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ECONOMIC IMPLICATIONS OF IOT-ENABLED SMART MANUFACTURING FOR SMALL AND MEDIUM ENTERPRISES

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Abstract

Manufacturing is on the verge of revolution with the Internet of Things (IoT), which enables linking of various different machines, sensors, production equipment, humans and information systems—gaining access to a wealth of operational information constantly. The economic impact of this change is particularly concerned with the small and medium enterprises (SMEs) in the company as they may have very small technical teams, minimal capital, and they may be extremely vulnerable to downtime, quality problems, inventory costs and demand fluctuations. The purpose for this mini project is to design a framework for exploring the role of IoT technology to increase the productivity of SMEs, improve their work downtime, monitor quality, provide visibility of stock, manage energy, plan the maintenance and make better decisions. The study takes up the systematic process of the given reference project (problem definition, variables and parameters, mathematical formulation, qualitative analysis, numerical simulation, interpretation, validation and limitations) into a manufacturing-economics context. The 'representative numbers' are not from a real firm or person but are given as an example. In this analysis the effects of different utilizations, defect rates, maintenance costs, inventory and implementation costs on the operating cost, output and payback are shown. Technology benefits and technology costs – all sensors, connectivity, software and integration, cyber security, training and data governance – are highlighted. The project shows how investments in IoT implementation in SMEs, when correlated to real operational challenges, can be an important competitive advantage for the SMEs, if implemented step-by-step, and assessed both from a financial and an operational point of view.

Keywords

Internet of Things, smart manufacturing, SMEs, Industry 4.0, productivity, operating cost, predictive maintenance, digital transformation, Return on Investment, economic analysis.

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1. Introduction

In the environment in which manufacturing SMEs are operating, having adequate machines to keep the workforce occupied and production yield or the use of energy, material and or orders fulfilment can make a huge difference in the margins. Often traditional systems have been built around information being siloed, with manual records, and/or periodic inspections [1]. For manufacturing, Internet of Things (IoT) can involve adding a sensor or device that can be connected and take reading more often, providing a better insight into machine conditions, production flows, environmental conditions and product quality.

Now, the basic question arises for the business if the IoT tech is capable of fetching more of such data, but is it also capable of making them an economic value? The value chain is represented as: sensor sensing & information communication, information processing and operation decision making, process response and economic coming. Increased production from existing investments, decreased unplanned downtime and production stoppages, decreased "scrap," decreased energy use, decreased inventory buffers, and improved delivery performance and maintenance costs [2].

The reference project gave emphases on the usefulness of a model begins with variables, parameters, assumption and not simulation itself [3]. This is again achieved by making the investment in IoT technologies its own decision system; and by taking only assumptions and parameters that are revealed and at the end of which economic consequences are deducted.

Thus, it can be concluded that for an SME an IoT project can be an investment with uncertainty. Initial Expenditure takes place prior to full benefits, benefits can depend on the following: Adoption Quality, Workforce Ability, Equipment Compatibility, Data Quality and Management Response. An evaluation soundness should be capable to differentiate the costs related to implementation or amortizable some one-time cost and the costs associated with running the improvement along with the gross cuts in operating costs from a real net economic benefit.

In a simplified economic system, an economic state can be described as a vector x(t) of production output, availability of machines, defect level, energy used, energy maintenance costs, energy inventory. Adoption of IoT changes the information that decision makers have access to and can change the probability transition rates for these variables [4]. The model that is developed need not be a model of the full range of manufacturing mechanisms, but rather a transparent model that can be used to demonstrate how changes of interest to the economist affect the model.

2. Objectives

- To Speak about the effect of Smart manufacturing which are using IoT on the economic performances of SMEs.
- To identify potential cost areas of the IoT that include hardware, software, integration, training, cyber security and maintenance.
- To develop indicators of IoT operational and monetary investments.
- To obtain an adequate numerical scenario to meet the conditions: representation, of the manufacturing without IoT, and the manufacturing with IoT.
- To become familiar with the impact of production, outages, defects, maintenance, inventory and energy consumption on economic results.
- To compute simple payback and return on investment ratio to show an SME project.
- Net economic benefit - to determine operational improvements following implementation and on-going costs.

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- To consider problems of risks and uncertainties, requirements and limitations of simplified economic models.
- To make a solution recommendation for the progressive rollout as appropriate for a low resources SME.

3.Literature Review

The IoT research area objects are considered as connected physical objects which sense, communicate and exchange information over a network. In the manufacturing sector, this configuration allows for monitoring the machine, the production process, materials and the environment [5]. The economic implications Overall, the concept of Industry 4.0 research continues to be expanded with its involvement of cyber-physical systems, industrial analytics, and automation and digital decision support.Smart manufacturing is a topic in the economic literature that sheds light on value potential related to productivity, flexibility and quality, maintenance and resource efficiency. But it is not a everyone's right. Investments in connectivity, data infrastructure, interoperability, skills, cyber security, and organizational change are just a few prerequisites to make an adoption feasible.

As the fixed investment is passed on to a lower level of production this cost may be a significant percentage of the overall cost for SMEs.As presented below, there is a research gap and motivation:There will be a "last mile" between the capability to describe and the capability to make salient the economic model of IoT capability at an SME-level which will exist and can be recognized. The motivation behind this project is therefore to relate technical indicatorslike machine availability, sensor coverage etc. and financial indicatorslike annual savings, incremental contribution, implementation cost, recurring digital cost, payback period and return on investment [6].

There will be a "last mile" between the capability to describe and the capability to make salient the economic model of IoT capability at an SME-level which will exist and can be recognized. The motivation behind this project is therefore to relate technical indicators like machine availability, sensor coverage etc. and financial indicatorslike annual savings, incremental contribution, implementation cost, recurring digital cost, payback period and return on investment [7].

4. Proposed Method

The method is written in the order of the modeling that is emphasized in the reference material: pose a problem; identify variables and parameters; construct relationships; create an analysis; simulate representative situations; interpret the outcome of the simulation; and, provide evidence for the model [10].

First, an operation-related problem must be identified; it should have measurable outcome. This may involve too much downtime, too many defects, too late on maintenance, too much inventory, too much wasted energy or too less visibility of production. Next, the project establishes time line and an economic gain that is to be measured. The proposed methodology was given in fig.1. In Table 1, it showsillustrative numerical parameters for the SME economic model.

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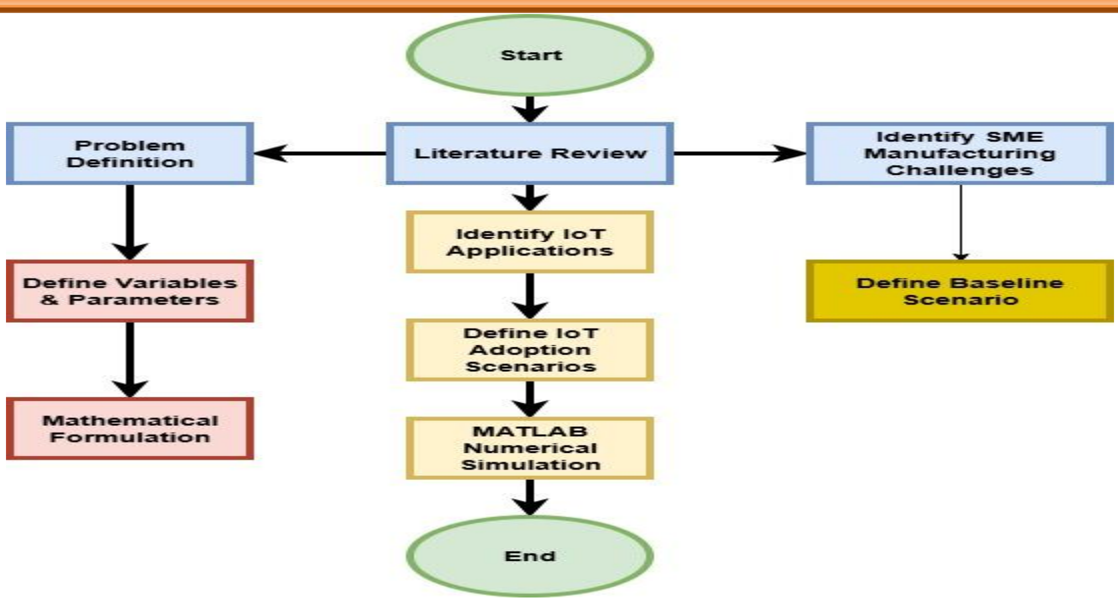

Fig.1 Proposed Methodology

Table 1. Illustrative numerical parameters for the SME economic model.

Variable / parameter	Illustrative baseline	IoT-enabled scenario	Unit
Annual output	100,000	118,000	units/year
Machine availability	82	93	%
Defect rate	6.0	3.5	%
Unplanned downtime	900	612	hours/year
Maintenance cost	1,200,000	900,000	₹/year
Energy cost	900,000	810,000	₹/year
Inventory carrying cost	1,500,000	1,275,000	₹/year
IoT implementation cost	0	2,400,000	₹ one-time
IoT recurring cost	0	360,000	₹/year

The numerical values above are intentionally presented as a representative scenario. They demonstrate how an SME-level analysis can be constructed; they should not be interpreted as universal IoT performance benchmarks. Values are scenario data,notmeasured company data [11]. Let R_0 and R_1 be the contribution of the baseline systems and the IoT based systems to environment per year, respectively. An increase in output that can be sold is represented by DR; and saving on the operating costs by ΔC; thus, annual gross-benefit is $B = \Delta R + \Delta C$. Net annual benefit is then the difference between B and C_r or, $NB = B - C_r$.ROI indicator (for 1 year simple)

$$ROI_1 = (NB - C_0) / C_0 \times 100 \qquad [2]$$

So if anything, not every project that will be worth will have a positive one-year ROI – the projects that will last longer actually require analysis over longer time horizons over cash-flow. Hence, if they apply (payback and ROI do not apply for every one of these projects), it should be recommended to use “DCF” (Discounted Cash Flow) methods as well.

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5. Theoretical Foundation of IoT-Enabled Smart Manufacturing

The architecture of smart-manufacturing is reduced to five level - physical assets, sensing and identification, connectivity, data and analysis, decision or control. Physical means include equipment like machines, tools, conveyors, motors, compressors and inspection devices [8]. The physical conditions such as vibration, temperature, pressure, current, speed and energy or electricity consumption etc., are converted into measurable data by using sensors. Connectivity expresses the observations. The action made on data which turns it into indicators, alerts, forecasts or recommendations is called Analytics. The final layer is a range of learning-to-maintenance and scheduling, quality, inventory or production decisions on economic performance of IoT-enabled smart manufacturing in fig.2. In Table 2, it shows the IoT-enabled manufacturing layers and their economic interpretationeconomic state variables.

Layer	Typical variables	Economic relevance
Physical assets	Machine state, cycle time, output	Capacity and utilization
Sensing	Temperature, vibration, current, count	Early detection and visibility
Connectivity	Packets, latency, availability	Data continuity
Analytics	Anomalies, forecasts, KPIs	Decision quality
Action	Maintenance, scheduling, inspection	Cost and output response

Table 2. IoT-enabled manufacturing layers and their economic interpretation.
Economic State Variables

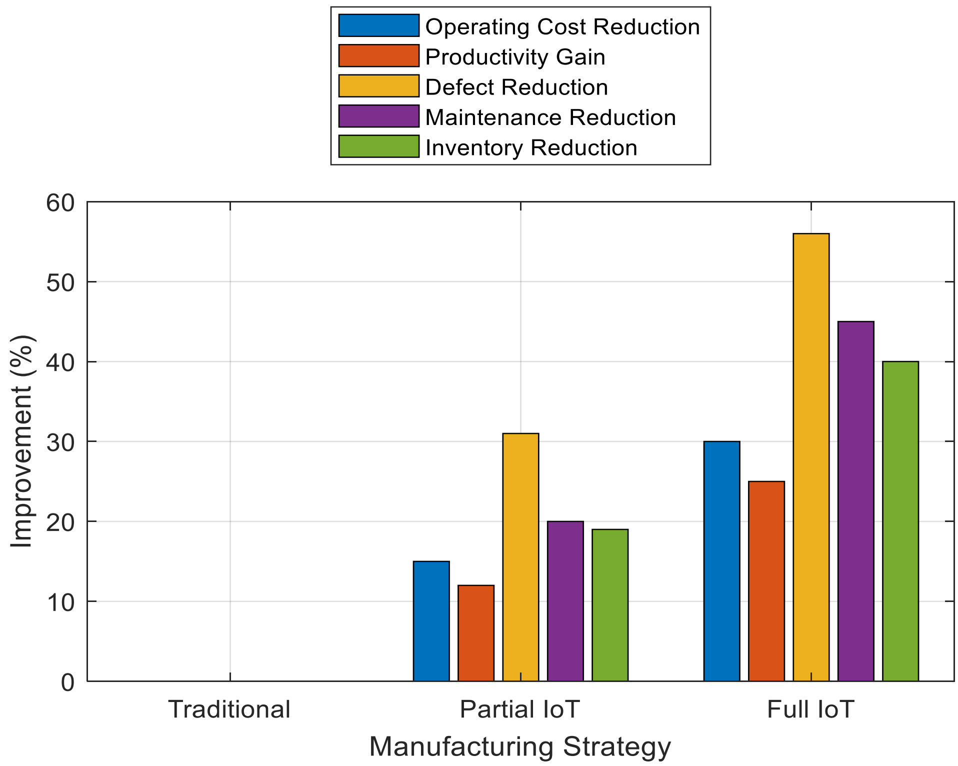

Fig.2 Economic Performance of IoT-Enabled Smart Manufacturing

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Make it possible to have the state of manufacture, such as "canning" or "raw.Allow manufacture state representation, e.g., “canning” or “raw”.

$$x(t) = [Q(t), A(t), D(t), I(t), E(t), M(t)]^T, \qquad [1]$$

The following equation illustrates how the output (Q), machine availability (A), defect rate (D), inventory (I), energy consumption (E) and maintenance expenditure (M) are linked together - not all potential pathways are included, but some of how electronic connections can trigger impacts are.

The Total IoT implementation cost can be divided in to two categories:

1. The initial expense to establishing.
2. Cost that is incurred on an ongoing basis. Initial cost encompasses the cost of the sensors, gateway(s), network infrastructures, software installation and configuration, software integration, installation, training and commissioning.

Examples of recurring costs are connectivity, data management and technical support, cloud or software subscription and device replacement and cyber security.In simple annual case, the NB may be expressed as NB = B −C_r where value of C_r is the operating cost of IoT and C_r is the cost occur after every year. Then, if the initial investment is only (C_0) and B (or cost of production per year) is approximately constant, Fig.3compared the operating cost vs IoT utilization.

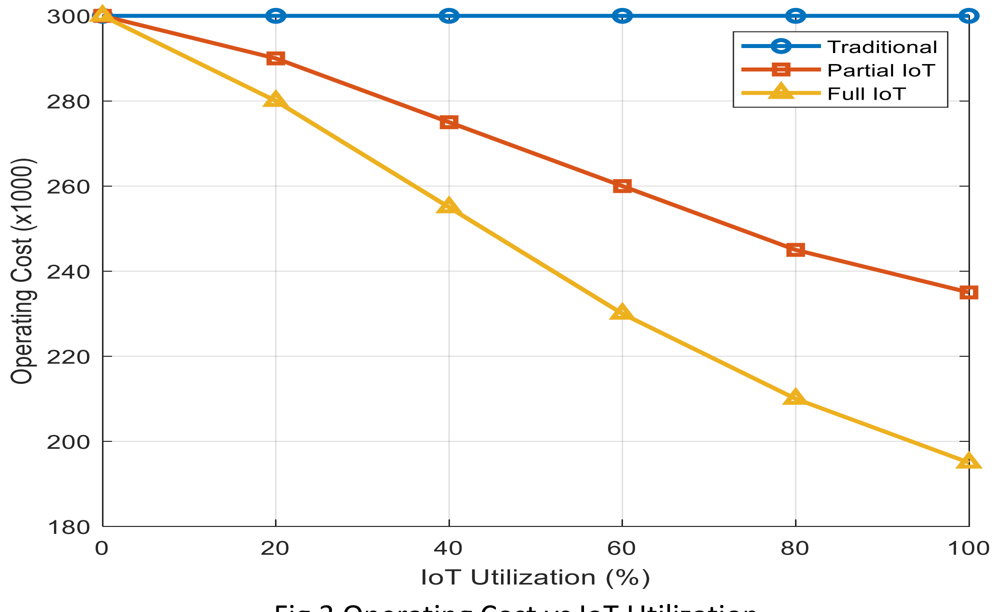

Fig.3 Operating Cost vs IoT Utilization

There is lower cost of "labor" (low workforce expenses). 'Equipment' expenses are reduced (low capital expenses). Perhaps reduced downtime – impairment of the machine through unscheduled failures which results in a dramatic reduction in time lost due to loss of machine. Quality improvement is obtaining a reduction in scrap, rework, warranty and inspection loses [9].Improve maintenance operations: introduce appointments and reduction of emergency maintenance. Reduction of uncertainty, reduction of risk of declining safety stocks - visibility of inventory. Energy conservation – non-conventional use of electricity, wastage of electricity Decision speed: enhanced access speed to the operational information/exceptional alerts.

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6. IoT-Enabled Economic Model Formulation

Suppose productive output, Q, is a product of four factors: the number of hours available for production, H; utilization (U); yield (Y); and output per productive hour (q). IoT can have an impact on U, resulting in earlier detection of process deviations impacting Y and effective H through reduced downtime with the help of improved scheduling and monitoring [12]. The model illustrates that improvements in the output can take place at multiple locations that are impacting the output and may not only be sensors.

Machine availability can be expressed in terms of percentage of availability i.e. percentage worktime of machine, which is calculated by the formula given below:

$$A = ((T - T_d)/T) \times 100,$$

where T is planned work time and T_d is machine down time. If the T_d is less reduced, there will be more production capacity generated. However, whether the extra capacity will be a benefit depends on the capacity of the downstream processes and labour to cope up with the expansion, and also whether the extra capacity can be sold.

When a gross production Q is carried out with a defect rate D, the output after the defects is sold will be Q(1-D). The more the units can be sold the less the units will be reduced in D, but there does not necessarily have to be a proportional relationship to the machine time used. Material cost, processing cost, selling price and rework/disposal cost are all related to economic advantage.

The maintenance cost can be expressed as $M = M_p + M_u$, M_p can be the cost of planned and M_u can be cost of unplanned maintenance. Ideally, IoT based condition monitoring is close to potential preventive maintenance as opposed to corrective maintenance. Rather than the economic objective is aimed at minimizing costs for maintenance, it is to minimize unnecessary total ownership costs whilst ensuring the integrity and reliability of equipment [13].

To provide a good approximation to the cost of inventory, CI, the inventory I can be used to calculate the annual rate at which the inventory is estimated to be used. For planning buffer stocks, the uncertainty of production and/or demand forecasts can be reduced. But decreasing stock can result in a risk of going “stock out”, thus it is not necessarily the best to be at the lower level of stock

There is a total price for energy called the Cost of Energy (CE) equals energy consumed (E) times energy price (pE), and with the assistance of connected meters and machine level monitoring, abnormalities in energy use or leakage, and idling of machines can likewise be identified. Economics value is when the energy savings are not affected after taking corrective action.

7. Numerical Simulation.

This publication focuses on the mathematics underpinning the various mathematical simulation and numerical computation that are used.The stages of the operational change are presented in terms of economic indicators, by means of a simulation scenario [14]. The simulation doesn't mean to make a prediction for a specific SME. Rather, it offers a carefully considered comparison which includes varying some parameters between a baseline (the basic state) and the IoT state on Production Output vs IoT Utilization in fig.4 and Table 3 illustrative annual economic calculation.

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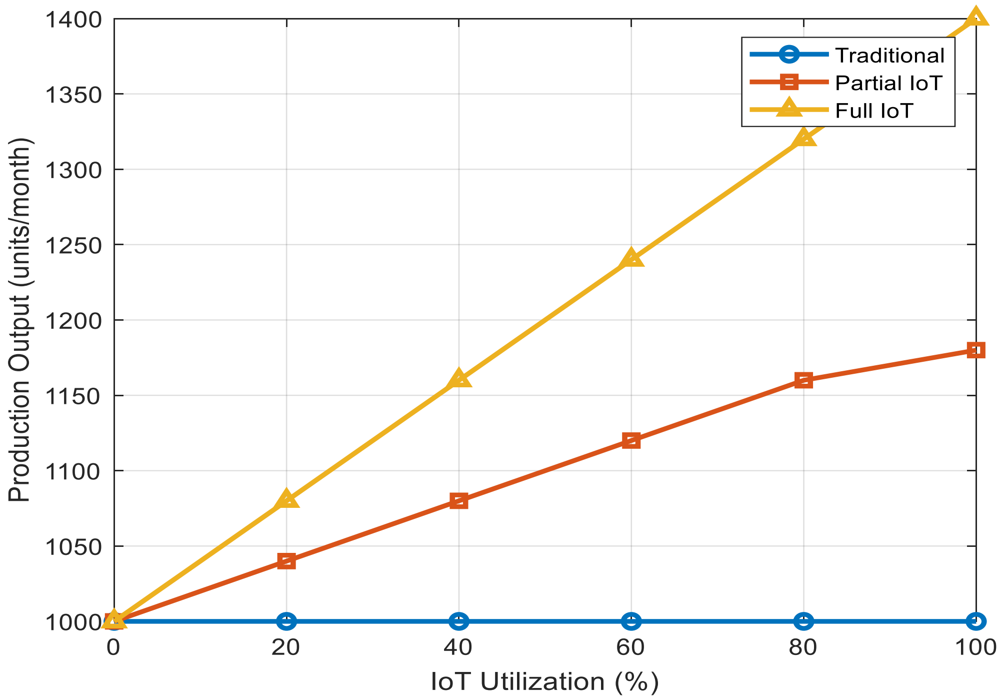

Fig.4 Production Output vs IoT Utilization

What if SME has an extra contribution of ₹1,800,000 due to an increase in the output which is saleable? Suppose that the maintenance savings is ₹300,000, energy saving is ₹90,000 and inventory carrying cost saving is ₹225,000. Our total annual benefit would therefore come out to be equal to ₹2,415,000/-. If the cost of IoT happens to be ₹360,000 (Recurring cost), the illustrative net annual benefit is ₹2,055,000.

Table 3. Illustrative annual economic calculation.

Economic item	Illustrative value (₹)
Additional contribution from output	1,800,000
Maintenance savings	300,000
Energy savings	90,000
Inventory carrying-cost savings	225,000
Gross annual benefit	2,415,000
Recurring IoT cost	360,000
Net annual benefit	2,055,000
Initial implementation cost	2,400,000
Simple payback	≈ 1.17 years

Baseline values also are standardized to an index of 100 to help interpret a direction of change. The IoT-enabled scenario has a productivity score of 118, an operating cost score of 82 and a downtime score of 68. These are indicative onlyin accordance with the above scenario parameters – and are not real averages in the industry on defect rate vs IoT utilization in fig.5 and maintenance cost vs IoT utilization in fig.6.

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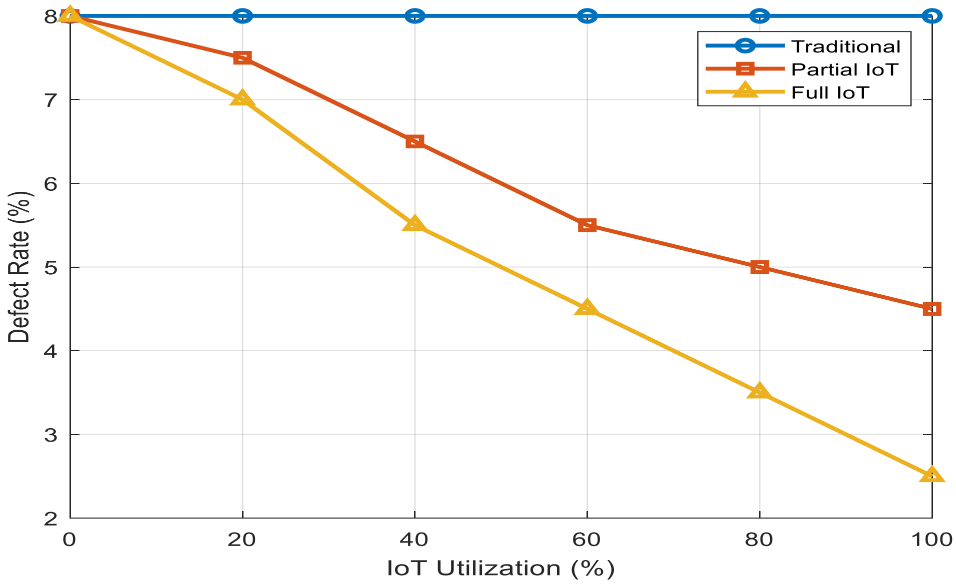

Fig.5 Defect Rate vs IoT Utilization

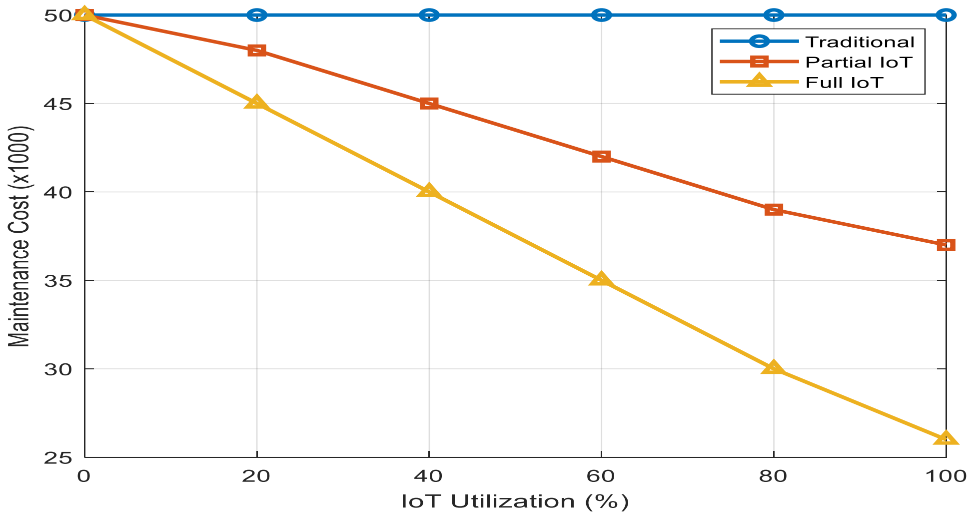

Fig.6 Maintenance Cost vs IoT Utilization

Case study suggests that there could be multiple small inclines that in aggregate would contribute to economic value. The monetary saving in the model covers saving in maintenance costs, energy costs, inventory costs and increase of the saleable output [15]. This should be an SME's attitude towards IoT when thinking about it: to see it as a bucket of things that can be made to work better rather than a one-shot technology cos8. Results and Analysis

8.Operational Results

The modeled changes have possible win-win scenarios in terms of capacity utilization, quality and cost control. As the year went on production increased and defeats delivery decreased, making production available. The other economic changes are cost savings in the maintenance process towards better informed intervention and in the change of energy and inventories.In Table 4, it showsbaseline versus illustrative IoT-enabled scenario.

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Table 4. Baseline versus illustrative IoT-enabled scenario.

Indicator	Baseline	IoT-enabled	Change
Annual output	100,000	118,000	+18.0%
Machine availability	82%	93%	+11 percentage points
Defect rate	6.0%	3.5%	−2.5 percentage points
Unplanned downtime	900 h	612 h	−32.0%
Maintenance cost	₹12.0 lakh	₹9.0 lakh	−25.0%
Energy cost	₹9.0 lakh	₹8.1 lakh	−10.0%
Inventory carrying cost	*₹15.0 lakh*	*₹12.75 lakh*	*−15.0%*

The simple payback period is about 1.17 years with the benefit of net benefit per year at ₹2.055MN for the first investment at ₹2.4MN. The sum is intended to be a simple one. Unattractive financing terms, depreciation, taxes, discounting, expiration of the lease period and uncertainty are not included. These factors should be included in a real investment appraisal and there should be several scenarios tested of operating cost comparison in fig.7 and illustrative sensitivity scenarios for investment Eva in table 5.

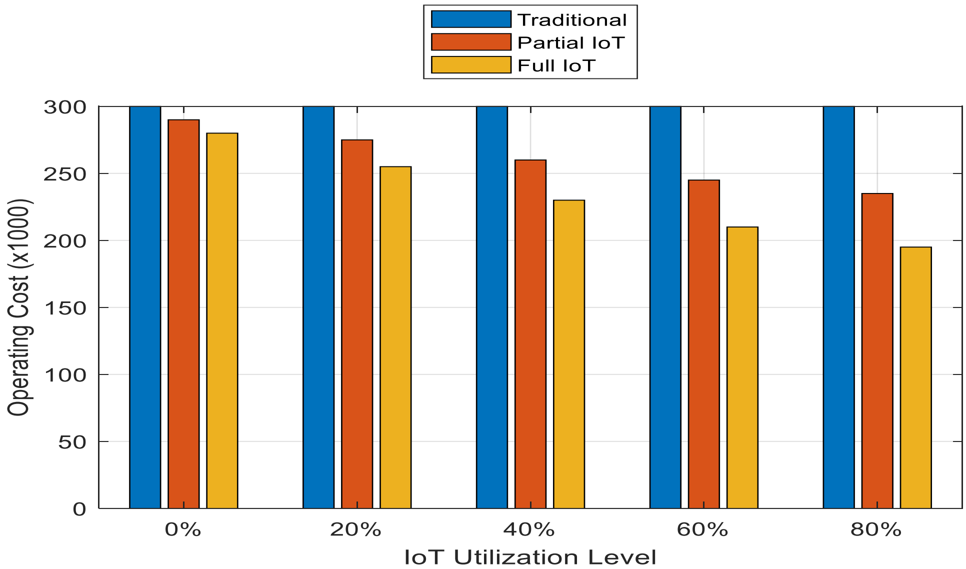

Fig.7 Operating Cost Comparison

Sensitivity analysis gives analysis of what is most important in economic outcomes in terms of assumptions [3]. In most cases, whether or not a particular firm is provided by such an SME is very sensitive, especially for a firm that has to sell the output for an additional contribution. The apparent productivity gain might not be a monetary gain, if additional production is unsold. Likewise, the information possible to be gathered and analyzed using the sensors dictates what maintenance savings will be; how many failures the sensors can be used to detect and act on.

. Table 5. Illustrative sensitivity scenarios for investment Eva

Scenario	Net annual benefit (₹)	Simple payback
Conservative	1,200,000	2.00 years
Base illustrative	2,055,000	1.17 years
Optimistic	2,700,000	0.89 years

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9. Applications to SME Manufacturing

These sensors can be used to continuously track vibration, temperature, current, pressure or number of runs the equipment has operated. Using analytics, anomalies will be identified and will aid in planning maintenance [6]. The metrics related with the economic but not the quality point of view are: unplanned downtime hours, emergency maintenance cost, mean time between failures, mean time to repair and maintenance labor utilization.

Inspecting devices can be connected for a correlation between process measurements and the condition of the production batch or the machine. Additional advantages of early detection are that it leads to lessens in scrap and rework. When assessing economically, take into account the percentage of defects, the quantity of rework hours, material loss and customer returns and inspection cost on production output comparison in fig.8.

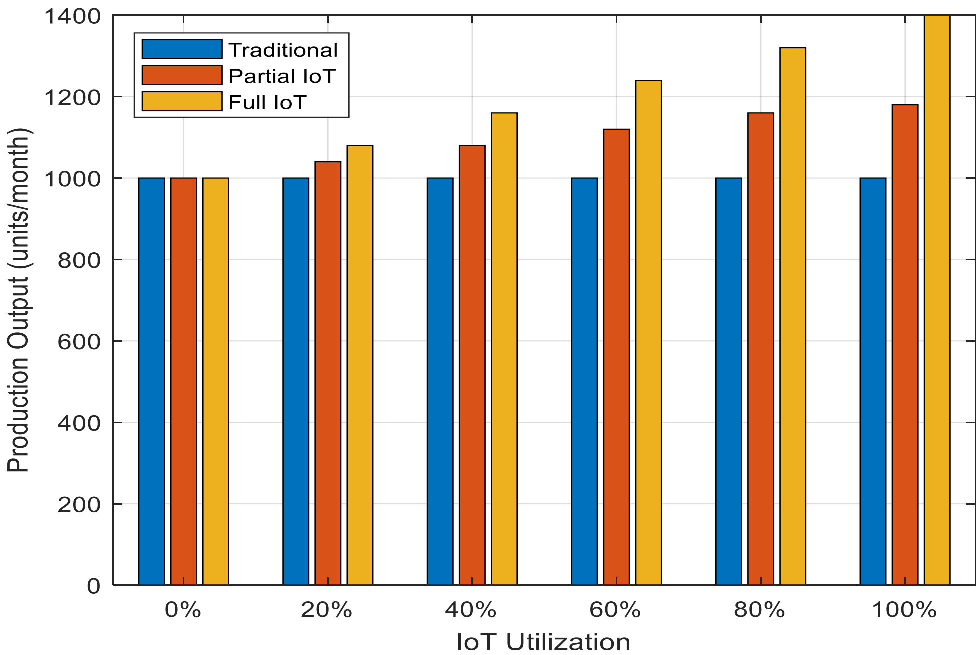

Fig. 8 Production Output Comparison

The Internet of Things (IoT) technology has the potential of offering increased visibility of WIP, raw materials, tools and finished goods. Improved visibility can help to minimize search time, uncertainty, and can assist production scheduling [8]. A measure of economic outcome is the carrying cost for cross-functional structure for evaluating IoT-enabled SME benefit in Table 6.

A machine level meter is able to easily detect a high energy consuming asset along with the unusual condition the machine is in. These energy products have the following economic indicators: kWh per unit, Peak Demand, Idle Consumption, Energy cost per production batch and Energy intensity.

Humans' decision will not be taken away by IoT. It does not delete information however, it changes data that is made available to operators, supervisors, maintenance and managers. Information can have economic value, because it can help to shorten the time period between information reception and decision making, avoid unnecessary losses or improve coordination of functions.

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Table 6. Cross-functional structure for evaluating IoT-enabled SME benefit

Domain	IoT variable	Economic KPI	Expected direction
Production	Availability, cycle time	Units/hour	Increase
Quality	Defect probability	Scrap rate	Decrease
Maintenance	Condition score	Unplanned repair cost	Decrease
Inventory	Location/status	Carrying cost	Decrease
Energy	kWh per asset	Energy/unit	Decrease
Management	Real-time KPI	Decision delay	Decrease

10. Model Validation, Risks, Limitations, and Discussion

Validation of indicators should be done by modelling them, comparison with observations of the plants before/after use. Some evidence that may be of benefit are machine log, maintenance records, production counts, quality records, energy bills, inventory records and financial statements. The reference project is about minimizing number of errors, NOT wrong model - and in the case of the overly complex IoT-dashboard, not an economic assumption. Model structuring and Data quality each should be verified [11].

The data recorded by the sensors can be missing, inconsistent, noisy, drifting, or it may not have been communicated or there may even be communication failures, or inconsistency in the timestamp. Subsequent economic inferences can be faulty if the information is incomplete. Data validation should include range checks, missing data analysis, sensor calibration checks, consistency in the time-stamp and reconciling this data with any existing production data for IoT investment payback analysis in fig.9.

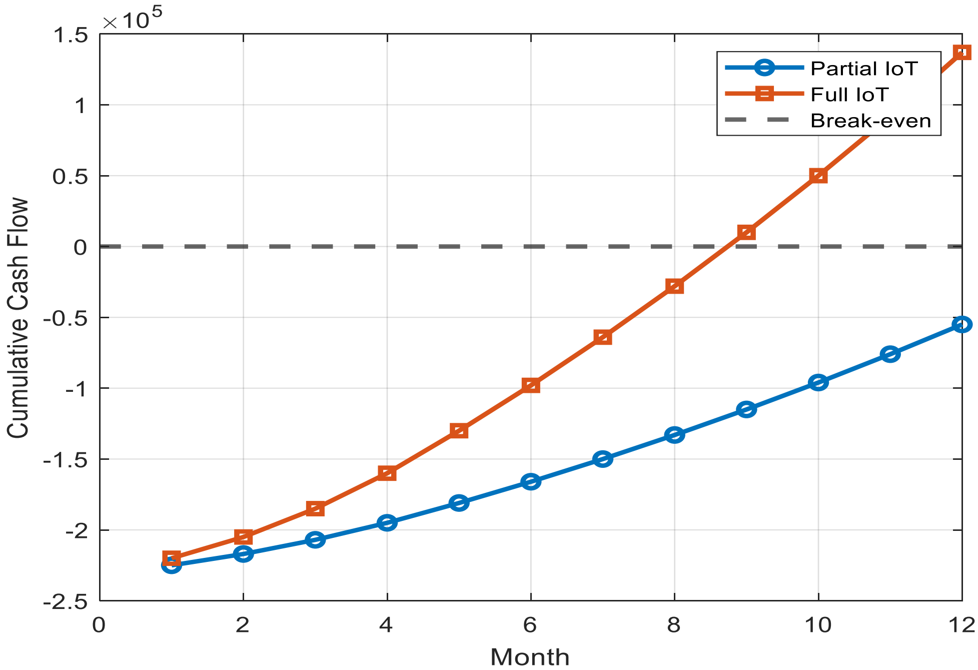

Fig. 9 IoT Investment Payback Analysis

Increased connected assets lead to a larger number of production assets available for digital attack. There may be some additional charges for the security measures and if there are, there should be a cost / benefit and a cost of insecurity analysis to take in any downtime, data loss, unauthorized

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usage, etc. and the cost of recovery. Thus, security must be taken as an economic risk control and not a technical option.

It is possible that legacy equipment might NOT support Direct Digital Connectivity.There can be integration problems and/or difficulty of integration because of interoperability problems, which can lead to increased time and costs of integration.Training may be needed to explain Alerts and Dashboards to staff [5].No changes to decision making procedures is required for collection of data by management.When opportunities for benefits arise, the new design of the processes is put off.Recurring software, wired/wireless connectivity expenses and needed cyber security and support might be underestimated.With a limited number of samples, the estimates given can be inaccurate at first.

Numerical resultis illustrative of scenarios and are not actual data from a particular SME.The model isn't particularly complex and not all production constraints are taken into account.Simple payback does not take into account the time value of money and financing structure.When the demand is not sure then the increment of the production capacity has certain bounds on its monetary value.The benefits that can be gained from technologies widely differ according to the industry, age of the machinery, and complexity of the process and implementation [12].The long term organizational (and cyber security) implications should be evaluated on a case-by-case basis.

Beautiful about IoT is the economic argument is an easily encapsulated operational loss. An SME should therefore begin with a measurable problem, establish a baseline, trial, measure the results of the trial and scale when benefits shown. This step-by-step construction program insulators against making a huge investment before an organization knows its data needs, workflow needs and capability needs are big enough to just

11. Conclusion

The SME Economics can be swayed by a number of factors with regard to productivity such as availability of machines, quality, machine maintenance, visibility of inventory of machines, energy management in factories, decision making etc. that can be influenced by the adoption of an 'IoT enabled smart manufacturing'. The methodology adopted for modeling in the project is given in the reference material and this methodology has been extended here to an economic manufacturing environment as follows: Defining the problem, Identifying the variables/parameters, Relationships formulation, Simulation of representative conditions, Interpretation of results, Validation of the assumed conditions, Model refinements. These illustrative plots demonstrate that it is possible to optimize the output sold and reduce the maintenance, energy and inventory costs to get a positive net benefit over the lifespan of the IoT (i.e. annual benefit minus cost of IoT over its entire life cycle). At the same time, the analysis helps in understanding the reasons for the lack of equivalence between the capacity and the economic value of technology. The worth of a sensor hinges on his information being utilized to take an action which will lead to a quantifiable benefit to the business (lower loss, enhance beneficial output, improve merchandise or service high quality, and so on.). It is incremental solutions for SMEs as a result, not technology solutions. Pilot projects should be targeted to areas of high-cost losses, look to maximizing the utilization of existing equipment for the project, create baseline KPIs, train and educate employees, and consider cybersecurity from the outset and include it as a component of project review and costing. Much more complexity can be added to this framework in the future, to include economic model using discounted cash flow, stochastic demand (cash flow), multi-year investment analysis, optimization, digital twin and real time data assimilation.

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Multi-year discounted cash-flow and total cost of ownership models. Probabilistic ROI, uncertainty quantification. Optimization of placement of sensors / data collection time. Models of how digital-twins can be linked to machines, and economic outcomes. Predictive maintenance and anomaly detection using AI. Risks valuation in Cybersecurity of Connected Productions. Comparative analysis of the manufacturing areas and dimension of the SME.Real Time and integrated operational & financial dashboards.

References

1. Bhardwaj, A. K., Garg, A., &Gajpal, Y. (2021). Determinants of blockchain technology adoption in supply chains by small and medium enterprises (SMEs) in India. *Mathematical Problems in Engineering*, *2021*, 1–14. https://doi.org/10.1155/2021/5537395
2. Cotrino, A., Sebastián, M. A., & González-Gaya, C. (2020). Industry 4.0 Roadmap: Implementation for Small and Medium-Sized Enterprises. *Applied Sciences*, *10*(23), 8566. https://doi.org/10.3390/app10238566
3. Guo, H., Yang, Z., Huang, R., & Guo, A. (2020). The digitalization and public crisis responses of small and medium enterprises: Implications from a COVID-19 survey. *Frontiers of Business Research in China*, *14*(1). https://doi.org/10.1186/s11782-020-00087-1
4. Hojnik, B. B., &Huđek, I. (2023). Small and Medium-Sized Enterprises in the Digital Age: Understanding Characteristics and Essential Demands. *Information*, *14*(11), 606. https://doi.org/10.3390/info14110606
5. Kallmuenzer, A., Mikhaylov, A., Chelaru, M., & Czakon, W. (2024). Adoption and performance outcome of digitalization in small and medium-sized enterprises. *Review of Managerial Science*, *19*(7), 2011–2038. https://doi.org/10.1007/s11846-024-00744-2
6. Kamble, S. S., Gunasekaran, A., Ghadge, A., & Raut, R. (2020). A performance measurement system for industry 4.0 enabled smart manufacturing system in SMMEs- A review and empirical investigation. *International Journal of Production Economics*, *229*, 107853. https://doi.org/10.1016/j.ijpe.2020.107853
7. Kayikci, Y., Kazancoglu, Y., Gozacan-Chase, N., Lafci, C., & Batista, L. (2022). Assessing smart circular supply chain readiness and maturity level of small and medium-sized enterprises. *Journal of Business Research*, *149*, 375–392. https://doi.org/10.1016/j.jbusres.2022.05.042
8. Khan, A. A., Laghari, A. A., Li, P., Dootio, M. A., & Karim, S. (2023). The collaborative role of blockchain, artificial intelligence, and industrial internet of things in digitalization of small and medium-size enterprises. *Scientific Reports*, *13*(1), 1656. https://doi.org/10.1038/s41598-023-28707-9
9. Li, W., Liu, K., Belitski, M., Ghobadian, A., & O'Regan, N. (2016). E-Leadership through Strategic Alignment: An Empirical Study of Small- and Medium-sized Enterprises in the Digital Age. *Journal of Information Technology*, *31*(2), 185–206. https://doi.org/10.1057/jit.2016.10
10. Mahmud, P., Paul, S. K., Azeem, A., & Chowdhury, P. (2021). Evaluating supply chain collaboration barriers in Small- and Medium-Sized Enterprises. *Sustainability*, *13*(13), 7449. https://doi.org/10.3390/su13137449
11. Neri, A., Negri, M., Cagno, E., Franzò, S., Kumar, V., Lampertico, T., & Bassani, C. A. (2023). The role of digital technologies in supporting the implementation of circular economy practices by industrial small and medium enterprises. *Business Strategy and the Environment*, *32*(7), 4693–4718. https://doi.org/10.1002/bse.3388

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12. Roblek, V., Meško, M., Pušavec, F., & Likar, B. (2021). The role and meaning of the digital transformation as a disruptive innovation on small and medium manufacturing enterprises. *Frontiers in Psychology*, *12*, 592528. https://doi.org/10.3389/fpsyg.2021.592528
13. Shaik, A. S., Alshibani, S. M., Jain, G., Gupta, B., & Mehrotra, A. (2023). Artificial intelligence (AI)-driven strategic business model innovations in small and medium sized enterprises. Insights on technological and strategic enablers for carbon neutral businesses. *Business Strategy and the Environment*, *33*(4), 2731–2751. https://doi.org/10.1002/bse.3617
14. Yang, H., Kumara, S., Bukkapatnam, S. T., & Tsung, F. (2019). The internet of things for smart manufacturing: A review. *IISE Transactions*, *51*(11), 1190–1216. https://doi.org/10.1080/24725854.2018.1555383
15. Zahoor, N., Golgeci, I., Haapanen, L., Ali, I., & Arslan, A. (2022). The role of dynamic capabilities and strategic agility of B2B high-tech small and medium-sized enterprises during COVID-19 pandemic: Exploratory case studies from Finland. *Industrial Marketing Management*, *105*, 502–514. https://doi.org/10.1016/j.indmarman.2022.07.006

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