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RESEARCH ARTICLE

IOT and IIOT: INNOVATION, COMPETITIVE ADVANTAGE AND FIRM PERFORMANCE OF DIVERSE ENVIRONMENTS

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ABSTRACT

The Internet of Things (IoT) is an innovation that creates value, a range of technologies that provide objects with intelligence, making sure that they communicate with humans or with other machines, providing a new level of interaction or information compared with the environment in which these objects can be found. The difference with respect to IIoT, the IIoT philosophy, and a fully capable IIoT infrastructure and network, is that it becomes easier to move that information because of the way we are collecting and storing the data. The applications we are using to support IIoT are typically cloud native and it improves collaboration across separate enterprises and up and down the supply chain because data can be transmitted more easily. A critical analysis of the novel IOT and its competitive advantages and performance benefits through this innovation has been performed. This is done by exploring its different elements of innovation and its impact on diverse business environments with the use of 20 published papers from Information Systems,Process Management, Management Scienceand Engineering Journals, the majority being most recent, 2012-2017.This paper aims to analyze and enlighten the competitive advantage and performance benefits of process management across diverse sectors that derive innovationfrom the nonpareil called the IoT.This analysis conveys, that companies enabling IoTas part of their daily functions have demonstrated moderate to significant improvements in their Competitive Advantage and Performance. Findings imply that businesses should consider using IoT as part of their operations, as it is no longer just the future, but the present, and will improve their business' Competitive Advantage and Performance. IIoT makes it possible to visualize the process, understand the science, and see where the edge of failure lies. The business benefit of IoT is asset reliability and uptime, but the real driver is the opportunity for the vendor to provide expertise in asset performance and management, it enables organizations to collect information, monitor and analyze the performance of their operational processes. Business operational efficiency improvement can have an immense impact on the overall profits of companies and help preserve their going concern.

INTRODUCTION

Even though there are heterogeneous definitions on the interpretation of the IoT, it has a corresponding boundary related to the integration of the physical world with the virtual world of the Internet (Vongsingthong and Smanchat, 2014). IoT connects the planet via a network (Trequattrini *et al*., 2012; Vermesan and Friess, 2014), distributed on a global level, across different sectors of industry and trade.It is a new vision that has quickly increased its importance in the modern telecommunication field (Atzori *et al*., 2010).As expressed by Murray, Papa, Cuozzo and Russo (2016), IoT represents a paradigm: an innovation that creates value affecting the competitive essentials, making functionalities and services, that before were not imaginable.

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Some authors (Andersson and Mattsson, 2015) assert that it represents one of the most promising innovations and it is important to know as much as possible about what the technical opportunities are to innovate, because the IoT could involve great change in the commercial and social field. IoT comprises hardware and software to enable objects to interact and to communicate with each other, supporting the development of new services. In this sense, IoT primarily affects the objects (products). Object enhancement, in turn, opens the opportunity to process design (Zancul*et al.,* 2016). In recent years, intelligent devices that include dedicated software, smart devices, sensors and advanced communication capabilities for sending and receiving data, are being used in more diverse economic areas (Ivanus and Iovan, 2016). In the perspective of "things", numerous devices and objects will be connected to the Internet and each will individually provide data, information, or even services. The devices providing things can be personal objects we carry around such as smart phones, tablets, and digital cameras. Our daily environment, home, vehicle, or office connected through a gateway device can also provide "things" (Coetzee and Eksteen, 2011). IoT has been playing an essential role ever since it appeared, which covers from traditional equipment to general household objects (Jing *et al.,* 2014) and has been attracting the attention of researchers from academia, industry, and government (Chun and Park, 2017).In most industries, established competitors and new entrants alike will leverage data-driven strategies to innovate, compete, and capture value (McGuire, Manyika, and Chui, 2012). Internet of Things (IoT) is one of the cornerstones of the future of the Internet. Some adopters of Big Data have a low-cost sensor imbedded in a variety of physical things or tangible products that collect real-time data (Turban, Volonino and Wood, 2015). Big Data comprises datasets that have become too large to handle with the traditional or given computing environment (Costello and Prohaska, 2013). It is used to characterize data sets that are large, diverse and rapidly-changing, as seen by ever-increasing numbers of organizations (He, 2014). In this sense, basic IoT technology is no longer at the purely academic research level, but is starting to be integrated into the fabric of our daily activities (Pentikousis, Agüero, Timm-Giel and Sargento, 2014). These sensors can regulate temperature and climate, detect air particles for contamination, monitor machinery conditions for failures and detect engine wear or maintenance (Turban, Volonino and Wood, 2015).

Literature Review

IoT is a technological phenomenon originating from innovative developments and concepts in information and communication technology associated with: (1) Ubiquitous Communication/ Connectivity and (2) Pervasive Computing and Ambient Intelligence'' (Yan and Wen, 2011). As an unprecedented technology and business trend, IoT has brought enormous changes to global supply chain environments. Schumpeter (1934) defines five main types of innovation that may arise: product innovation; production process innovation; innovation in organization; new market behavior; and new raw materials. Some authors (Dewar and Dutton, 1986) have suggested a second definition based on the intensity of innovative change, therefore classifying them in radical innovation, the creation of a new product replacing all the old characteristics, and incremental innovation, improvements or adaptations to existing solutions.

Others (Kim *et al*., 2012), have classified innovation, especially innovation of digital content services, linking the concept of divergence and convergence (Freeman and Hagedoorn, 1995; Jenkins, 2001; Nordmann, 2004) of existing services into new creative services with the concept of incremental innovation; or use and set up of an existing single service applying to other content or platforms to develop new services, and recombinative innovation, involving the combination of multiple sources of existing services to create new services. IoT could be considered simultaneously, incremental and recombinative innovation because it utilizes service and technical characteristics of pre-existing products to create new services and products which are more dynamic and efficient than existing ones (Murray, 2016).

IoT can be semantically defined as "a world-wide network of interconnected objects uniquely addressable, based on standard communication protocols" (Infso and EPoSS, 2008).Ashton (2009) asserts that it represents the foundation of a digital economy, the digital society and the grounds for the future of the economy based on knowledge (Foray, 2004; Zanda, 2012) and innovative companies.The main aim of this innovation is to enable interaction and integration of the physical world and the cyber space(Abdul-Qawy and Pramod, 2015).The IoT is also known as machine-to-machine (M2M), Industrial 4.0 or Industrial Internet of Things (IIoT). The term "Internet of Things" was first introduced by Kevin Ashton and other researchers at the Auto-ID Center at Massachusetts Institute of Technology (MIT) in the late 1990s (Borgia, 2014). It labelled the development towards a world where all physical objects can be traced via the internet by tagging them with RFID transponders (Schoenberger, 2002). The meaning is expanded towards a world-wide web of smart connected objects that are context-sensitive and can be identified, sensed and controlled remotely by using sensors and actuators (Atzori et al., 2010; Kortuem et *al*., 2010; Porter and Heppelmann, 2014). In short, the paradigm of the IoT is described as "any-time, any-place, and any-one connected" (Ryu *et al.,* 2012). Its implication is based on technology that makes things and people get closer than in the old days (Vongsingthong and Smanchat, 2014).

The interaction between real or physical and digital or virtual objects is an essential concept behind this vision. In the IoT, physical entities have digital counterparts and virtual representations; things become context-aware and they can sense, communicate, act, interact, exchange data, information and knowledge (Sundmaeker *et al.,* 2010). The Internet acts as a storage and communication infrastructure that holds a virtual representation of things linking relevant information with the object (Uckelmann *et al.,* 2011). As such, virtual objects serve as central hubs of object information, which combine and update data continuously from a wide range of sources. Virtual objects can be used to coordinate and control business processes remotely via the Internet (Verdouw *et al.,* 2015). The functioning of a device or sensor connected to the Internet through an online communication environment, referred to as IoT devices, is relatively simple and easy to understand. Regardless of their type and to accomplish their role, all IoT devices technical architecture are based on the following components**: interfacing component for transforming sensor data taken by the microcontroller, a hardware component consisting of microcontroller that performs dedicated functions and secure data communications and a software component incorporated in microcontroller (embedded software) that implements algorithms for collecting and transmitting monitored data. From the point of view of the means of data communication, IoT devices can be classified into Unidirectional and Bidirectional**.** Unidirectionaltransmits data and information in a single direction from source to destination andBidirectional sends and receives data and information in both directions (from source to destination and vice versa) (Ivanus, and Iovan, 2016). The IoT innovation covers many application fields, sometimes in combination, such as security, tracking and tracing, payment, health, remote control, maintenance and measurement (Andersson and Mattsson, 2015). In the last few years, IoT has impacted education, communication, trade and the public administration (Evans, 2011). Due to the importance of the phenomenon, several scholars have analyzed it from different points of view including the investment opportunities perspective for companies (Griffith, 2014), expansion of communication (Capriotti and Kuklinski, 2012; Echterhoff, 2013), optimization of energy consumption (Singh and Yiu, 2011), implications for marketing (Benady, 2014; Cristóbal-Fransi *et al*., 2014), implications for logistics (Pye, 2014; Yu *et al*., 2015) and the source of innovation that this new infrastructure represents (Wright and Bell, 2003; Yuksekkaya *et al*., 2006). In this investigation, it will be analyzed through its innovative traits and the benefits that diverse environments derive from it.

IoT in Manufacturing

In this section, some of the common and widely used applications of IoT are briefly investigated. In recent years, the Internet of Things (IoT) technology is being increasingly applied to diverse application areas including healthcare monitoring, disaster management, and vehicular management (Chun and Park, 2017). IoT permits to share big data flows among modern companies, by increasing productivity and reducing marginal costs. At the same time, it becomes vital for businesses to understand the potential of the IoT to manage business process management, technology strategy, technology forecasting, technology roadmap and a technology management portfolio (Del Giudice, 2016).

Production and distribution processes face a completely different environment from those of the past. Items or "things" are embedded into the environment, meaning they are continually connected and interacting with each other, exchanging information flows (Caputo *et al.,* 2016). The IoT device works through sensors which fetch external data from the environment on which they are connected and communicate via gateways sending the primary processed information toward the cyberspace. The internet connection is made via a service management system to ensure data security and confidentiality. The last level is the application layer through which information is presented either directly or sent to other systems for processing (Ivanus and Iovan, 2016).The phenomenon of the IoT is based on smart infrastructures revolution, connecting companies, machineries, transports and many more, under a unique system characterized by logistic mechanisms, energy resources and means of communication. In this direction, some traders predict that 100 billion devices will be connected to the internet by 2030 (Caputo *et al.,* 2016).
We still know very little about how the IoT is changing the way of interpreting the business process management inside and outside the firms and this topic is becoming increasingly hot in the leading managerial literature (Al-Mashari and Zairi, 2000).According to Rifkin (2014), people, machines, natural resources, production lines, logistics networks, consumption habits, recycling flows, and virtually every other aspect of economic and social life will be linked via sensors and software to the IoT platform, continually feeding Big Data to every node – businesses, homes, vehicles – moment to moment, in real time. Big Data, in turn, will be processed with advanced analytics, transformed into predictive algorithms, and programmed into automated systems to improve thermodynamic efficiencies, dramatically increase productivity, and reduce the marginal cost of producing and delivering a full range of goods and services to near zero across the entire economy.Furthermore, management scholars are aiming at investigating the impact and the role of the IoT on the business process management in terms of promotion of knowledge flow, innovation and competitiveness. Likewise, management researchers aim at understanding how the IoT fosters innovation inside organizations and which implications this phenomenon can have on business process management and competitiveness of firms (Al-Mashari and Zairi, 1999). This article will address the research gap and practical applications of theinnovation IoT, through the exploration of the benefits of competitive advantages and business performance derived from IoT in diverse fields.

Business Performance

According to Hroncich (2017), the difference with respect to IIoT, the IIoT philosophy, and a fully capable IIoT infrastructure and network, is that it becomes easier to move that information because of the way we are collecting and storing the data. The applications we are using to support IIoT are typically cloud native and it improves collaboration across separate enterprises and up and down the supply chain because data can be transmitted more easily.A new technology management scenario is therefore emerging where products consisting of electrical and mechanical parts become intelligent systems that combine hardware, software, control sensors, data storage and connectivity in infinite ways (Del Giudice, 2016).
The IoT brings major technological change that has the potential to provide significant data and provide visibility to consumer product usage (Vermesan, 2011). At the heart of the IoT is the concept that every "thing" in the world could be connected to the Internet; for example, each power socket in the home will have an IP address to enable data to be collected on connected equipment and power use (Cerf, 1997). It is possible to gain insights beyond single supply chains and gain visibility into contexts of usage, as the IoT vision is not restricted to devices. Connecting social media with things and integrating social media data such as calendar functions, personal blogs and Facebook with IoT functions (Albrecht, 2013) allows the integration of information from multiple platforms (Gubbi*et al.,* 2013; Atzori*et al.,* 2010). In short, IoT provides the potential for data to be collected on the experience of a good or service within a specific time, place and setting.
New generation of mobile applications is designed to fulfill the promise of the Industrial Internet of Things (IIoT). Users can remotely receive real-time, customized productivity alerts from multiple data sources, such as alarm management systems and process historians, and use this information to resolve problems (Robinson, 2016).

Thanks to the Internet of Things (IoT), the same technologies that have revolutionized the way consumers do everyday things can now enhance the way we manage maintenance of the plant environment. This doesn't require a brand-new plant or the latest equipment to derive benefit (Calvo, 2016).Mobile technology, including industrial mobile apps, improves situational awareness by keeping stakeholders abreast of critical alarms and events in near real time. Current developments in mobile technology enable key industrial personnel to stay connected to their enterprise—regardless of their location. The mobile app solutions help bring timely, relevant and proactive metrics and tools to resolve issues and improve efficiency and safety (Robinson, 2016). This practice is quickly becoming fundamental to maintenance management in industries, as it utilizes periodic assessments to analyze the health of equipment. When executed consistently, it enables an understanding of a more periodic state of the equipment, a heartbeat of its condition,to help inform maintenance planning. This in turn, prevents a reactive approach, such as downtime, production delays, inefficiencies, added costs, poor quality, increased scrap, warranty issues or product recalls (Calvo, 2016).

The IoT market can be segmented into three categories

- Business to Consumer (B2C): e.g. connected people, connected pet, connected home, connected car.
- Business to Business (B2B): e.g. connected agribusiness, connected buildings, connected industry (industrial internet).
- Business to Business to Consumer (B2B2C): e.g. smart cities, smart grid, smart utilities (Zancul*et al.,* 2016).

IoT are dynamic and adaptive, meaning that applications, associations and collaborations are dynamically established and configured depending on the situation at run-time. The information gathered is often used to support human decision making rather than to only automate a predefined process. Interaction with human users is essential both to use the systems efficiently, and to effectively improve the systems over time (Krogstie, 2011).Atzori *et al.* (2010) provide examples of IoT applications in industrial business processes. For monitoring environmental parameters, i.e. monitoring conservation status in perishable food warehousing and transporting. In industrial plants, i.e. a wireless sensor mounted on the machine monitors. The vibration, if it exceeds a specific threshold an event is raised to immediately stop the process (quality control). Once such an emergency event is propagated, devices and systems that consume it react accordingly.Under the vision of the IoT, applications can be fully automated by configuring themselves when exposed to a new environment. The intelligent behavior driven by the system can autonomously be triggered to seamlessly cope with unforeseen situations (Vongsingthong and Smanchat, 2014).

The business benefit of IoT is asset reliability and uptime, but the real driver is the opportunity for the vendor to provide expertise in asset performance and management. Each model follows a common architecture of sensor, communications network, and analysis that is very familiar to the process industry and noted by many prominent industry speakers (Risse, 2016).Sensors are a cost-effective way to take a snapshot of what's happening with a piece of equipment, down to the second. The technology is fast and efficient, enabling the monitoring of more process points and more machines. It is also suitable for use in a variety of applications. In fluid power, for example, sensors can be applied for condition monitoring of injection molding units, metal forming and fabrication equipment, conveyor systems, dispensingsystems, robotic assembly, and hydraulic power units, to name a few (Calvo, 2016).There are new opportunities for improved plant performance enabled by these new technologies and at drastically lower price points. Sensors for monitoring of gases, such as any gas-phase chemicals where a sensing material is applied onto a suitable physical transducer. These advantages include tunable sensitivity, continuous real-time determination of the concentrations of specific sample constituents, small power consumption, operation without consumables, and unobtrusive form factors (Potyrailo, 2016). The key question for manufacturers with existing plants then becomes: "How do we bring our facilities forward into a smarter state?" The answer should always be framed in the context of the end benefit, which is, better insights faster. Sensors are the starting point in the data collection process. They monitor the operation of "things" in the IIoT: pumps, valves, and other assets. Their cost of implementation and use is dropping rapidly, making it cheaper to acquire more data (Risse, 2016).The use of analysis and algorithms has increased efficiency, productivity and almost deleted the marginal costs of production and sharing of several products and services (Rifkin, 2014). The intention of IIoT is not to increase the position of a process analytical technology (PAT) controller, or real regulatory control, but to provide the infrastructure in a validated environment that reduces cost for validation to achieve the initiative (Hroncich, 2017).

IoT is also imperative to the area of healthcare, a World Health Organization report from 2015 shows an alarming increase in the number of people enrolled in the non-communicable diseases, diabetes and cardiovascular disease generating a rise in the number of hospitalization days and in the worst case, death (Ivanus and Iovan,2016). Improvement in human health and wellbeing is the goal of any economic, technological, and social development (Vongsingthong and Smanchat, 2014). The report reveals that 46% of total deaths are due to cardio-vascular diseases, most of which in turn can be caused by diabetes and other nutritional diseases. The report illustrates that 50% of death cases are statistically shown due to chronic conditions that require a preventive approach (Pezalla, 2016). Solutions for healthcare should involve such capabilities as tracking and monitoring, remote service, information management and cross- organization integration (Vongsingthong and Smanchat, 2014).For maintaining an optimum cost between health services and expenses, research institutes and technological innovation in medicine seek permanent solutions to prevent and combat the effects of chronic diseases ((Ivanus and Iovan, 2016). Its application can be seen in the diagnosis and treatment of diseases, including the diagnosis of HIV and AIDS, and in the prescription of nanodrugs for other diseases (Gubbi *et al*., 2013).Depending on the values of these parameters, information systems built on process flow will analyze received data and make decisions on different types of actions to be taken. These are triggered by predetermined thresholds and are communicated to the treating physician and the patient or depending on the situation, can generate alerts for and intervention of medical crews (Ivanus and Iovan, 2016). IoT enables the collection of manual data more easily, the customization of this data, and the result is available for control. The resulting in a better and easier multivariable modeling set up andindirect measurements can be accomplished. For example, in a biopharmaceutical plant, it is relatively impossible to measure the quality ofthe products, but you can indirectly measure this information. Therefore,making this information and results more easily available for real control(Hroncich, 2017). Also, the IoT-based remote monitoring system (RMS) has been applied in some fields. In the traffic field, an IoT-based RMS has been designed to remotely monitor the vehicle engine speed, engine gas emission, fault codes, geographic location, among others, which has greatly improved the efficiency of vehicle maintenance (Lin, Shiao,and Li, 2007; Yin and Huang, 2015). IoT by General Motors Company in 2010, has presented a prospect of the urban traffic system with zero traffic accident and a wonderful riding experience (LiandLi, 2012).

In the agricultural field, an IoT-based RMS has effectively reduced economic losses due to the quality deterioration of irrigated water (Zhu, Liand He, 2010). In the healthcare field, IoT-based RMSs have been implemented to monitor the heart rate, the body temperature, and other parameters of the elderly or sick residents, which have brought great convenience for doctors and patients (Sardini and Serpelloni, 2010;Alemdar and Ersoy, 2010). At an IIoT-enabled facility, all process values can be accessed at any stage, including temperature, pressure, weight, flow, pH, dissolved oxygen, humidity, and energy. Additionally, engineers can parameterize processes and monitor with increased resolution, to create a control strategy and alerting mechanism that prevents the equipment from ever reaching or getting close to their predetermined limits. Process refers to every smallprocess loop or discrete control in the plant. IIoT is a science to advance with an accurate vision and it is within this vision the paradigm shift for improvement exists(Hroncich, 2017).The effective strategy of Internet of Things (IoT) can help firms to grasp the emerging opportunities from the IoT and then improve their competitive advantage (Li, Hou, LiuandLiu, 2012).Now, more than ever, manufacturers need to harness the power of the Industrial Internet to realize significant operational and business performance benefits. The IIoTcan unite people and systems on the plant floor with those at the enterprise level, and enable users to get the most value from their automation systems without being constrained by technological and economic limitations. A secure IIoT ecosystem adds domain knowledge to solve challenging problems (Hroncich, 2017).

Competitive Advantage

The main key sources for a sustainable competitive advantage and for the survival of companies based on knowledge and high technology are the knowledge, because it represents a resource, and innovation technology, as it represents the dynamic capacity of the company (Martín-de Castro, 2015).The overarching goal of using analytics in manufacturing is to improve productivity by reducingcosts without compromising quality (Lade *et al.,*2017).In the new knowledge economy, innovations included in new revitalized products and processes are likely to become the driving factors and the source of future financial and competitive advantages for each firm (Del Giudice, 2016). From the resource-based perspective, researchers emphasize more on the opportunities and benefitsof adopting IoT, considering it a critical factor forfuture value creation (Kochand Mitlo¨hner, 2010; Lai *et al*., 2005).Implementations of digital manufacturing have delivered benefits including: 48% less downtime, 49% fewer defects, 23% increase in new product introductions, 16% gain in overall equipment effectiveness, 35% improved inventory and 18% less energy use for Cisco System Inc. (Hoske, 2016). In the Operation Phases, the IoT application allows factory automation (Houyou *et al.,* 2012), product manufacturing workshop (Liu *et* Xu, 2013) or mechanical production with amanagement system (Lvqing, 2011). In the Control Phase of IoT, some applications are Resource Management Systems(Lee *et al.,* 2012) used to control resources to accomplishplanning,monitoring and controlling systems for disturbances in production (Meyer *et al*.,2011; Yuan *et al*.,2013), tracking systems to control the necessary pieces of a product (Qu *et al.,*2012) or a management system to control the environment of agricultural and food production (Hu *et al.,* 2011; Shengduo et Jian, 2012).The added value of using and connecting the IoT is given by the capability of monitoring and permanent control of state systems (energy, traffic, transport, agriculture, health, community public services, among others) without human factor intervention (Ivanus and Iovan, 2016). Analytics is irreplaceable in manufacturing because it reduces test time and calibration. This includes predicting test results and calibration parameters. Also, improving quality, which entails, reducing the cost of producing scrap or bad parts by identifying the root cause for scrap and self-optimizing the assembly line. Moreover, reducing warranty costs by using quality testing and processing data to predict field failures, as well as cross value-stream analysis (Lade *et al.,*2017). IIoT resolves pain points that manufacturers have suffered with for years, such as rising energy costs, aging and remotely located workers, globally distributed operations, customer support across time zones, world competition, product proliferation, asset optimization, and others (Hoske, 2016). Additionally, it improves yield through the benchmark analysis across lines and plants. This results in, improving the first-pass yield and pinpointing causes of performance bottlenecks such as overall equipment efficiency (OEE) or cycle time. First-pass yield refers to the maximuminstances of the product passing quality tests in a single iteration. Often when the instance or part does not pass in the first iteration, consecutive iterations of the testing process are done with or without changes in the assembly of the product part or instance. Also, it is imperative for performing predictive maintenance, which entails analyzing machine health, identifying the top causes of failure, and predicting component failures to avoid unscheduled machine downtimes (Lade *et al.,* 2017).

According to Douglas Bellin, senior manager and industry lead of Cisco Systems Inc., manufacturing is moving from product-centric to services-centric, led by a digital transformation where services and the digital journey converge (Hoske, 2016).This delivers deeper insights into product and customer needs.To ensure successful deployment of the IIoT, industrial organizations must be willing to embrace change through developing a comprehensive framework that supports collaborative work processes across functional lines, as well as between internal and external resources(Blanchette, 2016).In supply chain management(Li and Luo, 2010), IoT offers competitive advantages such as the tracking of goods in real time as well as automatic control of stock. Each commodity in the logistics network is embedded with sensors to record information of items for fast updating of transactions of specific goods. Protection from thieves, and fast tracking and tracing of goods can also be autonomously triggered as alarm mechanisms by these sensors (Vongsingthong and Smanchat, 2014). This ensures a more effective logistical operation and minimizes, terror, theft and loss of merchandise and has easy implementation. By carrying radio signals of product identification and other information, RFID technology can provide unprecedented visibility to the supply chain (Masciari 2012), Right product, right quantity, right time, right place, right condition, and right price are what are expected in logistics sensors (Vongsingthong and Smanchat, 2014).

Radio-Frequency Identification (RFID) is gaining strong support from the business community due to its maturity, low cost, and low power. RFID acts as an electronic barcode to help in the automatic identification of anything attached. RFID tags are available in 2 types: active and passive. The active tags embedded within the battery on-board are widely used in retail, healthcare, and facilities management. The passive tags, containing no batteries, are powered by the reader and are more likely to be used in bank cards and road toll tags (Aggarwal, 2012). IoT uses the aspire RFID (Soldatos *et al*., 2010) application to applySession Initiation Protocol (SIP) (Anggorojati *et al*., 2013) to detect location and mobility management of RFID tags. The integration of the Electronic Product Code (EPC) global based RFID architecture with SIP to simultaneously detect locations and mobility management of RFID tags revealed the outstanding performance in cost consumption of tags registration and tracking in supply chain logistics (Vongsingthong and Smanchat, 2014).

Embedded smart sensors may provide the means to communicate with users by sending alerts via Internet connectivity. The connection can primarily be wireless or any other availablecommunication, such as DSL, GPRS, WiFi, LAN, and 3G (Uckelmann *et al*., 2011). Smart things must not only communicate but must also be able to process information, self-configure,self-maintain, self-repair, make independent decisions and play an active role in their own disposal (Vermesan and Friess, 2013).In relation to healthcare, remote monitoring of patients and people at high risk of accidents is a preventive method that can permanently assess the health of a patient. Using this method, the patient may carry on their activities as normal, without being hospitalized in a specialized institution, with the need to have constant contact with health systems and physicians. To achieve this goal, RMS uses advanced technologies for collecting data through sensors. This information is then transmitted using permanent connection to the Internet, respectively of their interpretation bythe healthcare information systems (Vongsingthong and Smanchat, 2014). The evolution of the Internet and smart devices connected to IoT has capacitated the implementation of data transmission and processing in real time by medical information systems. Smart bracelets and belts equipped with sensors, patches or implants which measures physiological predetermined health parameters of the monitored person send data synchronous or asynchronous mode in real time (Ivanus and Iovan,2016).

These historical benefits that IoT offers the world of healthcare has changed several persons' lives and made them more independent and free from the walls of a health care facility to enjoy the freedom of their daily lives. The competitive advantages for health care facilities that offer these smart devices to their patients will have the advantage of a niche market in the health industry because of the benefits patients get through having the ability to live life outside the facility and not be dependent on persons probing their bodies with different body samples to collect data to their progress against an illness. Persons will be more attracted to this service than having to halt everything in their life, to stay in the health facility for sometimes an undetermined amount of time for observation and treatments.In the IoT marketplace the future trends in the industry are phenomenal. It is estimated that there are about 1.5 billion Internet-enabled PCs and over 1 billion Internet-enabled mobile phones today. By the year 2020, there will be 50 to 100 billion devices connected to the Internet, ranging from smartphones, PCs, and ATMs (Automated Teller Machine) to manufacturing equipment in factories and products in shipping containers (Perera, Zaslavsky, Christenand Georgakopoulos, 2014). The number of things connected to the Internet exceeded the number of people on Earth in 2008. According to CISCO, each individualon earth will have more than six devices connected to the Internet by 2020. As stated by BCC Research's 2011 market report on sensors, the global market for sensors was around $56.3 billion in 2010. In 2011, it was around $62.8 billion. It is expected to increase to $91.5 billion by 2016, at a compound annual growth rate of 7.8% (Perera, Liu, JayawardenaandChen, 2014). The IoT allows for an increasing competitiveness of the global corporations by sharing specific knowledge and social value in the long term, thus influencing company performance and customer relationship management (Del Giudice, 2016). IoT saves time and money, quickly resolves issues, saves money and increases collaboration, provides infinite opportunities through its efficiency, increases interoperability and can save the environment and reduce climate change (Batagan, Toma,and Popa, 2015).

Methodology

A critical analysis was conducted using 20 published papers fromInformation Systems, Process Management, Management Science and Engineering Journals, the majority of which are most recent, between 2012-2017. The papers analyzed the Competitive Advantage and Performance of businesses that are using IoT as part of their operations.

Data Analysis

A critical analysis of articles with pertinent content to IoT was conducted.These articles were reviewed and their contributions encapsulated in this article. All the papers reviewed provided positive feedback on IoT regarding competitive advantage and business performance across various environments.

Conclusion

Innovation is a complex social process, companies innovate for so many reasons since there are different drivers that push them to innovate (Egbu, 2004). In the Information and Communications Technology (ICT) innovations and economic developments, a significant focus has shifted to the IoT related technologies where it is widely considered as one of the most important infrastructures of their promotion and one of the future promise strategies(Abdul-Qawy andPramod, 2015).The production processes of industrial firms are at the dawn of a new horizon, where the use of IoT is becoming inevitable for the efficiency and effectiveness of their industrial processes. It prevents a reactive approach, such as downtime, production delays, inefficiencies, added costs, poor quality, increased scrap, warranty issues, or product recalls (Calvo, 2016). These negatives represent hundreds of thousands of dollars for these industries and can be combated and prevented with the use of IoT. Within these firms, whether it is the operational manager or the CEO of the company, they can track and monitor their plants with the flick of their fingers on their smart phone and get real time readings, answers and predictions.Innovation represents the greatest source of competitive advantage and is an essential requirement for the success of organizations and their survival (Del Giudice *et al*., 2010; Egbu, 2004). The Competitive Advantage that IoT provides are priceless. Their sensors assist in the data collection process of these companies and provide data feedback, which then can be used to analyze and pin point failures. At an IIoT-enabled facility, all process values can be accessed at any stage, including temperature, pressure, weight, flow, pH, dissolved oxygen, humidity, and energy (Hroncich, 2017). By being aware of these failures, this results in more precision for R&D and accuracy in understanding where the error occurred in plant processes. Eliminating the worries and expenditures that arise with blind production, system function predictions and reactive operations.Moreover, in some countries electricity is one of the most expensive operational costs, for example, Puerto Rico. The essential benefit for companies operating under such circumstances is that IoT improves the way energy is consumed due to its system precision. Performance in general, improves both short-term and long-term, due to the live 24/7 monitoring of systems and quality control of the production materials. This is done throughindirectly measuring the information collected though the IoT. Every system and sub-system in the production process can be monitored, controlled and predicted. This assists in decreasing the wastage of energy usage on defective equipment, inefficiencies and fewer defects. These factors all giveindustries and businesses using IoT a safer and more secure short term operational goal achievement and this impacts the long-term benefits both financially and operationally.

Academic and Practical Implication

At the academic level, there has not beenmany publications in innovations such as the IoT. They have been moreexclusively from a technical point of view within optical engineering or architecture and design (Caputo, Marzi and Pellegrini, 2016). This paper contributes to the literature making the IoT innovation a priority through the exploration of its benefits and vast applications. At a practical level, the pertinent literature on the IoT phenomenon mostly addresses facts and implications but in a technical fashion aimed at solving technical and practicalproblems. A more comprehensive analysis of the benefits reaped from IoT through business performance and competitive advantages have not been elaborated toward a "non-technical" audience and has been addressed through this literature.The added value of using and connecting the Internet-of-Things (IoT) is given by the capability of monitoring and permanent control of state systems (energy, traffic, transport, agriculture, health, community public services, among others) without human factor intervention (Ivanus and Iovan, 2016).

Originality/ Value

The IoT innovation represents a paradigm: an innovation that creates value. It represents the way forward for many environments and can assist businesses through the correct applications, improve their operations and gain more profits through more efficiencies. This paper exposes the world of innovation, by presenting IoT in a simplistic manner. It provides imperative information for business owners who are considering or in transition of upgrading to using IoTs in their companies' operations. Additionally, this paper caters for the public and researchers interested in present technological developments and its future. The intent of this paper is to fill the literature gap on the analysis and evaluation of the IoT' competitive advantages and business performance in different environments.

Limitation and Future direction

Though there are extremely vivid benefits and a need for the applications of IoT, one concern with this innovation is its safety. This study should consider the factors of cyber security risks that goes hand in hand with the use of IoT as part of a company's operations. The issue of having a low defensive mechanism to secure privacy and cyber security can threaten a company's privacy and operations. Future research could study IoT complimentary security systems that minimizes the risks of security breaches. Also, the simplicity of the system is another factor to be developed through further investigation. The more complex the system's security, the more complex the system may be to manage and this may not be very attractive feature of IoT for non-experts. However, this research can enhance the simplicity of this IoT system through maximization of security and ease of operation through the continued application of innovation in IoT. Another limitation of IoT is, as a constrained device moves around different wireless networks, its Internet Protocol (IP) connectivity may be frequently disrupted and power can be drained rapidly. This can result in the loss of important sensing data or a large delay for time-critical IoT services such as healthcare monitoring and disaster management (Chunand Park., 2017). The security of IP connectivity is crucial to the comfort of the reliability of IoT, this is another field that should be more developed to ensure the safety of the usage of IoT across all environments.

Virtual supply chains will be an important area to embark on in IoT research, especially in the field of virtualization of business control in food supply. Development of knowledge in this area can assist companies in supply chain operations for perishable goods and impact the world entirely, through more food supply efficiency and minimizing the levels of food wasting which occurs daily. Such research could profit from studies on the economic value of traceability and RFID (e.g. Bottani and Rizzi, 2008; Sarac *et al*., 2010; Mai *et al*., 2010).Furthermore, future research can delve more into innovative applications of IoT in smart city development, which can enhance the efficiency of the wider environment. This has the potential to enable higher efficient and effective living and lower operational costs of entire cities.

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