HOW INTERNET OF THINGS TECHNOLOGY CAN HELP THE RETAIL INDUSTRY IN DRIVING BUSINESS PROCESS INNOVATION

Vlad Zamfirescu[1*], Natalia Bob[2], Cristian-Eugen Luchian[3]
[1) 2) 3)] The Bucharest University of Economic Studies

Abstract
Technology continues to evolve at an accelerated rate and it brings forth new technology paradigms that aim to disrupt existing business models. The Internet of Things (IoT) is a new technology paradigm that aims to innovate the Information and Communications Technology (ICT) infrastructure by leveraging communications protocols to interconnect smart physical devices. Organizations seek to deploy physical agents that have the capability to connect to other devices (machine-to-machine), as well as establish connections to a centralized platform that extracts data from smart devices, allowing businesses to augment the value generated by their data.
The retail industry is one of the most dynamic business ecosystems and it faces noteworthy challenges when it comes to seamlessly managing in-store operations. Starting from a brief presentation of the current state of the Internet of Things, we explore the intricacies of this technology paradigm and its applications across various domains. The paper then focuses on how the Internet of Things can disrupt traditional models by innovating the retail industry. Thus, we introduce an IoT driven concept that holds the potential of automating retail workflows and operational processes through the integration of smart devices in operations management IT solutions.

Keywords
Internet of Things, Innovation, Process Automation, Business Process Optimization, Retail Industry, Technology Integration

JEL Classification
O31, O32, M15

Introduction

With the rapid advancement of technology, there have been significant efforts in trying to break the boundary between the actual physical components of technology and the channels available for interacting with them. At a quick glance, it might appear that Internet of Things (IoT) technologies aim to directly link material agents ("*Things"*) through the power provided by the Internet as a linking mechanism. However, the core purpose of IoT

[*] Corresponding author, **Vlad Zamfirescu** – vlad.zamfirescu@hotmail.com

technology is to create a mechanism that can leverage the information produced by *"Things"* and interconnect them through the Internet in order to allow the seamless extraction of data and information to further augment it and create value (Huang & Li, 2010).
By leveraging IoT technology, businesses can further optimize their activity and drive innovation from within, thus improving resource usage and productivity. Organizations have the opportunity to extract more value from the ubiquitous residual data by automating business processes and providing a potential better framework for managing all functions of a business.
The primary objective of this paper is to provide the reader with the opportunity of grasping the state of the currently available IoT technologies and how they can be leveraged to drive innovation within companies in the retail industry. In the following section we will present the scope of Internet of Things in the general business context and some of its use cases across industries. Afterwards, we will focus on the retail industry and how IoT technologies can drive innovation and automate all the supply chain components that the retail ecosystem comprises.

1. Scope and Applications

The Internet of Things is rapidly evolving as it represents a core research subject that has the potential of disrupting the traditional technological model. As a consequence, many research groups are actively involved in consolidating existing knowledge and experimenting with emerging applications of IoT technology. In its initial phases, the Internet of Things term was pioneered by The Auto-ID Labs[*] which are currently one of the key research organizations in this area. Their researched is based on networked Radio-Frequency Identification (RFID) and sensory technology, as well as next generation Internet of Things. In collaboration with GS1[†]. The Auto-ID Labs are trying to expand current technological boundaries and drive innovation on a global scale through various projects, such as the Electronic Product Code™ (EPC)[§]. Such initiatives focus on accurately defining smart object properties and making them visible to external systems in order to standardize information and leverage it for increased performance. Gluhak and Presser (2009) share the aforementioned vision, as they consider RFID technology to be widely accepted in the business community. Furthermore, they also highlight the advantage that it brings from a total cost of ownership perspective, due to its maturity. Apart from RFID, the forthcoming of emerging technologies such as Wireless Sensor and Actuator Networks (WSANs) are shaping the evolution of Internet of Things by allowing industries to better manage the complexity of available IoT infrastructure. By breaking down processes and distributing activities across multiple nodes, WSANs can help businesses in automating tasks and increase responsiveness to contextual variables (Atzori, Iera & Morabito, 2010).
The members of the CASAGRAS Partnership are also supporting the advancement of Internet of Things through RFID mechanisms. The foundation of their research lies upon the establishment of a bidirectional binding between real-world physical items and processing units that can leverage existing data and extract context information in order to

[*] Auto-ID Labs - http://autoidlabs.org/wordpress_website/
[†] GS1 – The Global Language of Business - http://www.gs1.org/
[§] EPC Information – EPC-RFIDEPC-RFID – http://www.epic-rfid.info/

aggregate it and provide value for businesses. The main objective the CASAGRAS project is to develop a fully inclusive model consisting of both a framework, as well as a migration path for legacy technology and associated business processes. As the Internet of Things is still in its infancy, it is a promising technology paradigm that can potentially lead to a virtual object space where objects are represented in electronic visual and representational media. Such an environment would empower businesses and foster innovation through real-time analytics and improved process management. Furthermore, it encourages businesses to adopt a data-driven model which can lead to better decision making, business process automation, as well as resource usage optimization (CASAGRAS Partnership, 2009). For example, companies would be able to leverage the aforementioned virtual object space by implementing a business intelligence platform to extract data, aggregate it and analyze it in order to gain new insights on their endeavors. In this case, smart devices serve as data gateways that can automatically collect information as per the provided configuration and feed it over the network to the interested business functions. Fig. 1 illustrates a potential solution to integrating IoT technologies in business infrastructure and process workflows.

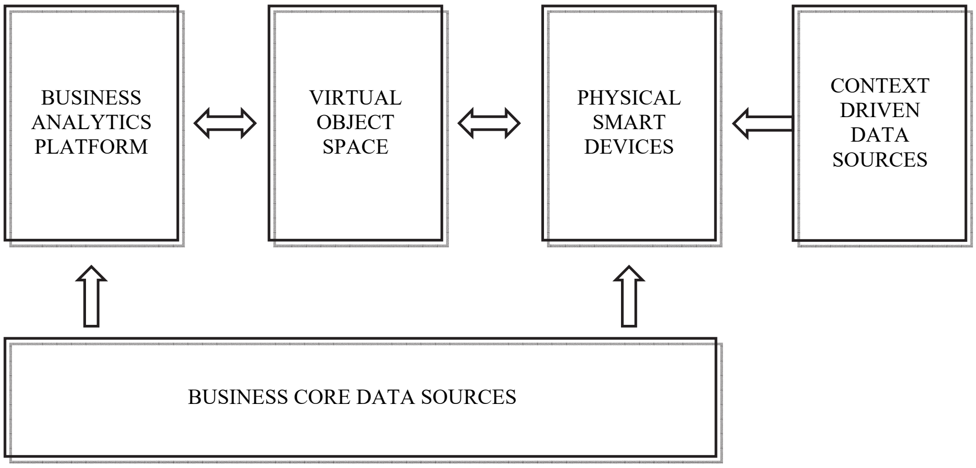

Fig. 1: IoT Driven Business Analytics Concept Leveraging the Virtual Object Space

As devices continue to advance both in terms of storage capacity, as well as processing power, new opportunities continue to arise for leveraging the Internet of Things in real-world applications. Not just from a business point of view, but from a consumer perspective alike, there is an increasing shift from PCs and laptops towards mobile devices. Moreover, mobile devices are continuously incorporating new features that aim to increment their sensory and computation capabilities, thus granting an incentive for organizations and their customers when it comes to investing in IoT technology expansion and intelligent devices (Coetzee & Eksteen, 2011). Fleisch (2010) identified seven key value drivers that render the Internet of Things relevant across every value chain, regardless of industry. According to him, these drivers deliver value from two core perspectives: machine to machine communications and user integration within the IoT ecosystem. The seven factors identified by Fleisch are driving existing real-world Internet of Things applications and can be grouped in one of the two aforementioned areas:

I. Machine to Machine Communication Value Drivers

a. *Simplified manual proximity trigger.* One of the most common implementation of this element is through RFID components or devices that expose themselves to external triggers and can be used to pass data or read it in order to perform a validation or generate an action (e.g.: access cards to secured rooms, payment authorization, manually triggered data exchange operations etc.)

b. *Automatic proximity trigger.* Compared to the manual proximity triggers, the automatic proximity triggers automatically perform a transaction when the physical distance between the communicating devices is within the perimeter allowed by the involved technologies. For example, production lines can implement automatic proximity triggers in various steps of the assembly process that can self-activate machines and perform certain tasks, thus reducing cost and better managing errors by eliminating manual processing of components.

c. *Automatic sensor triggering.* If the previous two drivers had a limited set of data that they could use to trigger actions based on proximity factors, automatic sensor triggering allows smart devices to continuously collect data from their context and update their state. By implementing sensory elements, physical devices can greatly benefit businesses by incorporating configuration parameters to monitor, extract and process data in real-time and perform predefined actions when certain conditions are met. More and more companies from the agriculture industry are implementing Precision Agriculture (Lee, Hwang & Yoe, 2013) due to its benefits throughout the entire life cycle of products.

d. *Automatic product security.* Through the implementation of validation rules and security checkpoints, smart devices can be configured to automatically check the integrity of data flows and other interconnected devices. In order to ensure product security, smart devices incorporate advanced cryptographic technology which often require a significant amount of resources and powerful processing units. However, securing physical agents is done only for critical business areas, as companies try to decrease costs by adhering to a data security model for non-critical business functions.

II. Integration of Users Value Drivers

a. *Simple and direct user feedback.* Smart devices can be configured so that they provide feedback to the users who are interacting with them. Usually, the most common types of basic feedback are audible (i.e.: producing a simple beep whenever an RFID enabled device goes through a gateway) and visual, when the IoT device has LED lights capable of providing validation to the user that a certain event has occurred.

b. *Extensive user feedback.* Data collected by smart devices can be uploaded in a centralized repository through a pre-configured gateway that uses built-in services to process the data and extend it before forwarding it to the user. For example, a retailer might use RFID technology to implement real time inventory tracking across his facilities and set up an aggregation gateway that collects data from each location. All the collected information could then be processed through built-in services and then used to cross-reference the resulting data set with organizational objectives in order to generate comprehensive analyses for the user who requested it. Also, due to machine-to-machine communication capabilities, the receiver of the analysis could also be another IoT device that scans the results and sends notifications to business users, should a certain result reach a predefined threshold.

c. *Mind-changing feedback.* This value driver aims to produce a behavioral change in users interacting with smart devices, which can be configured so that they continuously collect information about the user and identify patterns. These patterns can then be used to consolidate existing knowledge and make recommendations that would benefit the end user and determine a change in their actions. As a result of such complex interactions, users can thoroughly understand the current context in which they operate and can make better decisions for the future.

To better leverage the capabilities of the Internet of Things, businesses can use cloud computing technologies to build an ecosystem that integrates smart devices in their operations. There are three core components that serve as the base layer for implementing an IoT driven cloud architecture: *storage facilities* (in the form of cloud data centers, capable of storing all the data received from physical smart devices for further processing), *services middleware* (organized in complex computational modules that plug in to the cloud data repository and extract information in order to process it in accordance with the business needs) and *access layer* (by implementing a security protocol, user permissions can be better managed in order to prevent system intrusions and protect critical business resources). Companies usually adopt a Service Oriented Architecture (SOA) to address the complexity of individual services. The SOA model promotes the development of application components that expose functionality through services which handle individual units of business logic. If a service module is too complex, it will be split in multiple containers which are then linked through a communications protocol. Thus, businesses can manage their technological infrastructure and avoid system-wide errors that would temporarily cripple their activity (Rui & Danpeng, 2015).

The current state of the Internet of Things can contribute to advancing the business innovation capabilities within any given industry. This is most evident in B2C industries, such as the retail industry, where consumers need to be actively engaged and assisted in their decision making process so that they understand the true benefits of the products they are interested in. Furthermore, retailers can also implement IoT technology to gain a deeper insight on their business environment and better manage their operations in order to remain relevant and disrupt existing trends.

2. Retail Industry Disruptive Innovation

Existing IoT solutions in the retail industry tend to approach individual steps of business processes or enhance customer experience. Whether it is RFID technology used to track items and monitor in-store operations or sensors that detect when a returning customer enters the store, these implementations are aimed at performing simple tasks that are meant to be an extra step within a bigger process, and not act upon the overall process automation and disruptive innovation through smart devices. To truly tap into the potential of the Internet of Things, retailers have the possibility of disrupting their business model through an IoT driven approach to managing their resources and business processes. However, in order for this concept to be successfully implemented, a common framework should be developed and established across the retail industry ecosystem in order to align every party involved across the supply chain, from the very first step of the production process. There should also be a set of technological standards governing the smart devices and technology stacks implemented across the industry in order to ensure compatibility between business partners and their suppliers alike. Furthermore, interconnectivity of environments and smart devices is imperative when deploying an Internet of Things driven solution to improve process management and foster innovation. Thus, all the components of the integrated solution should be carefully designed and implemented in a controlled environment across all the core business functions and then linked to external systems through Application Programmatic Interfaces (API) that address both incoming as well as outgoing information (Wirtz, Rüth, Serror, Zimmerman & Wehrle, 2015). By sharing a common set of interaction methods and patterns, business units and their collaborators can build their own IoT module that is compatible with their underlying IT infrastructure, whilst not being required to upgrade their entire infrastructure due to containerization of business application logic within the IoT application module.

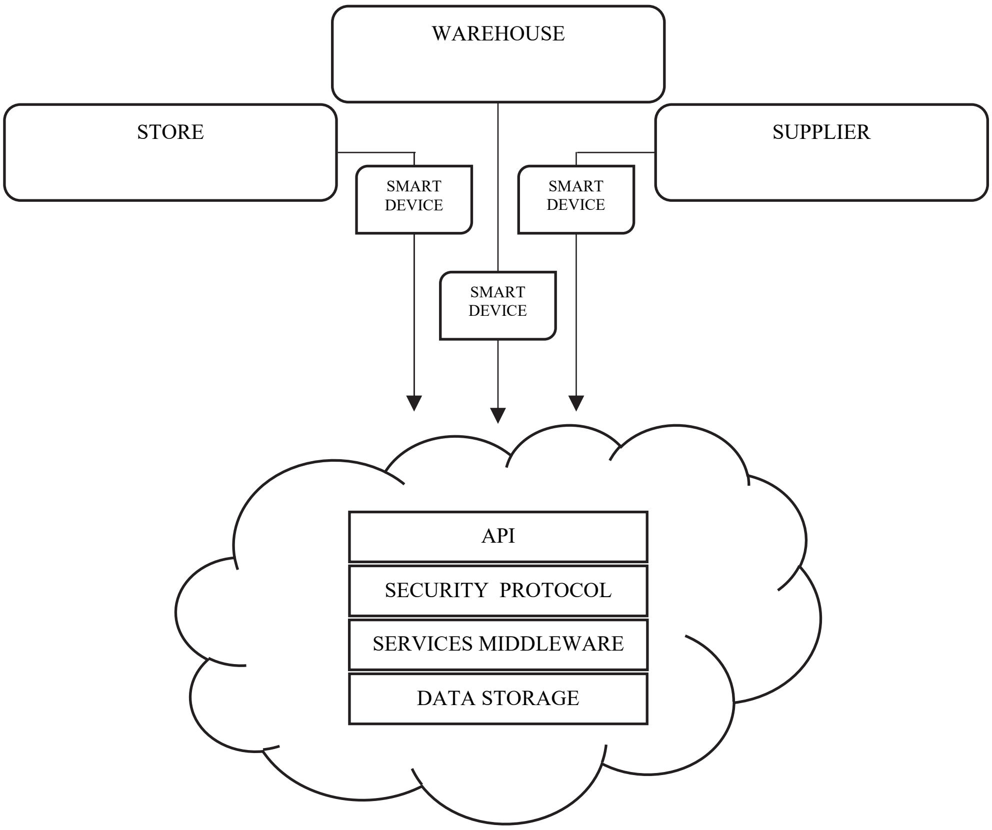

Fig. 2: Concept of a Potential IoT Solution to Warehouse Management in Retail

Fig. 2 describes a cloud based concept that leverages Internet of Things technology and has the potential of innovating and automating business processes across the entire supply chain. This solution concept aims to innovate the retail store stock replenishment process and fully automatize it, thus also limiting the impact of human errors. At its core, the environment employs a hybrid cloud solution that acts as the process controller for incoming data and application requests. The purpose of the cloud platform is to aggregate data from all the units involved through smart devices that behave like information gateways and accurately keep track of current item quantities and individual item availability through the supply chain. From the moment an item exits the production line, it will be uniquely identified through an RFID tag that also stores all the characteristics of the item. As soon as an item is ready to be shipped from the supplier to the retailer's warehouse, it will be scanned through a smart device enabled gateway at the supplier's location. This action will trigger an automatic update through the cloud API and it will update the cloud repository with availability data. Afterwards, the application controller will route the information and automatically push it to the other units' systems, making it available in real-time. From a supplier point of view, the automation of the ordering process can lead to the improvement of production lines performance and delivery speed. At the same time, when an item is delivered by the supplier and enters the retailer's warehouse, it goes through a smart device enabled gateway that will update the state of the processed item and push any updates in the cloud. Individual store locations can automatize their inventory replenishment process through smart devices by scanning sold items with a smart device that collects information through the attached RFID tag and updates the local item quantities in real-time. Then, based on user predefined quotas and thresholds, the physical gateway agent can place orders and post them to the cloud platform, making them available to the warehouse smart device listener or the supplier one, should there not be sufficient items available in the retailer's storage facility. The services middleware component of the cloud computing platform can be fully customized in order to increase the value delivered to both customers and the business through predictive analytics that crunch through the data in real-time and identify consumption patterns. Thus, retail companies can better address customer needs and quickly act upon on their inventory product base diversity to isolate local demand and quantify the impact of local trends on the overall strategic business objectives. The main advantage of the proposed concept lies within the agility and optimization capabilities that it grants to the business, making it possible for companies to efficiently manage their inventory and build custom services in accordance with their needs. Moreover, by implementing a modular approach to business process logic, organizations have the possibility to scale their operations without impacting existing workflows or affecting the overall process performance.

Conclusions

The Internet of Things has yet to reveal the true potential that it holds from a business innovation point of view. Companies are continuously experimenting with new approaches to efficiently integrate smart devices in their business operations and process workflows. However, despite its accelerate advancement, there are still several areas that need to be addressed tin order to make the Internet of Things technology ready to be deployed in production environments. Security is currently one of the most challenging aspects of smart devices due to the dynamic nature of IoT driven business operations. Moreover, researchers and early adopters are further investigating the infrastructure exposure to vulnerabilities caused by a fully automated and machine driven model.

The concept presented in this paper requires all units across the supply chain to adhere to a common standards framework that would ensure compatibility between smart devices, as well as cross-functional alignment. Still, existing IoT technology allows for the containerization of process workflow steps in pre-configured smart devices that can lead to better business performance, while also contributing to the overall customer experience. As the Internet of Things will continue to swiftly evolve and converge into the realm of stable and secure technologies, the IoT driven technological model presented in this paper will give organizations the opportunity to thoroughly check the validity of its technology stack and eventually deploy it as part of their core business model.

References

Atzori, L., Iera, A., Morabito, G., 2010. The Internet of Things: A Survey. *Computer Networks*, Vol. 54, Issue 15, pp. 2787-2805

Coetzee, L., Eksteen, J., 2011. The Internet of Things – Promise for the Future? An Introduction. *IST-Africa Conference Proceedings*, pp. 1-9

Fleisch, E., 2010. What is the Internet of Things? An Economic Perspective. *Auto-ID Labs White Paper WP-BIZAPP-053*

Gluhak, A., Presser, M., 2009. The Internet of Things – Connecting the Real World with the Digital World. *EURESCOM mess@ge – The Magazine for Telecom Insiders,* Vol. 2. Available at: <http://archive.eurescom.eu/message/messageSep2009/The-Internet-of-Thing%20-Connecting-the-real-world-with-the-digital-world.asp> [Accessed 30 March 2016].

Huang, Y., Li, G., 2010. A Semantic Analysis for Internet of Things. International Conference on Intelligent Computation Technology and Automation (ICICTA), pp. 336-339

Lee, M., Hwang, J., Yoe, H., 2013. Agricultural Production System based on IoT. *16th International Conference on Computational Science and Engineering (CSE)*, pp. 833-837

Rui, S., Danpeng, S., 2015. Architecture Design of the Internet of Things Based on Cloud Computing. *Seventh International Conference on Measuring Technology and Mechatronics Automation (ICMTMA)*, pp. 206-209

Wirtz, H., Rüth, J., Serror, M., Zimmerman, T., Wehrle, K., 2015. Enabling Ubiquitous Interaction with Smart Things. *12th Annual IEEE Intenational Conference on Sensing, Communication, and Networking (SECON)*, pp. 256-264

EU FP7 Project CASAGRAS, 2009. CASAGRAS Final Report: RFID and the Inclusive Model for the Internet of Things. pp. 4-15

Auto-ID Labs. [online] Available at: <http://autoidlabs.org/wordpress_website/> [Accessed 30 March 2016].

EPC Information – EPC-RFIDEPC-RFID. [online] Available at: <http://www.epc-rfid.info/> [Accessed 30 March 2016].

GS1 – The Global Language of Business. [online] Available at: < http://www.gs1.org/> [Accessed 30 March 2016].