The role of Information and Communication Technology in Industry 4.0

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Abstract: Industry 4.0 is an upcoming change in manufacturing Industries across different parts of the world. Industry 4.0 spotlights the start-to-finish digitization of each and every piece of information in the assembling process from contribution to complete item out of industry also connecting and integrating digital environments with value chain partners all the way to the end of the customer. It's a combination of automation and IoT. Information and communication technologies (ICT) play a significant part in the expansion of diligence. ICT has a number of new technologies, including cloud computing, large data sets, and the Internet of Things (IoT) that enhance automation. It is very important to connect the production line and all stakeholders in the supply chain and provide them with real-time information by developing ecology. For this purpose, we proposed optimum information and communication technologies for concerning participants of the logistics production chain. This spreads the possibility for all participants in the logistics production chain to examine the product unit stage from the product development stage to the supply of the merchandise to end-consumers.

Keywords: Industry 4.0, information and communication technologies (ICT), Cloud Computing, Wireless Technology, Internet of Things (IoT), Automatization, Big Data

Introduction:

Industry 4.0 is the fourth revolution in the industrial world, before we move on, it is important to understand the 3 previous industrial revolutions. The first is the use of hydropower and steam energy to mechanize production. However, steam power was used not only in the manufacture but also in the transport of the products. Steam-powered locomotives and steamships made it possible to trade long distances. The 2nd used electricity to create mass production. Fast advances in the formation of steel, synthetic substances, and power helped fuel creation, including efficiently manufactured buyer products and weapons. It became far more straightforward to get around on trains, vehicles, and bikes. Simultaneously, thoughts and news spread by means of papers, the radio, and broadcasts. The 3rd used electronics and information technology to automate production. This industrial revolution began in the 1970s when computers were used to semi-automate the industry. Meanwhile the introduction of these technologies, we have been able to mechanize and activate a whole engineering development without human support. Well-known examples of this are robots that perform programmed processes on their own. Now the fourth revolution builds on the third, the digital revolution since the middle of the last century. It is characterized by a technological fusion that distortions the boundaries between the physical, digital, and biological spheres. We are currently in the fourth industrial revolution, where technology has spread very quickly. Thanks to our technological

innovation, machines can now record, interpret and communicate with each other on their own. Producers are integrating new advancements into their assembling offices and their whole activities, including the Internet of Things (IoT), distributed computing, examination and artificial intelligence.

Subsequently modern data and correspondence advances (IoT) assume a significant part in the improvement of industry 4.0. Information and Communication Technologies (ICT) is a more extensive term for Internet of Things (IoT), which connects with all correspondence innovations, including the Internet, remote organizations, cell phones, PCs, programming, middleware, video conferencing, informal organizations and others, Media applications and administrations. It is a set of technologies that enable the acquisition, assembly, storing, handling, communication, recording, and display of statistics in the arrangement of sound, images, and signals. Today, it is used to combine numerous machineries with altered data sets and arrangements. ICT purposes to increase the quality, performance and interactivity of industrial services while reducing costs and resource use. Now with the advancement in technology, it provides the ability to connect computerized distant control of production machines and enables fast, real-time response to incident situations, gives ongoing material to buyers, or provides intelligent inventory tracing in production officialdoms, computerized source collection, and mechanical assembly. In this paper we explore the possibilities of using information and communication technologies (ICT) devices in the area of whole industry such as manufacturing department, warehouse, transportation and industrial franchise etc. it is essential to interconnect between all these entities of the organization to perform professionally. For this purpose, we also examine the available scientific techniques and literature research on the potential applications of ICT in industry 4.0. The main purpose of this paper is to select the suitable information and communication technologies (ICT) technology to connect all the departments and participants in the industry 4.0 such as manufacturing department, warehouse, logistic assembly series etc. The fundamental objective of the paper is to build the viability of production establishments by connecting entirely participants in the logistics production chain. In order to provide quality information to customers, their activities and needs should be monitored.

Literature Review:

The world has gone through several industrial revolutions throughout the history. The first Industrial Uprising was the streamlining of manufacture by hydro and steam power, the second industrial uprising presented mass production using electricity, and the third Industrial Uprising uses microelectronics and informatics to advance systematizes invention (Haddara, 2015).

(Weyer, 2015) In this article, the author describes that the technological advancement of ITCs over the past few years provides so many sets of tools such as IoT, Big Data, robots, cloud, and so on. These tools change our daily lives. These devices will also change the course of the production chain in any industry because the technology has spread so rapidly in recent years that this trend is sure to get into industrial production as well.

An intelligent factory is one that has a high level of automatic control, a good internet connection, etc. So productivity is high and the number of employees is low. Introduction of information and communication technology (ICT) play an important role in the development of industry 4.0, (Veza, 2017).

In this article, the author details the wireless communication technology, such as radio frequency identification (RFID) tags, sensors, actuators, GPS, Wi-Fi, satellite television, wireless computer components, 3G and 4G networks wireless phones and Bluetooth. The main strength of the IoT

idea is its great impact on industrial success and failure. With the implementation of these devices industries generates more and more revenue (Atzori, 2018).
There are so many applications which are influenced by the Internet (Albert, 2018). Applications can be categorized according to the type of network accessible, coverage, scale, heterogeneity and so on. We divide the application into four categories: 1st one is for home use only, 2nd one is Industry, 3rd one is the public services and the last one is mobile.
There are so many advantages of ICT but on the other hand there are so many disadvantages also which ruined our life (Deloitte, 2020). Lacks of job security, Privacy, Reliance on Technology are main issues of ICT because when you connect all devices of manufacturing firm, it creates space for the cyber-attack. In this way there are more chances to loss all the data which generated by the device in the organization.
The devices are the key component for any industry (Cheng, 2020). There are so many different information and communication technology (ICT) devices, all these devices have their own technical characteristic. Some of them fast, flexible and accurate those are very important for the manufacturing and production department. Some of them ability to enable 3D printing is more suitable for the supply chain and some of them are used by the transportation system for their GPS tracking system.

Research Methodology:

We use cloud computing or fog computing for industrial communication architecture. Both have their own technical characteristics. A cloud is an organization of various gadgets, PCs, and servers that interface with one another over the Internet. The cloud has many benefits, such as better performance, storage capacities and processing capabilities, and so on. On the other hand, cloud technology also has its downsides, especially in IoT services. High latency, Downtime and Security and privacy are the main issues for the industry to adopt this system. That's why industry uses fog computing instead cloud. Fog computing is a kind of decentralized figuring wherein information, handling, stockpiling, and applications are dispersed between the information source and the cloud. Fog computing, similar to edge processing, brings the cloud's advantages and power nearer to where information is made and followed up on. Fog computing is more helpful for business and an asset to the board. Some benefits included minimize latency, Reduce operating costs, Improve reliability, Enhance security and Conserve network bandwidth. It is also available via Wi-Fi, mobile network, Bluetooth and ZigBee network, which supports numerous strategies. Fog computing is a mediator among equipment and distant servers. Controls which data is shipped off the server and which can be handled locally. In this method, Fog is an intellectual doorway that empties clouds and enables more proficient data storage, processing and analyzing. Some technical characteristic of Fog and Cloud computing shown below:

	Fog Computing	**Cloud Computing**
Delay jitter	Low	High
Latency	Low	High
Distance	Network close to edge	Far from edge

Client and server distance	Single hop	Multiple hops
Delay jitter	Low	High
Mobility	Supported	Limited supported
Scalability	Scalable within network	High easy to scale
Access	Wi-Fi, Bluetooth, Mobile Network, Ethernet, ZigBee	Wi-Fi, Mobile Network, Ethernet

Zigbee is an arising, short-range, low-speed remote systems administration innovation. It is a specialized arrangement between remote flagging innovation and Bluetooth. It has own radio standard directions correspondence between great many small sensors. These sensors require almost no ability to send information starting with one sensor then onto the next through radio waves, so their correspondence productivity is exceptionally high. It is quite similar to Bluetooth technology but it is generally faster to use and often has less performance depending on how you use it. It is extra reasonable for little gadgets without a showcase, like remote controllers and basic household sensors. It is appropriate for usage when moments of low influence ingestion and transmission of composed sensor statistics are mandatory. Robotized fabricating processes expect correspondence to follow work progress. ZigBee is used in this situation where, sensor-based communication, low-power, low-speed communication technology required. This lasts longer and is therefore widely used for IoT-based applications. ZigBee can serve up to 10 meters and the IEEE 802.15.4 standard.

In a typical processing plant, the number of intelligent devices can easily exceed thousands. Each of them generates a lot of data. High-bandwidth is required for real-time connectivity, which is the Industry 4 standard. Connecting them by wired communication is only applicable to non-mobile equipment and the connection cost is huge. So high speed wireless communication is the most feasible option. Wi-Fi can be used to support logistics in industry 4.0. With the usefulness and highlights of a Wi-Fi organization, it upholds the associations between the vehicle, the freight and the materials it conveys. Likewise, when matched for certain different frameworks, for example, a sensor and information handling framework, Wi-Fi innovation will actually want to make a framework that examines information during creation, processes it, and sends the result as a robotization framework. There makes certain to be a helpful thing in the modern world, explicitly in decreasing creation costs by diminishing human contribution.

In the time of Industry 4.0, when machines should have the option to speak with one another and send information obtained by sensors, it turns out to be critical to guarantee proficient, dependable, and secure correspondence between gadgets. The utilization of super low power innovations, for example, BLE will empower the presentation of Beacon, a little remote transmitter in the assembling climate, and the execution of a 24-hour, ongoing checking framework. It upgrades the transmission interaction of little information parcels with incredibly low power utilization (approx. 0.01 MW). Expanded security during information transmission through gadget to gadget acknowledgment strategies and encryption of communicated information is one more benefit of BLE. While on the other hand RFID has opened up many avenues for tracking products through the entire manufacturing process and even further into storage, export and tracking issues. When used in the manufacturing process, RFID allows the operator to track the stages of the product process that has passed, the inspections have been completed and which devices have been set up. This tracking has enabled companies to speed up

production lines based on the speed of RFID and data storage off-paces existing technology. But it requires more financial funding to install this infrastructure that's why due to its expense Bluetooth Low Energy (BLE) is better option for the industrialist for installation. The BLE Gateway gathers information from the BLE labels and sends it to the Fog Computing or CC environment. The client gadget interfaces with the CC or Fog Computing and peruses information on the BLE labels. Close Field Communication (NFC) is a short-range remote innovation that makes your cell phone, tablet, wearable gadget, installment card, and different gadgets significantly keener. It is utilized for monetary installment or exchanges; the client can involve this gadget for versatile exchange and save a lot of time because of its highlights. NFC is for the most part safer than Bluetooth on the grounds that it works over a more limited range, considering a more steady association. In this way, NFC is typically an improved answer for swarmed and occupied spots where various gadgets are attempting to speak with one another, causing signal impedance.

Types of Wireless Communication Systems:

Because of the requirement for assortment of correspondence administrations in industry 4.0, various kinds of Wireless Communication Systems are grown today. Some of them are following:

1) Satellite Communication
2) Radar
3) ZigBee
4) WLAN (Wi-Fi)
5) Global Positioning System (GPS)
6) Television and Radio Broadcasting
7) Mobile Telephone System
8) Near Field Communication (NFC)
9) Bluetooth
10) Radio Frequency Identification (RFID)

Some of these devices which are widely used in industry 4.0, so their technical characteristic is shown below:

	Wi-Fi	**BLE**	**Zigbee**	**NFC**	**RFID**
Range	Up to 100 [m]	Up to 77 [m]	10–100 [m]	Up to 10 [cm]	Up to 20 [m]
Power consumption	High	Very Low	Low	Very Low	Very Low
Two-way data transfer	Yes	Yes	Yes	Yes	Yes
Frequency	2,4 GHz, 5 GHz	2,4 GHz	2,4 GHz, 868 MHz, 915 MHz	13,56 MHz	125–134,2 kHz, 13,56 MHz, 860–960 MHz 2,45 GHz

Results:

The optimal communication system in any industry or organization offers the best opportunity to provide users with the necessary real-time communication between departments or entities. Fig 1 shows the flow of communication system between different entities of the logistic production chain.

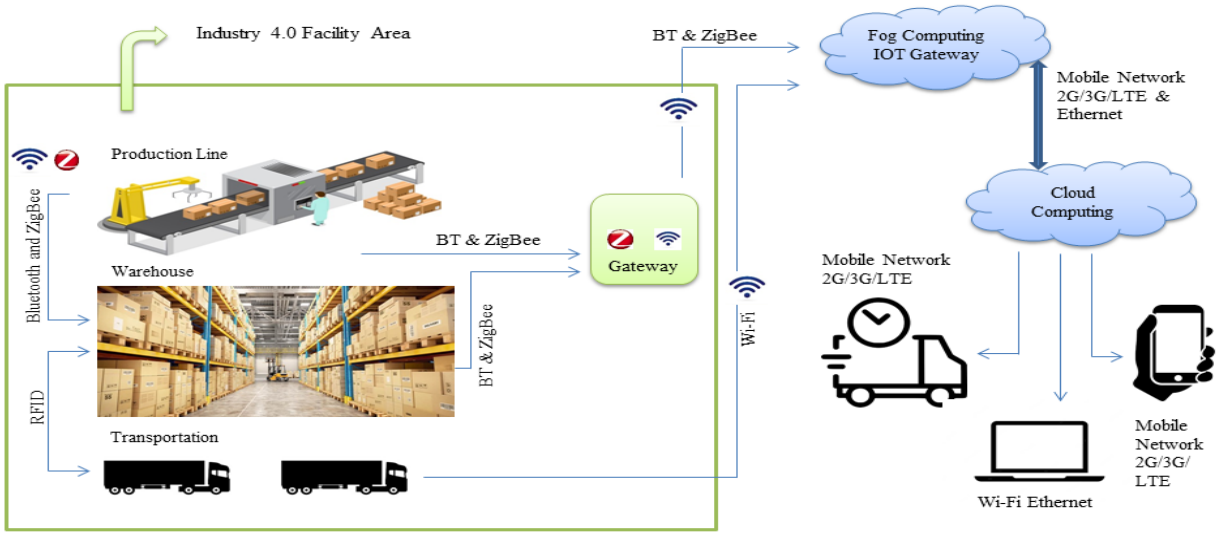

Fig 1: ICT for communication between entities in logistic production chain

Manufacturing and Warehousing Department:

Each industry has subgroups or different divisions such as manufacturing, warehousing, accounting, administration and transportation, and so on. The manufacturing department and the warehouse are connected via Bluetooth and ZigBee technology, as both departments worked in a specific circle. All the data generated by the two departments is collected and sent to the fog computer. In fog computing, this data is processed there and transmitted to the cloud computing, if necessary, to provide product information to the end user or various franchises. To reduce data latency, fog computing is used in the manufacturing department and storage/warehousing prior to the cloud-based service.

Indoor Movement:

Production line, Robots, sensors, indoor electronic devices or vehicle used ZigBee technology because of low power consumption and accurate real time communication. This technology is cost effective and performs efficiently in this area.

Transportation:

Transport makes a huge commitment to the economy and is likewise a serious power in business. By moving products from the spot of procurement to the spot where they are required, transportation offers a fundamental support for the organization to associate with its providers and clients. It is a fundamental movement in the coordinated operations capability, supporting the monetary utility of spot and time. Moved vehicle utilized BLE and RFID innovation with the goal that they can be identified while entering the distribution center. During the transport of the

vehicles, they worked inside the warehouse to transmit the data to the fog computer via Wi-Fi. Using BLE tags and transmitters, it is possible to find delivered entities within a warehouse. But during the outside transportation vehicles use android mobile phone or other electronic device which have capability to use GPS system. Using GPS it is easy to find out the required location. The major advantages of GPS are Navigation with low cost, Employer Monitoring, Available Anywhere, Traffic and Weather Alerts and Updated and Maintained.

End User and Franchises:

End clients or establishments can really take a look at the expected data about the item accessibility by utilizing cell phone which connected through the cloud computing via Wi-Fi. They can also use their laptop or computer to check their real time order status about the product, for this purpose their laptop or computer is connected through Ethernet.

Functional Requirements:

Fig 1: shows the functional requirements of the industry stakeholders and technical characteristic of the different ICT technologies. Wi-Fi technology is used to send information around storing variations to the Cloud computing database. This gives constant admittance to data about unit advancement. The temperature, mugginess, fire, closeness and distance sensors inside the stockroom and creation chain impart through ZigBee innovation, however we likewise use LoRa and Zwave innovation for this reason. This permits M2M correspondence between the sensors and the ZigBee Gateway while utilizing ZigBee correspondence innovation.

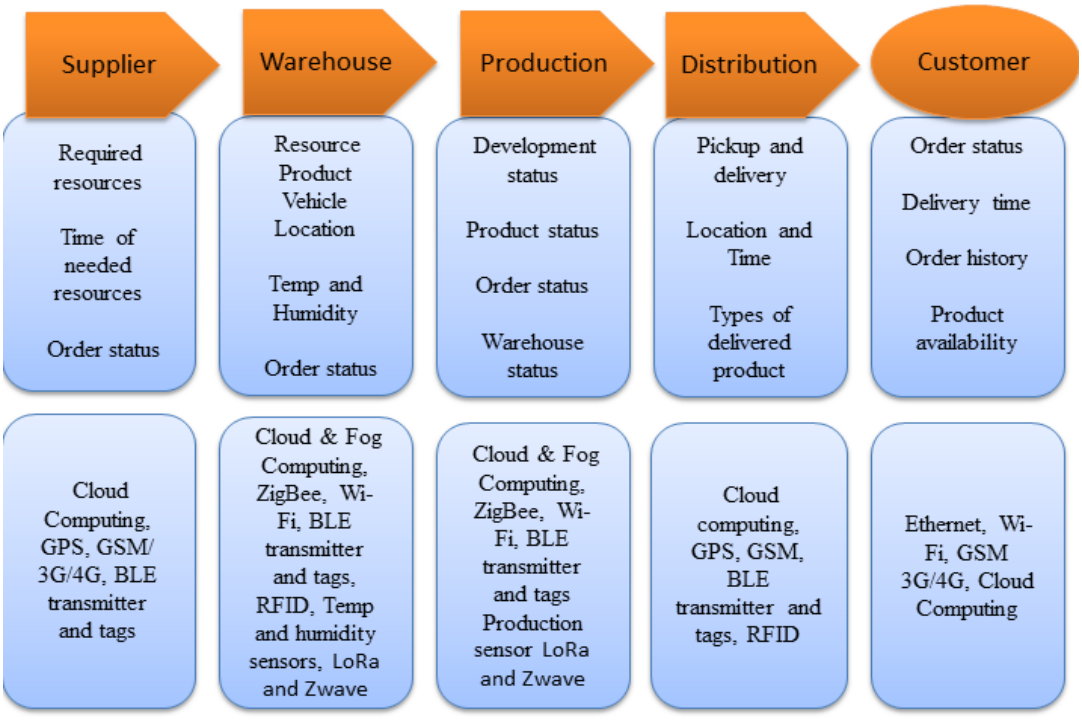

Fig 1: Flow of ICT in Logistic Production Chain

Conclusions:

Industry 4.0 is upcoming change in manufacturing Industries across world, with development in the arena of Internet of Things (IoT), Artificial Intelligence, 3D Printing and ICT, The way machines interact is going to change. The existing material and scientific research were utilized to possible use of ICT within Industry 4.0. But in our traditional communication system has many problems to connection between entities in industry 4.0 which affect our product efficiency, effectiveness, growth and the last revenue. In this paper we proposed a model to connect all the stakeholder of production line and logistic supply chain, which is based on different ICT technologies, fog computing and Cloud Computing. In this way they connect with each other and share required information without any delay. By connecting the stakeholders, it is possible to impact on productivity and efficiency, better flexibility and agility, and increased profitability.

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