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UNPLANNED DOWNTIME AND PRODUCTION EFFICIENCY: VALIDATING IIoT BENEFITS

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Abstract

Low Production Efficiency & low Throughput because of unplanned downtime of machines are always vital concerns in the MSME PVC sector, as reported by many research studies. The Industrial Internet of Things (IIoT) is a part of the industry 4.0 revolution. 'Kevin Ashton coined the Internet of Things' term in 2009. As found by some studies, its application in Smart Predictive Maintenance (SPM) is very well accepted by industries of large-scale industries. Still, the MSME sector is not yet aware of its cost-benefit analysis. This research follows the case research method. The case discusses the implementation and benefits of IIoT for one MSME from one of the countries, one of the largest manufacturing hubs. This research aims to validate the IIoT benefits to improve Production Efficiency by employing Smart Predictive Maintenance (SPM) schedules, reducing the unplanned downtime of machines due to sudden failures. The case under study discusses the application of IIoT and corresponding improvements in Predictive Maintenance from one of the leading PVC pipe Industries. This research, the end presents the general IIoT framework for MSME PVC industries to reduce unplanned downtime and increase their Production Efficiency.

Keywords: IIoT, Unplanned Downtime, Production Efficiency, PVC Industry, MSME

1. INTRODUCTION

The pain areas in the MSME sector across the world include Production time Loss, Lack of Operating Visibility, Low-quality data, Inability to identify root causes of inefficiencies, High maintenance cost, etc. Industrial IoT addresses all of these issues with real-time data availability, as many experts from different studies suggested. It can reduce machine downtime drastically, reducing production time loss considerably. The dashboards of connected machines can provide real-time data and asset health monitoring for decision-makers to understand the efficiency levels on a real-time basis. Also, extensive traceability is achieved, so the root cause analysis becomes extremely easy for these decision-makers. Using new technologies and wireless data

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transmission improves the data quality and streamlines data management and communication processes. It is said that "A stitch in time saves nine" and “Prevention is better than cure”; using Industrial IoT tools and methods for Preventive maintenance has proven very fruitful for the MSME sector as observed by many experts and their studies in this field. Taking correct preventive measures at the right time using IIoT technology leads to cutting down elevated maintenance costs.

The Industrial Internet of Things (IIoT) is a part of the industry 4.0 revolution. {Kevin Ashton coined the 'Internet of Things' in 2009 [1]. It is a network of objects embedded with sensors, software, and network connectivity that collect and exchange real-time data [2]. After getting this real-time data, it can be used to generate actionable insights. IIoT has many applications in the industry. As found by some studies, its application in Smart Predictive Maintenance (SPM) is very well accepted by industries of large scale, but the MSME sector is not yet aware of its cost-benefit analysis [3],[6]. In the overall growth of the industrial economy of the MSME Company under study, the contribution of production is significant compared with other companies in that country. To achieve the economic target set by the country's ministry, the MSMEs' contribution to their GDP is to take up to 50% from the current 29% [4]. The region's MSME sector has also shown its agility, mindset, and dynamism to adopt new IIoT tools and technology. This has helped to sustain the economic growth of the country. The sector has also shown commendable acceptance levels and innovativeness to survive against volatility in the market during the COVID-19 period.

Low Production Efficiency & low Throughput are always critical concerns for this MSME sector, as reported by some of the studies [5]. Today, the industry contributes 11% to its GDP, 45% to the country's total manufacturing output, and 40% to the nation's workforce. MSME Businesses employing IIoT devices are progressively focusing on the business results from quick technology acceptance. IIoT initiatives are now not for internal operational and functional improvements but for end-to-end processes connecting suppliers and customers, as mentioned by some research studies [6]. All business stakeholders and IT people are now aligning their IoT strategies and implementations with their strategic business goals, as revealed by many studies [5],[6].

2. METHOD

The case method approach is followed for this research. The case discusses the implementation and benefits of IIoT for one MSME from that country under study. The company has been in the PVC pipe industry for 25 years. It generates annual revenue of around $ 300 billion over the previous three years and plans to increase to $ 500 billion in the next two years. But the business faces a lot of unplanned downtimes, which increases the production lead time and affects the bottom lines, as mentioned by their production managers during data collection. The owner of the company is the person of farsighted and always ready to accept new technology innovations as early as

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possible. Before implementing the IIoT in one of their Production operations, they wanted to understand the cost-benefit analysis and define a framework that could execute in other plants across three continents.

After relevant secondary research and opinions from 37 experts from this niche field, this research presents the general IIoT framework for this PVC MSME industry to reduce unplanned downtime and increase production efficiency. This research answers the question -How can IIoT help PVC industries from the MSME sector? The TWO research questions are as follows-

RQ 1: Does IIoT implementation reduce unplanned downtime of machines significantly or NOT?

RQ 2: Reducing unplanned downtime of machines increases production efficiency and helps to improve the revenue or NOT?

3. RESULTS AND DISCUSSION

Basis the research study conducted by the researchers for 30 days with different production processes from the company, the study of AS IS PROCESS and the root cause analysis after each breakdown observed for a month in this study. It noticed that waiting for spares was huge time wasted in the "AS IS" and mainly impacts production efficiency and productivity.

A brief description of the observations is:

- Manual readings were taken and noted after every specific time interval per the decided parameters by the experts interviewed after 20 to 30 minutes.
- The reason for the breakdown is unknown when there was a sudden breakdown of an asset. No FAQs or Breakdown Help Manual is maintained.
- The Skilled Technician is assigned to identify the reasons for such breakdowns.
- It takes 2-3 hours and sometimes even 1 to 2 days to identify the exact cause of the defect/failure.
- Suppose the identified defect is a misalignment of the gear drive shaft. Then the technician checks for the respective tools and spare parts needed to rectify the fault. Suppose they are available, well, and suitable. He solves the problem, and the asset is good to go again. But, if spare parts or tools are unavailable, which probably happens in many cases, it further adds to the unplanned downtime in such cases. They get ordered, and production is down until their arrival.

The traditional maintenance process followed at the company under study was replaced with IoT-enabled New Methods, Tools, and Techniques in their production and maintenance department. It took nine months to implement and get the results as

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expected. IIoT-based Solution has the following new things observed by researchers after nine months for the same plant.

- Manual Data Collection was replaced by different Sensors, Bar Code Readers, and QR codes at 25 machines and 17 workstations.
- Machines were connected with Computerised devices/sensors and barcodes/QR codes to measure the readings, and managers could understand the life of the tools attached to the machines.
- Per schedule, the spare parts and their inventory were accurately predicted, and all the needed details were ready. It has massively reduced downtime after IIoT tool and technique implementations.
- Firefighting was replaced by root cause analysis of very few breakdowns, and their solutions were recorded for future reference with such communication to all concerned people. Also, a digital library for such solutions was made freely and 24 x 7 available to all concerned people.

The improvements seen after IIoT implementation for the case under study are listed below from the expert's opinions and available literature in this case.

Table 1: Results achieved from IoT Implementation for the given case

Sr. No.	Observed Parameters	Status	Values in Range
1	Unplanned downtime of observed plant	Minimized	14% - 32%
2	Maintenance Costs of observed machines	Reduced	21% - 46%
3	Overall Throughput of the Plant	Increased	23%
4	On-time delivery of products	Increased	27% - 34%
5	Service level	Increased	21%
6	Overall Equipment Effectiveness	Increased	5% - 13%
7	Improved quality of products	Increased	18% - 32%

The following table shows downtime's production and revenue loss before IoT implementation for the given MSME. The figures are taken from the respective people managing the operations in the company under study.

Table 2: Total Production and Revenue Loss

Sr. No.	Heads/Parameters	Value	Unit
1	Downtime	800	Hrs.
2	Loss of Production	700	Kg / Hour
3	Loss of Profit	30	$ / Kg
4	Total loss of Revenue	16,80,0000	$

The following table shows the cost of implementation of IoT solution for the MSME-like case under study.

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Table 3: Cost of IoT Implementation for MSME under study

Sr. No.	Heads/Parameters	Cost/Unit ($)	No. of Units	Total Costs ($)	Assumptions and Description
1	Cost of IoT Implementation	-	-	3,60,000	Approximate Average Costs from Experts Opinions under study
2	Cost of Sensors	15	200	3,000	20 sensors per machine for the case under study
3	Cost of IoT Gateway	800	1	800	From Market
4	Cost of IoT Platform	4800	1	4,800	From Market
5	Cost of Maintenance of IoT infrastructure	4000	17	68,000	Approximate Average from Experts' Opinion
6	Total Cost of IoT implementation for the case under study			4,36,600	

The following table shows the projected total savings from improvement in downtime for the given case.

Table 4: Total Savings from Downtime for MSME under study

Improvement in Downtime	Percentage (%)	Total Savings ($)	
		Annual	**Monthly**
Low	15	2,52,000	21,000
Medium	20	3,36,000	28,000
High	30	5,04,000	42,000

The following table shows the projected Return on Investment (ROI) calculated for this specific case based on the values collected and assumptions from expert opinions.

Table 5: Projected ROI for MSME under Study

ROI = (Savings – Cost of Implementation) / Cost of Implementation			
Year	**Improvement in downtime (%)**		
	15	**20**	**30**
1	-32	-9	36
2	34	78	167
3	97	162	294

From the above results and statistics, the IoT implementations for MSME are very beneficial to this sector, particularly in the PVC pipe industry case.

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For a 15 % of improvement in downtime, there is 97 % ROI in the third year. At the same time, a 30 % improvement in downtime yields 294 % ROI in the third year, which is enormous and practically possible for the MSME case [7].

IIoT is a disruptive technology, and accepting such disruptive technology is never easy for MSME firms, as mentioned by many studies [8] [9]. Sometimes it demands a complete change of processes, and Business Process Reengineering (BPR) is not easy for all. Adopting a new work culture by the firm's people is a significant challenge and hindrance in a successful IIoT implementation, as observed from the case.

4. CONCLUSION AND FUTURE SCOPE

To Deliver Value for Money, IIoT consultants need to figure out the firm's KPIs, and consultants' collaborative efforts [10] and the client are highly recommended [11]. Understanding of Hardware Issues: Data captured using sensors in IoT environments. IIoT gateways collect and transmit data to the cloud collected by Sensors [12]. Most of the legacy machines do not have pre-installed sensors. External sensors must be installed on these machines, but this is not foolproof. This is a challenging task, as talked about by many experts [13]. Hence, understanding the current infrastructure and the associated compatibility matters before one starts IIoT implementation [14],[15].

Improper data Capture and storage: Even the entire IoT infrastructure did not face any challenges, and the system is running very well; still, there can be inappropriate data capture possible [16][17]. In such cases, one should look for software to handle anomalies in run-time and how incorrect data gets recorded [18].

Data Security Issues: Due to many software security attacks, businesses and their customers are continuously concerned about their data security today [19] [20]. Corporate surveillance can gain intellectual property, as reported by some experts [21] [22]. IIoT data safety issues can be solved using a 'Complete Governance' approach [23]. This method provides more secure access to sensitive reports and your confidential data.

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