MIT SCALE RESEARCH REPORT

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DEMYSTIFYING INDUSTRY 4.0: IMPLICATIONS OF INTERNET OF THINGS AND SERVICES FOR THE CHEMICAL INDUSTRY

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Summary: Have you ever imagined a world where your refrigerator tells what food items you need to order or your washing machine washes clothes at a time when electricity cost is lowest for the day or a product knows its destination as soon as it is produced and transmits its coordinates to the buyer while in transit. This is not an imaginary work from a science fiction. Welcome to the connected world of "Internet of Things". "The Internet of Things" (IoT) is widely presented as the next revolution in which massively distributed sensors will generate information. In this concept, any real-world object can communicate via the Internet and can potentially be globally discovered and queried. Our thesis explores the implication of such a connected world on the realm of Supply Chain. It is hard to predict tomorrow with little deviation from today, through our research we have tried to envision the complex world of chemical supply chain in years to come. Through our study, we identified several areas in which the capabilities brought by IoT technology will bring efficiencies in the current supply chain, the research also identified areas in which IoT enabling technologies will reduce human interventions and enable better decisions.

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KEY INSIGHTS

1. Adoption of IoT technology in chemical supply chain can bring efficiencies in supply chain.

2. Identification of areas in supply chain where IoT enabling technologies can reduce human intervention and associated systematic errors.

3. Identification of areas in supply chain where IoT enabling technologies can enable better and faster human decisions.

Introduction

"Internet of Things" was coined about 10 years ago at the MIT Auto-ID Center, Kevin Ashton in 1999 and David L. Brock in 2001 were among the first to use and propagate the term. "In what's called the Internet of Things, the physical world is becoming a type of information system—through sensors and actuators embedded in physical objects and linked through wired and wireless networks via the Internet Protocol that connects the Internet".

IoT encapsulates three important technological layers:

- Sensing/Actuation Layer: This layer consists of sensor technologies and smart objects that impact data acquisition and its utilization;
- Network Layer: This layer is supported by mobile Internet and advanced wireless networks. It aims at disseminating large quantities of real time information. Here information exchange is between people and things or among things themselves
- Application Layer: This layer enables intelligence either by distributed data processing at the device and/or by centralized processing enabled by cloud computing and management technologies

As such "Internet of Things" is not a new concept. Many of the essential components like semiconductors, sensors and wireless networks have existed for decades. A number of developments have contributed to business adoption of the IoT. Most important of which are enumerated below:

- Falling cost of the underlying technology
- Convergence of a number of other technology development
- Ubiquitous smartphone and tablets

Methodology

To understand the impact that IoT will have on the supply chains in the chemical industry, we first worked with our thesis sponsor to find a suitable business unit that will serve as our case. We then visited one of the plants of the concerned business unit i.e. construction chemical division, and did the first phase of interview to get an overview of the concerned supply chain. These activities helped us in gaining basic knowledge about construction chemical supply chain.

In the second phase of our research we conducted a series of semi-structured interviews with processes owners of different processes constituting the supply chain. These interviews helped us in getting deeper understanding of the chemical industry, the company itself and the company's business as well as supply chain processes.

After the collection of needed information, we analyzed the data collected till then. In order to understand the complete picture of the construction chemical supply chain, we started preparing the process flow map of this supply. Through this activity we came to understand that we needed much deeper understanding of the construction chemical supply chain. So, we designed a new questionnaire and conducted third of phase interview. These interviews were semi-structured but leaned towards an unstructured approach, where the interviewee had the freedom to get into details of a process. After this phase of interviews, we prepared the process map of construction chemical supply chain. We then set up the second plant visit to refine and validate our process map. We then used the current supply chain map to envision the future state of this supply chain when technological capabilities of IoT are added to it.

Results

After understanding the state of art of construction chemical supply chain and the technological capabilities provided by the IoT enabling technologies. We developed propositions about future state of the construction chemical supply chain processes. These propositions cut across different processes of the supply chain and help in realizing values for the organization in form of reduction in better forecast accuracy, reduction in inventory costs, reduction in labor costs, reduction in shrinkage costs, better and timely decisions, reduction in human error etc. The propositions developed about the future state are enumerated below:

Proposition 1: Availability of real time information about product consumption and inventory levels from sensors embedded in smart containers along with social media news feeds will increase the forecast accuracy.

Proposition 2: For products with low demand variability (X class items) wherein forecast-based planning is done, the additional step of production plan approval can be eliminated. For products with

medium demand (Y) variability the order approval step can be automated via "IOT" enabled approval process.

Proposition 3: *Enabling customers to place orders themselves through smart containers/tanks/drums or mobile apps will decrease the workload on CSO.*

Proposition 4: *There will be no need for people to track the current raw material status if all suppliers will put all raw materials requested by the subject company into a smart containers/pallets. The quantity, location, and name of items will be available real time in its closed-loop supply chain.*

Proposition 5: *The accuracy of inventory position can be improved due to the use of RFID-based warehouse.*

Proposition 6: *Before starting the production of each job, the weighing machine can check if the worker is using the right raw materials and in the correct proportions. Therefore, the human errors in the production process can be reduced.*

Proposition 7: *Setting up sensors in the production lines would help the company to get the exact information of each production process and understand accurate wear and tear level of each component of the machine. Therefore, the more accurate data can result in more feasible production or* maintenance plans.

Proposition 8: *The delivery receipt confirmation by the customer can be real-time. The customer can confirm order via smart card identification or through the mobile device.*

Proposition 9: *The smart containers will provide real time location data which can be transferred to customer or the customer can track it via a website. This will eliminate the need for human intervention in the process; it will also reduce loss and theft of material in transit and phantom stock-outs.*

Conclusions

The advent of "IoT" and its integration with the supply chain to harness the true potential of current and evolving technologies in the space posses a significant challenge to the industries. Supply Chain leaders and managers across industries want to understand the capabilities brought by "IoT", its impact on the supply chain and how to take advantage of the "IoT" wave. The current research answers the above questions for construction chemical supply chain of a large chemical company. Therefore, from the research results, we can emphasize that adoption of IoT technology in chemical supply chain can bring efficiencies in supply chain. Moreover, these efficiencies can possibly be realized in other fields since the IoT characteristics are universal and specific to chemical products.

The major characteristics of IoT can be enumerated as:

- Real time information
- Connectivity
- Communication with other systems

The research findings show that how application of "IoT" enabling technologies with the above mentioned characteristics in different processes of supply chain can render several process improvements including:

- More accurate real time data
- Enhanced visibility
- Enhanced visibility
- Reduced inventory
- Reduced costs
- Reduced human errors
- Increased service quality
- Reduced in process cycle times
- Elimination and reduction in human errors

The research also provides the kind of current technology enablers for each of the supply chain processes identified for the construction chemical supply chain and how these can be used for reducing the errors associated with human interventions. Further it identifies the area where these technologies e.g. smart phone integration with ERP and predictive analytics can enable better and faster human decisions.