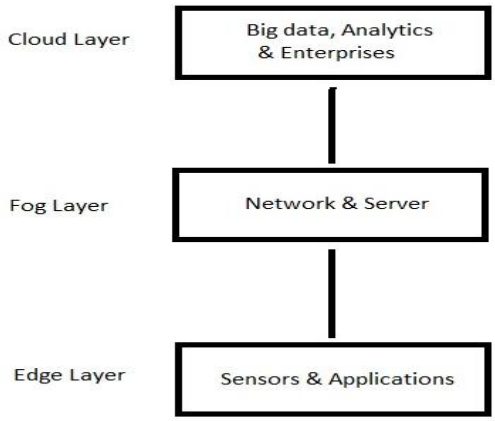

Figure 1. 1 General concepts of IIoT

3.2 IIC architectural model of IIoT –

Industrial internet consortium (IIC) has given 3- tier IIoT system architecture for industrial IoT. It is divided into 3 different tiers viz. edge, platform and enterprise tier [7].

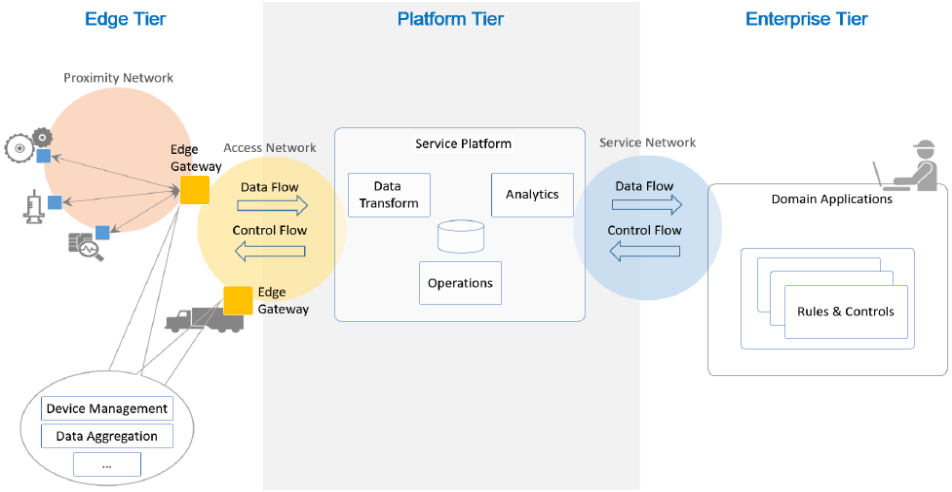

Figure 1. 2 IIC architectural model of IIoT , Source- [7]

3.3 Purdue architectural model of IIoT –

Purdue model of IIoT is a well-known model in industries. It is divided into 6 levels and 4 zones viz. safety zone, manufacturing zone, dematerialized zone and an enterprise zone. Many organizations used this model for reference [8].

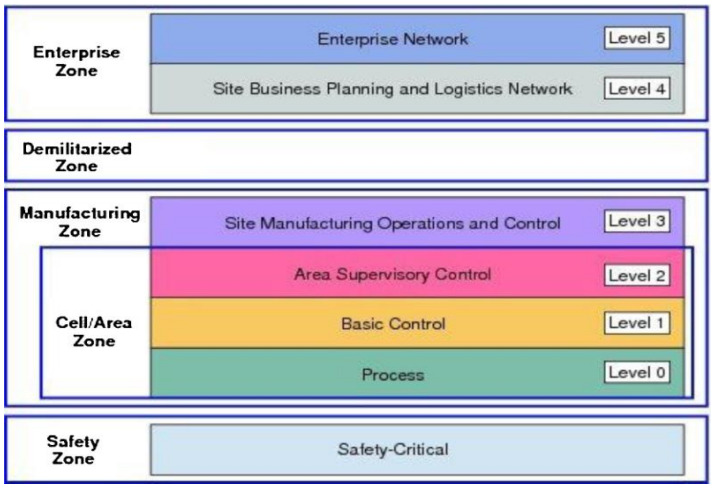

Figure 1. 3 Purdue architectural model of IIoT
Source- [8]

4. CEMENT MANUFACTURING PROCESS

Lime stone is a primary raw material for cement industries, it can be retrieved from open cast mines with the help of drilling and blasting equipment. After blasting small chunks of limestone are transported to crushing for crushing. After crushing process, other raw material like clay, sand, coal etc. are mixed with crushed limestone in mixing unit. After mixing, this mixed raw material is pumped into kiln, where it burns up in the temperature of1500 centigrade and forms a clinker compound.To produce ordinary portland cement (OPC) cement, gypsum is added to the clinker and to produce pozzolana portland cement (PPC) cement, pozzolana material like ash etc. are added along with gypsum to clinker in required portion and fed into grinding mill to produce cement.

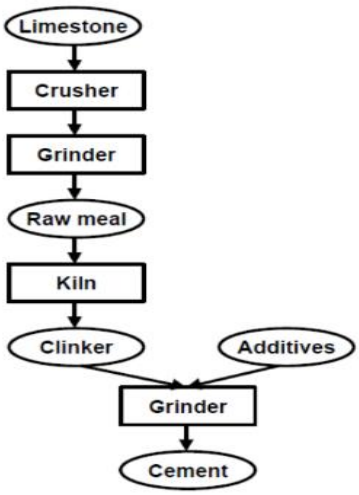

Figure 1. 4 Cement production process, Source- [9]

5. TECHNOLOGY REQUIREMENTS IN CEMENT INDUSTRIES

India is developing country and it needs higher cement production to meet domestic demand which is 210kg per capita, although it is far low than worlds average 580kg per capita [10], [11].Total Indian cement industry's production capacity is around 550 MTPA, but it produced around 329 MT of cement in the year 2020, which shows underutilization of production capacity. To meet customer requirements, cement industries need technology up gradation time to time. Various risks are involved in cement manufacturing, from damage of property to loss of life. In crushing unit, dust flyover can create respiratory irritation, difficulty in breathing. Dust flyover can monitored and compensate with the help of IIoT technology. Kiln, where temperature generally reaches up to 1500 °C, person can't monitor process by his physical presence. In this situation CCTV camera, a temperature sensor comes handy. From cement raw material searching process to delivery of cement to consumer end, IIoT devices plays a vital role. Some uses of IIoT devices in cement sector are discussed here.

5.1 To reduce labour cost – Even a small cement plant needs many sub plants and is heavily dependent on many resources. If a cement plant is operated manually, it needs huge manpower for production. Manpower and its management itself increase cost. To reduce manpower engagement cost, associated expenses, use of IIoT technology is required to improve cement plant's capacity, productivity, quality, efficiency etc.

5.2 To reduce worker's fatigue – As cement industry is resource consuming industry and are operated 24X7, there are various repetitive jobs required to be complete on daily basis. Manpower engagement in these kinds of repetitive and intense jobs is not feasible through any point of view. Intense jobs always have health-related issues. In this kind of situation IIoT technology comes in picture with new feasible solution and that is robotics. Roots never tired in harsh situation and can perform their duty in time and on time.

5.3 To increase productivity – Manpowercan't do work 24X7 without rest, but machinery can do it. Thus Automation using IIoT technology can increase the plant's productivity and availability significantly.

5.4 To improve production quality – IIoT based automated systems follows strict rules, they will not allow any parameter deviation in manufacturing process. This will improve product's quality.

5.5 For safety – IIoT based automated systems can generate various types of alarm including fire alarm, overflow alarm, high-temperature alarm etc. which can alert nearby manpower before any mishap. These alarms becomes extremely important for workers safety. Due to these kind of automation, now person need not go to height for just checking levels of tanks/silo etc. This system also reduced working requirement of manpower in unsafe conditions/environment.

5.6 To reduce maintenance cost – IIoT based automated systems can monitor equipment health and can predicate requirement of maintenance, thus reducing further damage to equipment. This reduced maintenance cost and time.

5.7 For decision making – IIoT based automationsystem can gather data from most of the equipment of cement plant. It can also store equipment trends in servers. While making any decision regarding plant management or maintenance, decision makers can use various trends of plant.

5.8 For control and monitoring – IIoT based automation technology has enabled user to monitor various devices from control room itself. Now user need not to go to field to check each devices or equipment to monitor their condition.

5.9 To reducing downtime – With the help of IIoT technology, maintenance team need not to waste their time to find fault in any supply chain, sensors themselves can find and point out fault location to maintenance team.

5.10 To reduce production cost – IIoT based automation system has reduced manpower engagement, reduced maintenance cost, increase quality, delivery and safety, thus it has significantly reduced overall production cost for cement industries.

6. IIoT KEY ENABLERS

IIoT is not a single technology; it is a group of several existing intelligent technologies. Some of the important IIoT key enablers are discussed here, those enabled IIoT technology to come into existence.

6.1 IP (Internet protocol) –This network protocol was developed in the 1970s. A first remarkable version of IP was IPv4, but as day by day networked devices like sensors, CCTV, smartphones, etc. are increasing, availability of unique IP addresses for each device reduced drastically. To overcome this problem, IPv6 was introduced, which can provide2^128 unique addresses. In IIoT technology, every sensor or devices can be assigned a unique IP address, based on the requirement. With the help of these addresses, devices or sensors can communicate to the central server. Communication between sensors and central server could be based on wired or wireless technology.

6.2 Wi-Fi –It is a networking technology that allows high-speed wireless communication between networking devices and can penetrate walls. This technology was invented by Vic Hayes. It is based on IEEE 802.11 standards which came into existence in 1997. It normally uses two bands 2.4 and 5 GHz[12] and generally accepted as a high-speed default connectivity option for IIoT devices.There are many versions of 802.11 launched each with greater speed and range than to its precursor. It is more vulnerable for attack than any wired network.

6.3 RFID –RFID or Radio-frequency identificationis a wireless method to identify any object withan RFID tag. This system has mainly three components viz. antenna, transponder, and transceiver. Transponder with antenna is known as RFID tag, while the transceiver is a reader, which sends signals to the transponder to activate it. Once activated, the RFID tag can communicate with the RFID receiver. Mainly two types of RFID tags areavailable active tags and passive tags. Active tags have their own power source while passive doesn't. Active tags are bigger than passive tags due to the battery source.A most general example of RFID tags can be found in shopping malls, where these can be found attached to clothes, grocery items, etc.

6.4 Cloud computing –Cloud computing provides on-demand computing to users as a service. It can provide platforms, infrastructure, and software as a service [13]. Since sensors have a lack of memory and processing power, cloud computing is used to analyze data, which is received from large numbers of sensors. Cloud computing also supports artificial intelligence for decision making, thus it can reduce human

intervention. Cloud computing has many advantages like scalability, faster decision making, faster implementation, easy and global access with proper security.

6.5 AI (Artificial intelligence) –AI is intelligence similar to human or animals, which can be shown by machines.AI can work with different kind of sensors to optimize resources; it can predict situations and can alert users before they occur so the user can take actions to avoid that kind of situation. Health monitors can detect sugar level, heartbeat, blood pressure, etc. and by using AI, these systems can alert a person before any unwanted situation occurs. Same can be applied in industries for predictive maintenanceof equipment. This technology also used in speed recognition, problem-solving, planning, etc.

7. IIoT DEVICES AND THEIR USES

Cement plant uses many devices, equipment for its smooth operation. Some of the common and important IIoT devices are discussed here.

7.1 Sensors –Sensors are kind of device those can sense any physical or chemical condition share this information with processing system on demand.As cement industry is heavily dependent on processes, various kind of sensors required to monitor these processes. To run the process smoothly, some parameters likepH, temperature, level, pressure, flow etc. need to be observed continuously. This observation can be done with the help of sensors. Level transmitter, temperature detector, gas detectors, speed sensors, pH analyzers, proximity sensor, limit switch, positioner, fire, smoke sensors etc. are some example of sensors.

7.2 PLC – Programmable Logic Controllers are important devices of industrial automation. This device generally has its own memory, input-output, and processor. These are used to control various sensors, control valves, etc. PLC can work as mediator between field devices and control room. PLC can also be programmed to act on some specific set of rules. For example, they can control the flow of any line depending upon tank level.

7.3 HMI – Human Machine Interface is an interface device between human and machine. It is simply a mobile or laptop like screen on which one can give inputs and can receive output. In cement industries, it is used for interface between operators and Servers. PLC is like a computer system without display and HMI works like a monitor of computer system for PLC.

7.4 RTU – Remote Terminal Units are similar to PLC device, except they generally come with wireless connectivity and battery. PLCs are cheaper devices than RTUs. PLCs need continuous AC supply while RTU can work on their battery. PLCs need extra equipment to communicate wirelessly.

7.5 SCADA – Supervisory Control and Data Acquisition is a combination of hardware and software system, which is used to control or monitor field controller devices like PLCs/RTUs. SCADA systems can record events, communicate and control field sensors. Operator can control SCADA from HMI. SCADA can work on some predefined rules, more rules can be added to it upon requirement. SCADA system can raise alarm in the case of any predefined rule has been activated.

7.6 DCS – Distributed Control System is an automated control system like SCADA, except it is generally used to control large numbers or devices. Like SCADA, DCS also has predefined rules and alarm system.

8. CONCLUSION

IIoT technology is still in its growing phase and will get popular in among other sectors also in near future. Day by day sensors are becoming smarter and cheaper, this will allow them to be used in even small cement plants. Indian cement industry needs to be incorporate IIoT based automation system to meet customer demand. Though this technology is in demand, still it faces some challenges including security, compatibility, privacy, etc.those needs to be rectified. This paper tries to give some insight into this technology including definitions, architecture, and applications after reviewing various research papers and online database.

REFERENCE

[1] Bhati, M.S. and Jain, J (2019).*Automation in Cement Industries. International Journal for Scientific Research & Development (IJSRD) 7(6),* 2019, 399-401

[2] IBEF. (2031, July). cement-india. Retrieved September 8, 2021, from www.ibef.or: https://www.ibef.org/industry/cement-india.aspx

[3] GE Digital. (2017). Retrieved September10, 2021, from GE Digital website: https://www.ge.com/digital/blog/everything-you-needknow-about-industrial-internet-things

[4] ITU. (2005). *ITU Internet Reports 2005: The Internet of Things.* ITU.

[5] Minerva, R., Biru, A., & Rotondi, D. (2015, May 13). *Towards a definition of the Internet of Things (IoT). IEEE.*

[6] https://internetofthingsagenda.techtarget.com/definition/Industrial-Internet-of-Things-IIoT

[7] Industrial Internet Consortium. (2019). "The Industrial Internet of Things Volume G1: Reference Architecture".

[8] Boyes, H., Hallaq, B., Cunningham, J., & Watson, T. (2018). *The industrial internet of things (IIoT): An analysis framework, Computers in Industry, 101, 1–12.*

[9] Cankaya, S., & Cankaya, S. (2015). *Occupational Health and Safety in Cement Industry. Journal of International Scientific Publications, 243-250.*

[10] Bureau of energy efficiency. (n.d.). Retrieved August 20, 2021, from beeindia.gov.in: https://beeindia.gov.in/node/166

[11] IBEF. (2019, January). cement-india. Retrieved August 8, 2021, from www.ibef.or: https://www.ibef.org/industry/cement-india.aspx

[12] Beal, V. (n.d.). *Wi_Fi.html*. Retrieved July 30, 2021, from www.webopedia.com: https://www.webopedia.com/TERM/W/Wi_Fi.html

[13] IT Knowledge Portal. (n.d.). *cloud-computing*. Retrieved July 19, 2021, from www.itinfo.am: http://www.itinfo.am/eng/cloud-computing