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RESEARCH ARTICLE

TREADING THE IOT JOURNEY IN A SMART FACTORY

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ABSTRACT

Smart Factories have become a key link to success for a manufacturing driven organization. They can solve many problems that manufacturing world faces today. Analyzing the data generated on the shop floor and understanding them can drive data driven decision making. This can in turn help create competitive advantage for an organization. big-data and IoT play an important role in this mastering the data on the shop floor. Multiple organizations have started their IoT journey, many are about to start theirs. This paper attempts to provide a starting point for companies to start the IoT journey.

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INTRODUCTION

In this era of "data explosion", analyzing data and making sense out of it is critical to an organization's success However, often times, extracting and analyzing data is not straight forward. A good example is shop floor, it generates tremendous amount of data. However, most of it goes "un noticed" as it's not easy to extract data from equipments and on many occasions they are unstructured. IoT provides the ability to extract these data, analyze them even if they are "big" and identify patterns in them. This offers enormous power to Data Scientists, Super Users and even Users in the form of real-time analytics. Hence, IoT platforms are gaining immense popularity in manufacturing domain.

IoT in the context of a smart factory?

What is a smart factory? simply put, it is an intelligent entity which can read large amount of data, make sense out of it and drives decision making based on the analysis.It helps plants usethe "right" amount of resources (Man, Machine & Materials) to achieve target output with minimum defects. It creates a "smart" eco-system where humans, equipments and devices interact as well as collaborate with each other.

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IoT, in simple term, refers to interconnected devices sharingreal-time data to facilitate automated control, optimization and decision making. Number of "packaged" IoT platforms have emergedrecently to help accelerate the IoT journey.

Key Drivers for adoption of IoT:

There are multiple drivers for IoT adoption, the following ones are a few key ones;

Capability to Extract Data from Equipments & Devices: IoT provides "connectors" to extract data from multiple types of sources such as equipments, systems, Programmed Logic Control (PLC), devices, sensors, barcode readers etc and bring them onto a single platform to perform real-time analysis. "Edge Analytics" provides the ability to manage data volume. In fact, IoT platforms can support information flows both ways which "closes" the loop.

Predictive Analysis and Machine Learning capabilities: It provides the ability to analyze large volume of data (aka big-data), derive meaningful conclusion and take necessary actions. It can support dash boards for decision making based on complex what-if analysis. Developers can develop multiple applications using an IoT platform. Analytical capabilities can facilitate predictive analysis, e.g.

Predictive Quality, Predicative Maintenance etc. Machine Learning capability can be developed using an IoT platform.

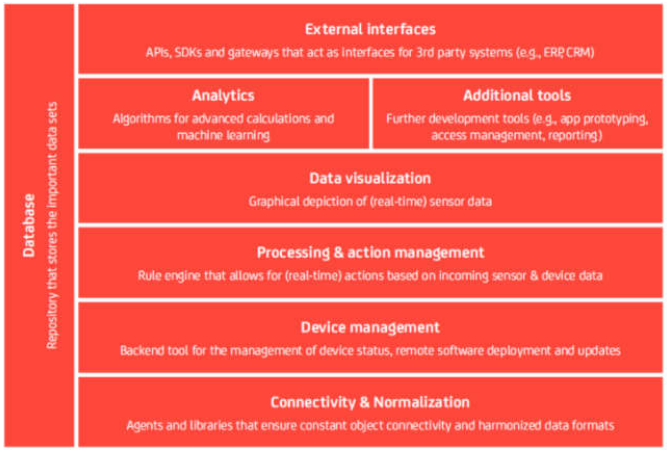
Interconnected Devices driving efficiency: It can connect different types of devices (industrial, personal) to provide better control and drive efficiency.

Driving Optimization: IoT platforms can be used to drive optimization in plants such as Energy optimization, Facility optimization, Asset Management etc.

Real-time or near Real-time Dash Boards: It can generate real-time or near real-time dash boards for executives to facilitate better decision making.

Understanding the IoT Family: First and foremost, IoT is an overarching term. It's useful for individuals as well as corporations. Hence, at a broad level it can be classified as "Consumer IoT" or "Industrial IoT (IIoT). Consumer IoT enables inter connection of devices such as cell phone, Thermostat at home, Refrigerator etc for better control and optimization. IIoT or Industrial IoT refers to connecting devices, equipments, systems, sensors etc to optimize shop floor operations, which will in turn help improve productivity and reduce cost. Industrial IoT normally comes as a platform, it can be "Open Source" or "Commercial". IIoT are offered as Platform as Service (PaaS) as well.

IoT Eco-System



Source:https://iot-analytics.com/5-things-know-about-iot-platform/

The diagram represents the architecture of an IoT platform at a broad level. Essentially, it facilitates extraction of data from varied sources such as equipments, systems etc. It provides a platform for developers to develop applications on top of it. Different types of Dash boards can be developed and advanced analytics can be performed by Data Scientists for productivity improvements, revenue increase etc.

Once an organization decides to implement an IoT platform, buying the platform is one part of the solution. They an implementation team in place to develop Use Cases. They will include Developers to extract the data using connectors, massage the data using Edge Analytics and then populate the data in the database layer. Reporting team need to develop dash boards for analysis. Data Scientists will analyze reports and dash boards to derive insights and conclusion. There has to be a team to maintain the solution. Hence, an IoT platform comes with a Development Team, Data Scientists and Support team. These are important blocks of IoT eco-system.

Do I need IoT: This is a tricky question; the answer can be both "Yes" as well as "No". IoT has dominated discussions in the past few years. The mention of IoT invokes images of the ability to virtually decode all the puzzles on the shop floor. However, we need to set realistic expectations before starting the IoT journey. So, Return on Investment (ROI) should drive the discussions. while deciding to go for IoT.

Where do I start: We can start by first identifying the prospective IoT platform vendors. Ideally, 2-3 vendors should be short listed. While shortlisting the vendors the following should be key considerations,

- Market Visibility (Coverage by Analysts, Customer Case study etc)
- Strength of eco-system (Platform capabilities, Out of Box Connectors, Ability to build Applications and Dash boards, Availability of SI Partners)
- While selecting an IoT platform key factors such as TCO (Total Cost of Ownership), Ability to build applications, Scalability, Out of Box Use Cases should be considered.

ROI Analysis & Finalizing the Use Case: Detailed ROI analysis needs to be performed to confirm if it justifies the investment. There are two aspects that needs to be considered, (1) Total Cost of Ownership (TCO) (2) Benefits resulting from IoT. Arriving at these two numbers is not straight forward, the following section will attempt to provide key line items that go into the equation.

Total Cost of Ownership (TCO)

One-time Cost: *Platform Cost:*In case, a decision is made to go with a 'packaged" or "commercial" IoT platform there will be a very significant initial investment. The amount depends on multiple factors such as vendor pricing, modules being bought, Perpetual or PaaS model etc. In case of PaaS, there will be yearly recurring fee.

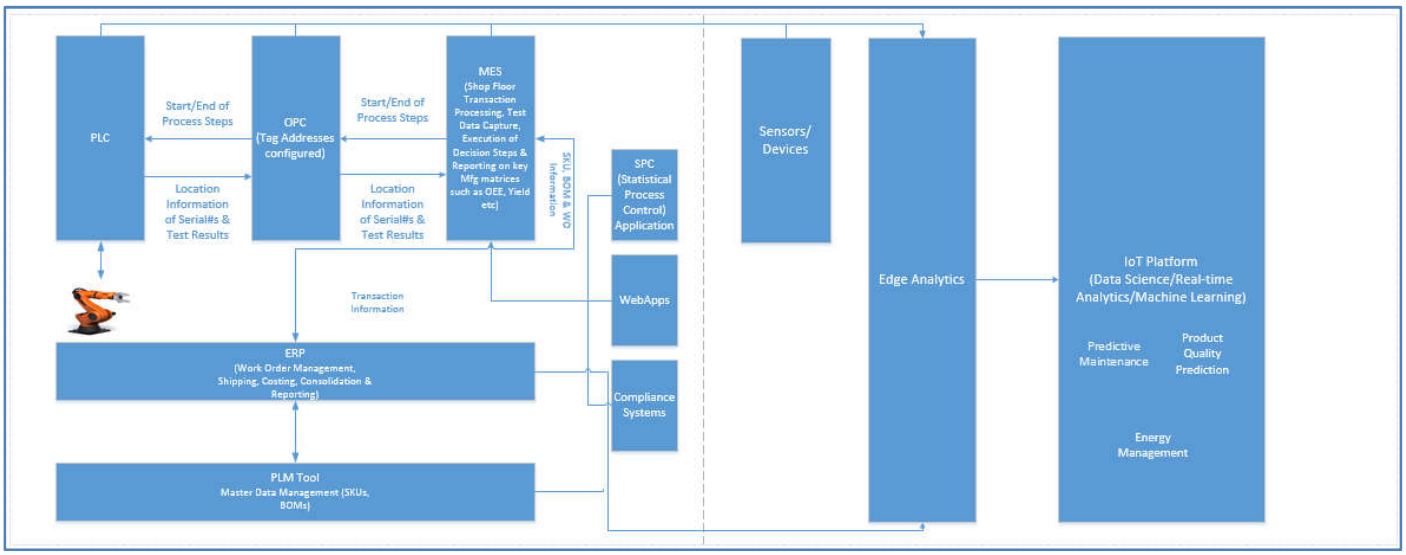
Cost associated with Equipment Readiness: Factories might have equipments which don't adhere to modern communication protocols such as SECSGEM, may not be equipped with sensors. Investment will be required to make the equipments ready to talk to each other and talk to the platform.

Implementation Cost: IoT projects, just like any other projects will progress through Scoping, High Level, Detailed design, Development, testing, Deployment and Post go-live support. IoT platform vendors themselves may offer this service or an SI vendor can be hired.

Security related Cost: Security needs to be in place per specifications, that may need additional investments in terms of improving network architecture, buying new products such as Palo Alto (PAN) etc and consulting fees to achieve desired security level.

Investment in Network/Connectivity: There may be additional investments to put in place appropriate connectivity backbone (wi-fi is not the preferred one).

Downtime during Deployment: This is an intangible cost, often ignored while calculating the ROI.



Source: Setting up a Smart Factory (Industry 4.0)-A Practical Approach (originally published in MESA International)

When IoT solutions are deployed in factories there will most likely be down time required which translates to cost in terms of production loss.

One-Time Cost= *Platform Cost+ Cost associated with Equipment Readiness + Implementation Cost + Security related Cost + Investment in Network/Connectivity Downtime during Deployment.*

Recurring Cost-Ongoing support: Support team need to be in place to trouble shoot any issue or make enhancements to existing solution. There will be a cost associated with this team.

Platform Fees (in case of PaaS): In case of PaaS, we need to pay fees every year.

Benefits

Improvement in efficiency: IoT solution help improve efficiency in terms of energy optimization, better Asset utilization etc which will lead to cost savings.

Reduction in Defects: IoT use case "Predictive Quality" can be deployed to help reduce defects which helps reduce cost.

Predictive Maintenance: This helps prevent machine break down and unplanned Down times.

Improved understanding of Customer behavior: IoT can provide the ability to gain insights into customer behavior which helps design the right product for the right segment. This will help gain market share and revenue.

Stop Revenue Leakage: Analysis through IoT helps prevent revenue leakage for energy companies by preventing energy thefts/ For credit card companies it can help identify potential default.

Asset Management: Helps in reducing the cost associated with managing assets. This is not an exhaustive list, this outlines some important ones. Initial investment should be recoverable in terms of benefits in given period (depends on company policy, can be X number of Months or Years). If ROI makes sense execution needs to be planned.

Illustrative System Architecture

The following diagram shows a typical system architecture leveraging IoT (Internet of Things) platform. As can be seen, seamlessly integrated PLC (Programmed Logic Control), OPC (Open Platform Communication) and MES (Manufacturing Execution System) provides a robust and fairly automated platform to process of shop floor transactions. ERP (Enterprise Resource Planning) facilitates consolidation, costing and generation of Financial Statements. PLM (Product Life Cycle Management) tool manages SKUs (Stock Keeping Units) and BOMs (Bill of Material). IoT platform pulls real-time or near real-time data from multiple sources such as PLC, ERP, MES, Equipments, Sensors etc, massages and compresses the data through Edge Analytics and bring them over for analysis. Complex What-If analysis, Predictive Analytics Machine Learning etc can be performed on the data for different Use Cases.

Execution: There are two options for execution, Big-Bang or piecemeal. Both have their own advantages and disadvantages. In a big bang approach, Organization will buy the platform, decide on the Use Case(s) and implement all of them in one shot. In a piecemeal approach Organizations start small, with a proto type, study the impact and then go onto other Use Cases.

Word of Caution

A few important points may be called out regarding IoT implementation;

- IoT are NOT panacea for data driven decision making, when executed the right way with realistic expectations, they are likely to yield desired results.
- Cost of IoT platforms as well as implementation cost are high. Long term road map will justify the investment
- ROI is a key diver, organizations need to do thorough due diligence to ensure ROI is attractive
- Choosing the right Use Case is critical
- Realistic expectations should be set with key stake holders while going for IoT. There will be a time lag beforethey start seeing outcome
- Most stake holders, if not all should be "bought in" to go for IoT

- It's very important to choose the right IoT platform and right implementation partner

Conclusion

IoT is relatively a new concept, but adoption is increasing by the day. If implemented for the right Use Case with a robust underlying ROI, it can prove immensely helpful to organizations. Organizations can start with baby steps and gradually take the solution to the next level. With appropriate buy-in and expectation setting IoT can add real value to business.

Glossary

ROI-Return on Investment
MES-Manufacturing Execution System (Shop Floor Transactional system where the operators log the process steps, material consumption etc)
ERP-Enterprise Resource Planning (OLTP-Online Transaction Processing system; Oracle, SAP etc)
PLC-Programmed Logic Control (Industrial control system which controls the actions/movements of equipments through Ladder Programming)
OPC-Open Platform Communications (Middle Layer between MES & PLC)
PLM-Product Life Cycle Management (Item Hub)
IoT-Internet of Things
FG-Finished Goods
WIP-Work in Process
SKU-Stock Keeping Units
BOM-Bill of Materials
UAT-User Acceptance Test
MW-Mega Watt (Measure of Energy generated)
WO-Work Order

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