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A Novel IIoT Based ERP-PLM System for MSME of Indian Market

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ABSTRACT

For a developing country, MSME (Micro, Small and Medium Enterprises) plays a very vital role in the social and economic growth of the country like India. But it faces different difficulties to the recent change in market scenario and the adaptability of the new technological innovations to boost its production quantitatively and qualitatively. As recently, the Internet of things (IoT) has a very greater impact on almost every field of our daily life cycle. This emerging technology can be used to tackle the above problem. In this paper, an ERP-PLM (Entrepreneur Resource Program- Product Lifecycle Management) system is proposed along with the new innovative technology, i.e. IIoT in the industry. This proposed system enhances the sustainability and productivity of MSME in the Indian market, which leads to achieve greater profit and provide a good quality product as well.

1. Introduction

From the past history, it has been observed that the Micro, Small and Medium Enterprises (MSME) has a major contribution towards the economic development of the giant economies of the world and it also contribute to the job creation to a great extent. According to the G20 SME conference held at Australia in 2014, MSME is the most common business

found all over the world, which takes around 99 % of the business that is done in major economies. It also contributes to creating more jobs and helps the government to tackle the growing demands of the jobs in developing countries like India. The MSME provides better quality products at the best price as the competition in terms of the quality and quantity is high in a developing country, and it also gives value to its stakeholders.

To sustain in the market, they have to give a quality product at an affordable price. Thus, the MSME is adopting the information technology solution for a better-quality product at the correct time to deliver the product keeping track of all the business needs to enhance their profit. In recent years, it is a trend to use the automation systems to control different production processes like Operation Management, Supply Chain Management, Supplier Relation Management and Customer Relation Management and as a whole, the Enterprise Resource Planning to coordinate all these processes.

All these Management processes and the technologies were evolved independently to address various processing issues such as sourcing, scheduling, production planning, capacity planning etc. The MSMEs that are spread across the globe, now integrate with each other and working collaboratively as a value-added partner due to globalization.

Due to the globalization, the MSME sector grows rapidly, which made the production processes more complex. This integration of all the production processes with the information and technology leads to facilitates all the decision to be more real-time and actionable. In this scenario, the information interchange is very highly necessary, and any silos of information aren't acceptable. The introduction of information technology in manufacturing industries leads us to a new manufacturing era that is collaboratively working with all the production processes to achieve the goal.

The transformation of the industry using the information technology called as Industry 4.0 results in the transformation of vertically integrated units of Industries to a horizontally integrated chain of value-added partners to give a new momentum to the industrial revolution. The introduction of IIoT refers to as Industrial Internet of Things will lead the MSME to a new era which is the next industrial revolution.

The IIoT is the main drivers of the integration of manufacturing and operational process with the information technology as now a day the development is taking place in the field of information technology and communication technology. As a result, the manufacturing process of emerging businesses is more productive with the ultimate utilization of all resources and efficient response to consumer needs.

In future, all the manufacturing units, as well as the associated production units, are interconnected with the Internet, and the pieces of machinery are also equipped with the embedded processors, storage units and sensors that will be used as a trans-receiver i.e. they can receive and transmit the instructions and information from/to the units.

The connected pieces of machinery and the manufacturing units have a better power to trigger different activities in the production process to achieve the ultimate goal with the help of the big data and cloud computing. The self-configured distributed and interconnected intelligence has more empowered production systems with a better interactive environment with the operators, and it will also facilitate the root level improvements to the industrial processes.

The business models, value creation, down to stream services, and work organization are the extensive implications of Industry 4.0 and IIoT. In the Industry 4.0 era, the extensive use of IIoT along with big data analytics gives tremendous growth for the MSMEs in India.

2. Literature Review

The ERP systems are the software-based solution that facilitates a number of solutions in the field of manufacturing processes such as purchasing, supply chain, finance, human resources and customer services [1]. As a result, the software package and the package customization came in to picture for huge investment [2]. The ERP system also facilitates the systems to integrate with the present business processes that will enhance the workability in an organization in terms of the data to be handled, upgradability to the new technology, portability and adaptability to the other systems etc. [3]. But the outcome of the projected benefits lies in the successful implementation of the system [4]. The successfulness of the system lies in the adaptability of the system to the different processes as well as to the other social factors [5] and the coordination among these factors [6]. A significant change in the organizational structure and the working process will also affect the implementation of the ERP system [7]. In developing countries, there is a specific difficulty in terms of information technology and management practices for different cultural contexts [8]. The previous research has investigated on the change in different aspects of the business processes while a little emphasis on the individual employee or the factors influencing the employees to adopt the change in complex technology like ERP system [9]. As recently, the economy of India is changing very fast due to the govt policies and other factors; there is a vast scope for the research to find out the factors that influence the ERP system implementation in MSME [10].

3. ISSUES RELATED TO MSME

In Indian Market, MSMEs have to face some of the major issues and challenges due to which the expected outcome can't be achieved. These issues are discussed below:

- I. **Financing:** The major constraint of the MSME is the non-availability of finance and credit at the right time. The banks which are providing the

credits for the MSME are charging high-interest rate as the risk involved in the area is too high as well as the transaction cost. This is the reason that most of the MSMEs can't work with its full potential.

- II. Equity: Due to the high risk for the invested money, the flow of the equity is very low for the MSME sectors. As a result, the new technology, which is essential for the growth of the MSME, can't be implemented due to of investment.
- III. Infrastructure: The participation of the private sector is very low due to the lack of infrastructure or due to the low-level infrastructure. In order to improve the infrastructure, high investment is required from the banks as well as from the equity.
- IV. Taxes and Regulation: In India, there are too many regulating agencies for the MSMEs. Due to the constant inspection conducted by these agencies, the operations of the MSMEs are suffered to a great extent.
- V. Marketing: The MSME sector has to collaborate with the companies of other countries in order to improve its commodity chain. To achieve this, it has to adopt the new era technologies like ERP System and IoT etc.
- VI. Technology: Now a day, the consumer always expects more comfort and quality-based product at a reasonable price. In order to supply a qualitative product, the MSME has to change its production technology which involves high cost.
- VII. Lack of Support: The archaic nature of the mechanism involved in MSME leads to the many failures of business. There are no such govt policies to revive the MSME. The govt. has to make a well-designed structure for the growth of the MSMEs.

4. Erp System

Enterprise Resource Planning (ERP) system is a well-organized systematic software-based management service which provides the information related to the manufacturing, finance, sales and service, customer management in an organization. The ERP regulates the information regarding all the entities of business functions within the manufacturing unit and informs the stakeholders to take an effective decision. The integrated database, which contains all the information about the organization is the main feature of the ERP system. It also facilitates the visibility of all the aspects of the business processes involved in an organization, coherent and automated work process, a concentric reporting system for the statistical analysis of the information. It also facilitates the use of common software in its environment, which includes mobile, exchange rate tracking software, currency convertor and consolidated financial statements. The ERP system implementation faces different challenges and issues in the Indian market due to lack of awareness, wrong notion that ERP is only for large scale industries, failure case history of ERP implementation in MSME, lack of capital available, change management and limited availability of the

resources of IT support staff. The factors that have to be considered while implementing ERP in MSME in the Indian market is proper planning of the infrastructure resources, educate the staff about the ERP system and make them aware the benefits of the ERP system, planning of the human resource for better allocation of the staff as per the requirement, the commitment of the management towards the implementation, better training of the system at regular interval and contacting right people for the implementation who have correct information about the workflow of the organization. All the factors have to be well understood by the organization where ERP will be implemented.

5. Constraints Of Implementing Erp System In Msme

The following presents a brief discussion on the prioritized factors in descending order.

1.1. Project champion:

A project champion is a key person who held all the responsibility for the implementation of an ERP system. He/she should have authority to set targets or achievements and make necessary changes as and when required. He/she must have good technical as well as managerial skills [11] along with the leadership quality [12].

1.2. User Knowledge:

The user of the ERP system should have proper knowledge about the ERP. They should have advanced IT skill. They should be trained at even interval for the changes that are made during implementation. The interdepartmental working knowledge plays a vital role for the user. They should know how the work is flowing in an organization.

1.3. ERP Importance:

In order to project the importance of the ERP, the benefits of implementing an ERP system in an organization should be discussed with the end-user. The end-user should be well aware of the services that they will get after implementing the ERP system in their organization. According to the International Data Corporation (IDC), the large-scale industries are well aware of the benefits of the ERP system, but the MSMEs have no idea about the ERP or less information about the ERP. The survey conducted by IDC reveals that in India, there about 80% of large-scale industries are using ERP while about 35% of the MSMEs, specifically the Medium scale industries are using it.

1.4. ERP Team composition:

For successful implementation of the ERP system, the team selection is very important as they would be driving the ERP system. The team selection should be based on high technical skill and managerial skill. The technical skill should include IT skill as well as the workflow of the organization [13]. The team should be capable of drawing a solid blueprint

for ERP implementation. The Indian MSME's suffers due to the lack of skilled personnel in the field of information technology.

1.5. Interdepartmental Communication:

Some of the authors have identified that the information flow in an organization specifically in Indian market suffers so much due to the lack of expertise, lack of infrastructure and also due to the location. As in India, the branch offices are located at different places across the country, and those places have their own communication language.. A small and micro-scale enterprise may depend upon other enterprises. This leads to complex information flow. Thus the ERP team should be capable of handling the complexity of the information flow in a different department of an organization as well as inter dependable units of manufacturing. Proper coordination between the departments will lead to the smooth running of the firm [14].

Package Selection:

The selection of the proper package is a very crucial point which drives the successful implementation of the ERP system in any enterprise. Generally, organizations are selecting those packages which are more users friendly and cost-effective due to the lack of skill personnel in IT section as well as due to the lack of investment. Thus, the package selection for the ERP implementation must be taken very carefully [15-18].

6. Product Life Cycle Management

Product Lifecycle Management is the database management system of the product which is going to be monitored at each stage of its life. Different services provided by the PLM system are as follows:

- It facilitates the gathering of data related to a product from its beginning to its end, i.e. conceptualization of the product, product design, design review, production planning, bill of material, and data relevant to manufacturing unit, machining and servicing/ maintenance of the product.
- It also replenishes data creation, data retrieval, updating and deletion services to manage the data.
- It also facilitates a distributed and decentralized working environment. It helps the globally distributed producers, partners, suppliers and consumer. It can integrate with the ERP system to give a better product management system. Sometimes it needs some customization for different business needs.

A typical PLM system, as mentioned earlier facilitates features like Data Management/ Document Management, Part / Product data Management/ Configuration Management, Process Management/ Workflow Management, Program Management/ Project Management, Collaboration Management, Visualization of data, integration with other systems, Infrastructure Management, Product Review, Change management [19].

7. PLM Integration With Erp System

At the earlier stage, the PLM is integrated with the CAD with the help of these features. Afterward they also enhanced their features by using PLM-ERP and PLM-CRM (Customer Relationship Management).

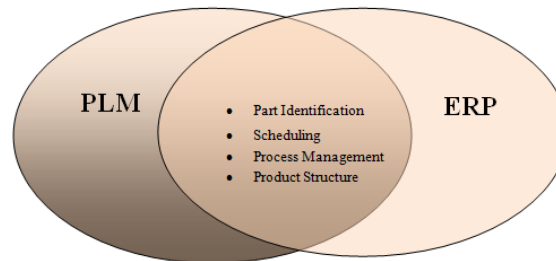


Figure 1: Intersection of PLM and ERP

Here the virtual data are managed by the PLM, and the manufacturing processes and delivery processes are managed by ERP [20]. In the PLM-ERP system, there are some crossover functions, i.e. identification of parts, process scheduling, process management and structure of the product etc. These functions need a transformation to manufacture billing of materials keeping insight that the manufacturing billing of material keeps all the information regarding particulars of each manufacturing sites. As there are some overlapping function in PLM [21] and ERP, both should be implemented in an integrated dataset with proper synchronization between them. The main difficulty is that different companies provide different systems with the vast dataset and these vast software products need special care while integrating with each other.

8. IoT BASED PLM SYSTEM

The word IoT refers to the Internet of Things that draws the attention of many researchers due to its application in domestic and industries front. It is an inter-networking of the physical objects. These objects are used for the data collection as well as at some case it can take an effective decision. Thus, these objects are often called as smart objects. Now a day, all such smart devices are equipped with the sensors to collect the data about the object and such data is uploaded to the Internet and stored in cloud services. According to the author [26], by 2020, the size of the connected smart devices will reach about 21 billion. The biggest market for the IoT is the industry due to its amorous application. Thus, now the industries are focusing towards the IoT.

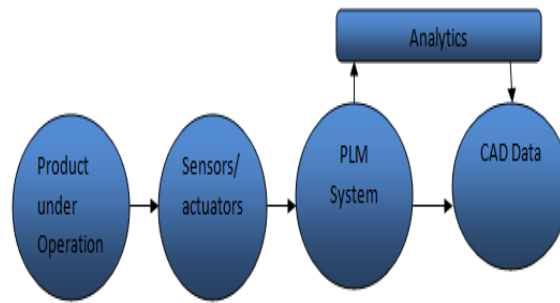


Figure 2: *IoT with a PLM system*

According to Gartner, the most commercial application of IoT is the industrial one. Thus, it has been awarded a technical name as IIoT (Industrial Internet of Things). In industries, IoT can be implemented in all the workflow, starting from the inventory to the production unit. It can detect the status of each equipment, whether it is operable or not. It can also send information about its idle time so that the equipment can be utilized up to its optimum level. The IoT also facilitates the manager to check the condition of particular equipment before its breakdown. So that defective equipment can be repaired or replaced at the correct time without hampering the manufacturing process. This result in saving the time and money for MSMEs as time and money are very limited for the MSMEs in India. The advantage of IoT is that the manager can track and control each and every process of the manufacturing unit remotely. It also gives information about particular equipment's frequency of failure so that an effective decision can be taken about that equipment. Figure 2 shows the IoT with the PLM system. The data which is collected from the sensors attached to the pieces of equipment will be fed to the PLM system [22]. The PLM system processes the live data. These live data facilitates the managers to have a better decision on the amendment of the design and track the functionality of the product in an overload condition. Due to the integration of the PLM with the IoT, the vendor can improve their design from the previous data collected from the sensors. This will be helpful for the CAD vendor as well as for the organization itself [23]. By the integration of the ERP system to PLM-IoT system, the customer's feedback about the product and the availability of the product can be easily monitored.

9. IoT Based Used Case Scenario Analysis

1. Use cases are those cases which are occurred generally and result in a breakdown in the manufacturing process. When IoT is integrated with PLM, the frequency of breakdown of a machine can be tracked and based on the previous data, prediction about the occurrence of such failure is possible using an effective algorithm. This also helps in the maintenance of the machine at a regular interval. This also enables the manager to maintain an inventory system using ERP system [24].

2. The IoT enable us to predict the load on the machine that leads to proper planning of the maintenance of the machine. The planning of the maintenance includes preventive maintenance, avoiding overload situation and supply of the spare parts of the machine in time. It also helps the HR department to allocate sufficient resources to the respective department.
3. The indication for the delivery slippage can also be detected by the sensors data in the ERP through supply- chain module.
4. The sensor data facilitates the analysis of the faults leads the management to understand and identify the following points.
 - The favorable conditions for the frequent breakdown.
 - Whether the particular component fails repeatedly is from a specific company or a lot.
 - Whether it is a human error caused by a particular machinist.

10. IoT Based Plm-Erp System

In this system, the sensor is attached with the product, and the data collected from the sensor will be fed to the PLM system which will give aid to the manager for replacing a particular component with the help of ERP system. It also helps in the feasibility study of the component [25]. The feedback from the user of the product is collected by the ERP system, and it will help to modify or restructure the design for a durable and cost-effective product. The ERP system can also track the record of the frequent service request for a particular product which leads to identifying the proper analysis of the cause of failure with the help of IIoT and PLM system. All the sensors are connected with the IIoT server, and the server collects the data and analyzes it with the previous standard data. If some discrepancy found, then the IIoT server sends a request for the information regarding the frequency of the problem. If the problem persists for a specified time, then the IIoT server sends a request to the PLM system. The PLM system then analyzes the request from the server and take proper decision with the help of ERP system. Here the ERP system gives the information about the availability of the spare part and the vendor supplying it, rating of the part, its delivery time, price comparison chart of the different vendor with the help of purchase module of ERP system etc.

Therefore the IIoT can be used at different stages of the manufacturing units whose capability could be enhanced with the integration of the ERP and PLM system. The present model is feasible and cost-effective for the MSMEs also. Figure 3 shows the IIoT Based Integrated PLM-ERP System.

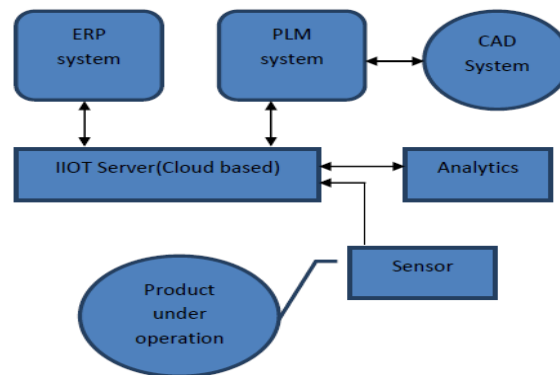


Figure 3: IIoT Based Integrated PLM-ERP System

11. Conclusion

The IoT has the potential to connect things together. In present days all the systems depend on each other. They are either directly or indirectly dependant. So the IoT can bring all together to enhance their capability. As the application of IoT increasing day by day, the integration of two complementary attributes, i.e. PLM with the ERP will be a revolutionary solution to the industry with the IoT framework which will be driving the large-scale industry as well as the MSMEs. The IIoT with PLM-ERP minimizes the production cost and also enhances the quality of the product as per the customer feedback. The IIoT has a tremendous scope to utilize the full functionalities of the PLM and ERP system. The researcher has to focus on the IoT enabled ERP and PLM system. There should be some global authority to govern the protocols for the IIoT enabled ERP-PLM system so that interchangeable products are possible.

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