Improving Cold Chain Distribution Using Internet of Things (IoT) Action Research in Pharmaceutical Supply Chain

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ABSTRACT

Our research is an IoT solution to obtain the right data at the right time at the right place for the right person. We analysed our clients' infrastructure and management levers to determine the gap in data visibility as well as general design principles for a cold chain IoT solutions. Our results demonstrated IoT value creation for the sponsor company, via actionable intelligence and verified theoretical capabilities of IoT solutions. We designed reference IoT architecture and explained design constrains in IoT service provider selection. Further testing of this proof of concept is required and necessary to fully assess the complex capabilities and capacity of IoT systems as our results are based on a limited number of shipments.

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KEY INSIGHTS

1- We identified an IoT solution in the global distribution process of products to increase control, visibility and traceability.

2- We created a generic IoT architecture to monitor cold chain distribution process via a 3PL.

3- We selected specific hardware and software components to implement the general IoT architecture.

4- We demonstrated improved data visibility due to IoT in our business case study.

INTRODUCTION

A representative from Pharma X stated that "the dream is to have a cold supply chain that has increased visibility, efficiency and agility".

Pharmaceutical companies have overcome cold chain challenges by way of a multitude of management levers such as innovations in packaging, temperature monitoring, improvements in warehousing, shipping and transportation as well as limiting transit time to comply with constraints of the regulatory process and legalities imposed by customs and health ministries for various regions.

IoT provides a new way of gathering, sharing and interpreting data, which innovates the decision making process via predictive and descriptive analysis which in turn would result in change and/or improvement in supply chain performance.

EXTANT KNOWLEDGE

Whilst "nothing is as practical as a good theory" (Lewin 1945), a proof of concept

would verify theory and determine the utility of IoT for organizations. Real-time information transfer via an IoT solutions has benefited supply chain operations (Opentext 2018), however an in depth understanding of the supply chain challenges and capabilities of IoT solutions will generate insight into opportunities for optimizing and transforming supply chain operations. Phadnis (2018) has identified opportunities for application, improvement and theoretical frameworks where IoT capabilities can affect supply chains, in positive and negative ways.

Benefits and challenges of each supply chain are identified prior to assessment of the needs of the client and the client infrastructure. A unique characteristic of IoT solutions is that it verifies the diagnosis of the client's benefits and challenges. We leveraged on this unique characteristic in the research and selection process of the IoT solution architecture and design.

RESEARCH APPROACH

Our qualitative diagnostic action research process was conducted utilizing action research following five phase cyclical process expounded by Susman & Everd (1978) in Figure 1. The five phases constitute diagnosing, action planning, action taking, evaluating and specifying learning.
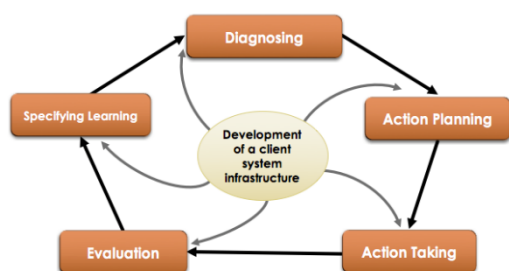
Figure 1: Susman & Everd (1978)

We obtained operational data, from Pharma X to gain insight into a potential IoT solution opportunity based on theoretical research. We concluded that increasing the data visibility for

temperature monitoring is an opportunity of value creation via IoT solution.

In formulating an IoT design solution, we reviewed IoT architecture blocks (Figure 2) whilst being mindful of the capacity of the solution to achieve extensibility, maintainability, reliability, durability, scalability, and other non-functional objectives in the future.
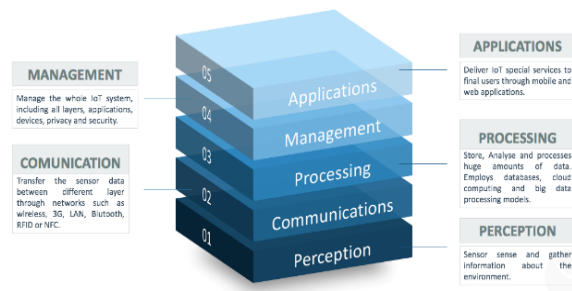
Figure 2: IoT Architecture Blocks

Our process led to a development of a methodology of selection for an IoT solution, crucial for future IoT solution seeking clients as well as furthering theoretical work. The practical result is determining best fit for Pharma X is an IoT solution with the following IoT architecture layers (Figure 3).

RESULTS

Our key results from the deployment of the selected IoT solution of this document is illustrated and summarised by Figure 4. It compares increased data visibility without IoT and with IoT in the data distribution process as well as the temperature monitoring display for the shipment duration by the IoT designed solution that was deployed.

Whilst obtaining increased data visibility via IoT solution like all data is invaluable, knowing how to leverage on the data is equally or more important than obtaining the data. When we implemented the solution, we received notification of the temperature excursions within the first 30 minutes of the goods being
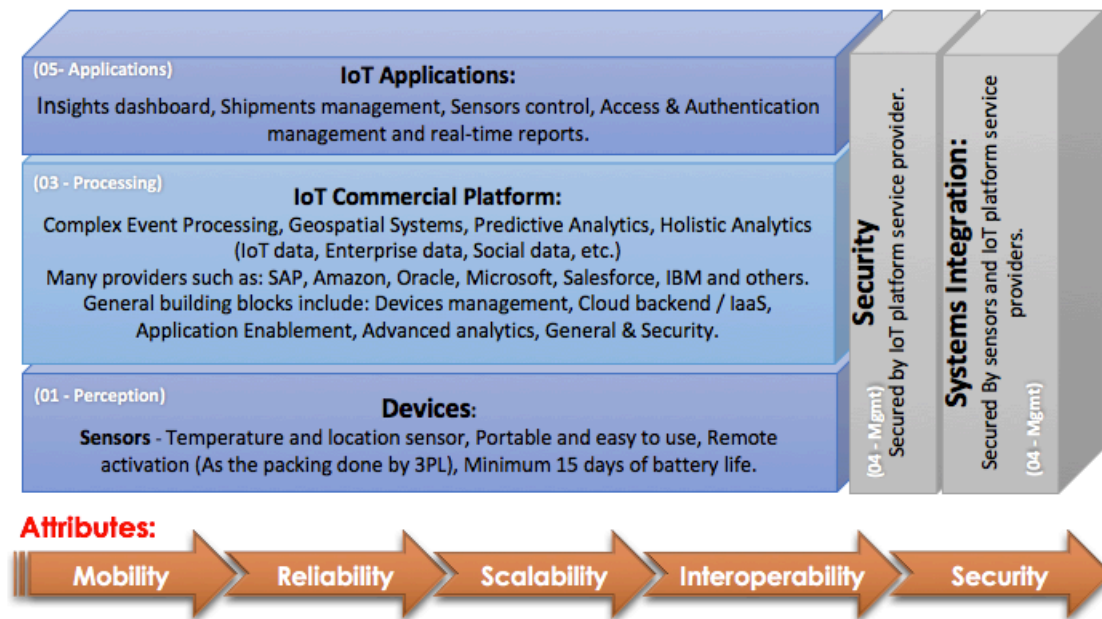
Figure 3: Generic IoT Architecture Layers for Cold Chain Distribution via 3PL

in transit. Unfortunately, the current state of operations for the sponsor company is designed for *ex post facto* data and not real-time data for temperature readings as illustrated in Figure 4.

In order for IoT solutions to create value in supply chain management, the operational processes and the roles of the individuals in the process have to transform.

Data from this research provides:

a) General design principles for IoT solutions for supply chain managers;
b) methodology of selection process for IoT SaaS provider solutions;
c) a demonstration of improving cold chain distribution via 3PL from increased data visibility of an IoT Solution; and
d) initial insight into opportunities to change the distribution process as well as the organizational change management programs.

Initial insight from this research is not generic but specific to the needs of the sponsor company and as such, is subject to findings of future research. We fear that the paucity of testing opportunities led to the findings of the research being confined as a black swan event.
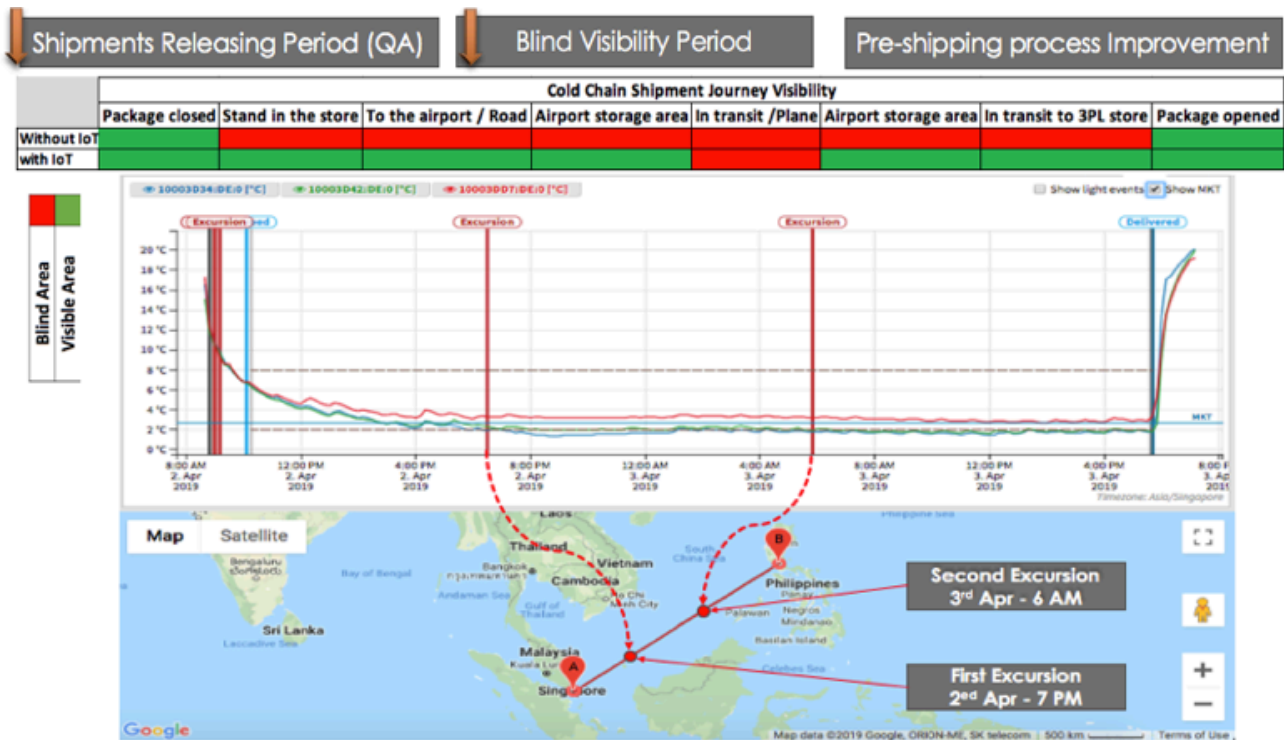
Recommendations

We identified several practical improvements which leveraged on the results of our action research, namely:-

i. Design an in-house solution for scalability and reliability.
ii. Utilise AI technology to enhance insights from the IoT Solutions.
iii. IoT Solution is a powerful auditing tool for third party service provider contracts.
iv. IoT Solution aids in audit compliance

Our results and recommendations are not confined to the sponsor company and the industry. We our research as an illustration of improving the distribution process for temperature sensitive products via IoT Solutions.

We caution viewing this research as being exhaustive and advocate that this research is subjected to re-examination and validation by further and future work.

	Cold Chain Shipment Journey Visibility							
	Package closed	Stand in the store	To the airport / Road	Airport storage area	In transit /Plane	Airport storage area	In transit to 3PL store	Package opened
Without IoT								
with IoT								

Figure 4 - Key Findings for Applied IoT Solution

In conclusion, we hope our work highlights the capacity of IoT solutions as a catalyst for change in cold supply chains.

REFERENCES

Lewin, K. (1946). Action Research and Minority Problems. *Journal of Social Issues*, 34-46.

Opentext. (2018, August 20). *How IoT Enables an Intelligent and Connected Supply Chain.* Retrieved from SupplyChainBrain: https://www.supplychainbrain.com/articles/28635-how-iot-enables-an-intelligent-connected-supply-chain

Phadnis, S. (2018). Internet of Things and Supply Chains: A Framework for Identifying Opportunities for Improvement and its Application. In E. B. Raman, *Emerging Technologies for Supply Chain Management* (p. 84). Penang: WOU Press.

Susman, G. I., & Everd, R. D. (1978). An Assessment of the Scientific Merits of Action Research. *Administrative Science Quarterly, Vol 23. No. 4,*, 582-603.