Importance of the Use of the Internet of Things and its Implications in the Manufacturing Industry

Laura Contreras,
(PhD student in Strategic Planning and Technology Development)
Juan Perez,
(PhD in Strategic Planning and Technology Development)
UPAEP, México

Doi: 10.19044/esj.2018.v14n10p378 URL:http://dx.doi.org/10.19044/esj.2018.v14n10p378

Abstract

The research presented in this paper is a literary analysis of 91 papers of 31 different journals of world recognition from different countries (England, Poland, Spain, China, Switzerland, Netherlands); focusing on productivity improvement inside a business through Internet of Things (IoT) in the manufacturing industry. It is essential to know the implications in the use of IoT for productivity improvement because IoT is having great influence in different context, one of them is businesses. The objective of this paper is to know the implications of the use of IoT to increase productivity, focusing on security and data privacy in the manufacturing sector. Suggestions are made regarding big data, digital manufacturing, the supply chain, cybersecurity, and monitoring and control systems for implementing IoT to improve productivity in a manufacturing industry. The use of new tools and technologies for improving productivity imply that the detailed aspects for its implementation must be analyze.

Keywords: Internet of Things, Manufacturing Industry, Productivity

Introduction:

Imagine that in a manufacturing business a problem has occurred many times in the production line, in which a piece is stuck in one of the machines, but thanks to the use of the Internet of Things (IoT) the machine automatically resolves the problem without human intervention. The IoT allows the communication between different devices in order to generate great amounts of data that have the potential of generating new knowledge through different domains (Ryu, Kim, & Yun, 2015). In the business sector, researches are being made regarding the use of IoT; one of them is the use of a framework that

helps in decision making in real time to improve the performance through the supply chain, allowing the increase in incomes and bringing stability (Rezaei, Akbarpour Shirazi & Karimi, 2017).

The IoT brings many benefits to manufacturing companies but there are great concerns regarding data privacy and security because of the storage vulnerabilities that are imply in the use of this technology (Campo, Calatrava, Perandones, Jie & Martinez, 2017). For the above, it is relevant to know the impact of the IoT inside a business environment as a tool for improving productivity.

The problem detected is that there is no certainty in data security or data privacy, although IoT provides great benefits regarding productivity improvement and response time inside a business (D´Outreligne, 2015).

The objective of this papers is to analyze the implications of the use of IoT for productivity improvement in the manufacturing sector, focusing on data security and privacy, through the analysis of relevant material; in order to better understand some of the factors that must be considered when implementing IoT as a tool for improving productivity. A comparative of 90 papers is presented with the findings and suggestions, in order to achieve the research objective.

Implications of data security and data privacy in the use of Internet of Thing

The IoT brings the innovation capacity in processes and products through the use of edge technology. It is suggested to invest in IoT with a focus on the capacity for developing relationships between players in the supply chain. The information to innovation can be achieve through the data collection and dissemination, from the above it is inferred that it is very important to secure the information (Yu, Nguyen & Chen, 2016). Researches are been done regarding an Smart Office, this implies the use of IoT to do the data collection through different devices (Ryu et al., 2015).

The risks in an IoT system are critical and represent many challenges, because the IoT includes characteristics and nonspecific parameters, it has a dynamic nature, it uses diverse hardware, it has global connectivity and a wide access. According to Alkhalil & Ramadan (2017), the principal challenges for IoT are: guarantee the security of the origin data, manage massive information that is produce, indexing origin, multiple data consumers, problems with data transformation during task, flexible tools for querying origin data and interoperability.

The IoT brings the opportunity to create new design with smart devices that allow to improve the health sector. The automation, interconnectivity and sensitive data transfer for this kind of services implies ethic questioning related to privacy and security (Bhattacharya, Wainwright & Whalley, 2017).

To prevent problems related to security, Banerjee, Lee & Choo, (2017), propose a block chain for IoT, using the registers for financial transactions which are codify and maintained for all the users; because of the necessity of the availability of public groups of data and the necessity of sharing secure groups of data.

The design privacy and the introduction of universal principles of usability have the potential of taking IoT to the next phase, as said by O'Connor, Rowan, Lynch & Heavin, (2017); they propose a practical solution that involves eConsent and the use of IoT in health systems. The eConsent refers to the virtual consent that people give regarding the use of their personal information through an online form. The proposed solution consist in the use of the privacy design principles and the universal usability principles to convert the users into partners of the process.

According to Riahi Sfar, Natalizio, Challal & Chtourou, (2017), IoT is a disruptive technology that has the potential to bring an evolution in the way technological ecosystems are being used; the majority of these challenges are based in the vulnerability of the objects inside the IoT and the parity of closeness in the physical world with the virtual world through the use of smart objects. In their work, they present a serie of guidelines that bring more security and privacy in an environment that uses IoT; among them are the standardization and the access permits.

Sahmim & Gharsellaoui (2017), present some solutions for privacy problems, mainly falling on the confidentiality of data, encryption, the dissemination of sensitive data, the use of anonymity, durable policies, platforms of reliable modules, segmentation of data, mediators reliable, identity and access management; and security administration.

The Internet of Things and productivity

The managers of the industries recognize the benefits that the IoT provides, however, only 12% are willing to invest in it. One of the studies analyzed is that carried out by Shea (2015), where 80% of the respondents mentioned that connection technologies help to increase productivity, but also that the technology is not yet mature enough and that the organizations do not have the skills to implement it.

For this reason, methodological approaches have been presented for the preventive maintenance of equipment through the use of the IoT, which allows to improve business productivity through the monitoring of data that reduces losses (Tedeschi, Mehnen, Tapoglou & Roy, 2017). The use of the IoT as part of a circular business model, manages to improve productivity in the industrial washing sector, having savings of almost 30% and reducing water consumption by about 1% (Bressanelli, Perona & Saccani, 2017). Likewise, studies have been carried out regarding automatic learning to manipulate the

information transmitted through the IoT which generates Big Data, characterized by speed in terms of time and location dependence. The key to creating intelligent applications in the IoT is the processing and analysis of Big Data. From the above it is deduced that the manipulation of information is key to improving productivity if the IoT is to be implemented (Mahdavinejad et al., 2017).

Real-time monitoring within the industrial plant, for mass production can reduce losses associated with pauses in the production line. Complemented with the monitoring of contextual information, it can provide intelligent information; to achieve this, it is necessary to use tools in a context that implements the IoT (Pease, Conway & West, 2017). Flexibility in manufacturing, together with mass customization, achieve improved quality and productivity through intelligent manufacturing; the resources to achieve this imply the use of the IoT in such a way that it facilitates the processes of manufacturing and manufacturing in the cloud (Zhong, Xu, Klotz & Newman, 2017).

It is relevant to investigate this issue because the trend in the industrial sphere is globalization and the use of new technologies (such as the IoT) to improve different processes, including productivity (Nolan, 2013).

The Manufacturing Industry

Nowadays, different analyses were done regarding sustainable development in the manufacturing industries. In the analyses made by Singla, Ahuja & Sethi (2017) was indicated that practices regarding corporate strategy, stringent implementation of government regulations and export orientation are necessary for achieving competitiveness. If a company is competitive, it can be inferred that its productivity is efficient.

Also, the Supply Change Management plays a central role in achieving productivity, because it has a significant relationship with competitive advantage. Information technology has a significant relation with competitive advantage (Matthew, 2017). For the above it is imply that IoT is conceivable a key component in achieving a competitive advantage in a manufacturing industry and with this improving productivity.

In developing countries, the manufacturing industries tend to be concentrated in a single area generating a static economy; in contrast with advance economies where the manufacturing industries are more disperse creating a dynamic economy (Avila & Sandoval, 2017). Productivity growth in a manufacturing industry might be measure by technological progress (Shee & Stefanou, 2016).

The Internet of Things in the Manufacturing Industry

If firms are able to manage the delivery mode, this can lead to improve their external operations, cost and waste reductions; making the company more flexible and meeting the clients expectations faster, ultimately achieving a sustainable competitive advantage (Al-Shboul, 2017). Transforming a business conceivably is achieved through technology innovation. Processes are being innovated more than products (Baragde & Baporikar, 2017). The success of IoT systems depends on the consumer perception of its usefulness, ease of use, and privacy risk (Dong, Chang, Wang & Yan, 2017).

IoT technologies can be used to develop and enhance performance measurement systems, as the one propose by Dweekat, Hwang, & Park, (2017) for supply chain performance measurement. Industry 4.0 through IoT can enable automated material handling, digitalized reporting and quality transactions in a manufacturing industry (Graney, 2017).

Metamodels for the integration of the IoT in a manufacturing industry are being proposed, such as the one presented by Rodríguez & Triana, (2017) where three layers were considered for its implementation, giving ground for more work regarding data security and system reliability. Also, exploratory studies for the innovation and sustainable growth in Small and Medium Size Enterprises (SMEs) using IoT enhanced the structure and process related capabilities (Shin, 2017).

Methodology:

The scope of the research is qualitative and quantitative due to the nature of it, in order to understand the implications that come to have within a company for the implementation of the IoT. It was decided to carry out an exploratory investigation based on the Okoli methodology displayed in Figure 1. The design of the research is transactional, since the papers are compared to understand their relationship in terms of the implications in the use of the IoT in productivity in the last 5 years (2014 – 2018).

According to Segal (2015), the transition to the IoT implies having an infrastructure that supports it, with cloud-based services, with updated systems and with connections to third parties through this platform. So for this research it is assumed that these elements are already available.

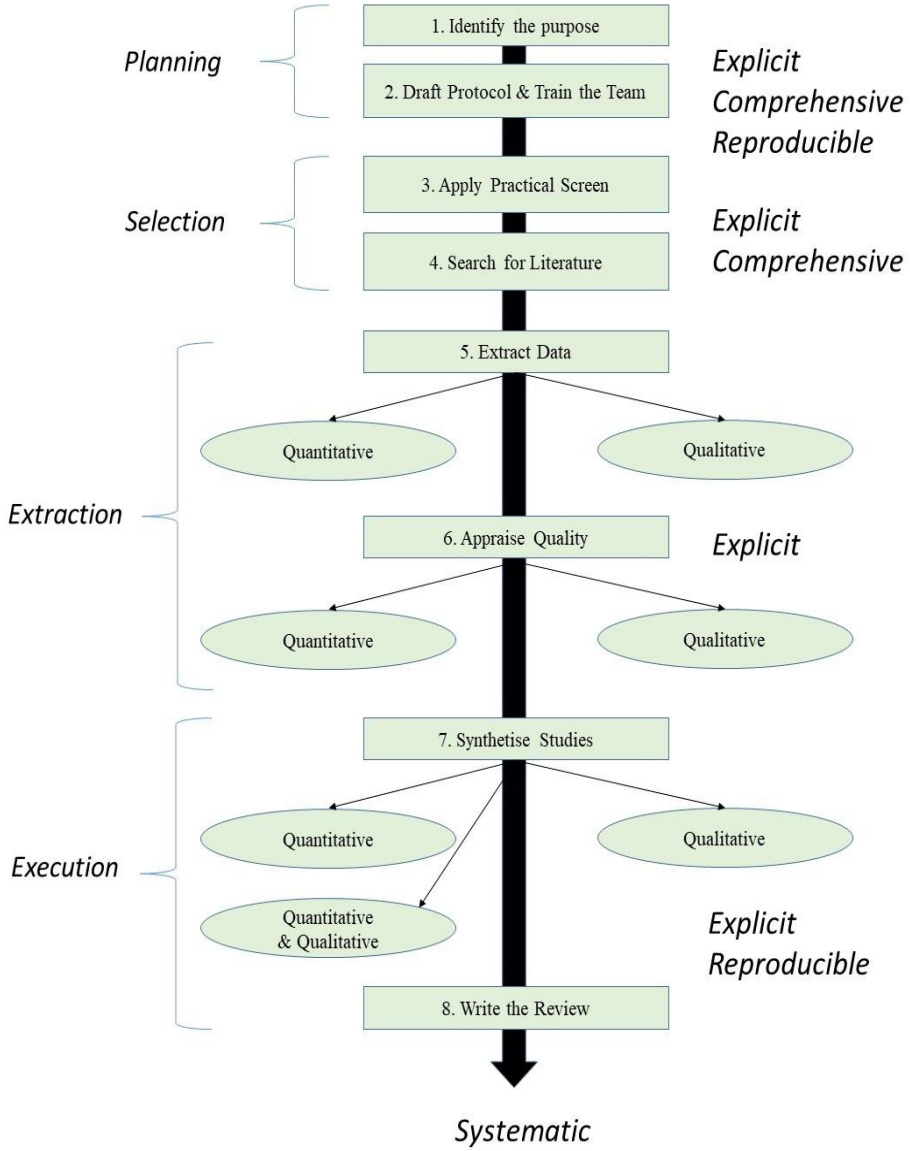

Figure 1. Okoli methodology.
Source: Okoli, 2015.

The empirical study based on cases, has been used as the main research method in this work since the review of the literature shows the case-type study, as a sampling technique that is used in qualitative and quantitative research (Hernández, 2010). Likewise, a protocol was used for the systematic review of the literature displayed in Table 1, based on recently published works according to the methodology of Okoli (2015):

No	Journal Name	Papers
1	Applied Energy	1
2	Business Process Management Journal	4
3	CIRP Annals - Manufacturing Technology	1
4	Computer Law and Security Review	1
5	Digital Communications and Networks	1
6	Digital Policy, Regulation and Governance	1
7	Engineering 3	1
8	Frontiers of Mechanical Engineering	1
9	Industrial Management & Data Systems	1
10	International Journal of Advanced Manufacturing Technology	1
11	International Journal of Operations & Production Management	1
12	International Journal of Production Economics	1
13	International Journal of Public Leadership	1
14	International Society for Cellular Therapy	1
15	Internet Research	2
16	Journal of Industrial Engineering and Management	1
17	Journal of Information, Communication and Ethics in Society	1
18	Journal of Knowledge Management	2
19	Journal of Network and Computer Applications	1
20	LogForum Scietific Journal of Logistics	2
21	Procedia CIRP	27
22	Procedia Computer Science	5
23	Procedia Engineering	4
24	Procedia Manufacturing	21
25	Procedia Technology	1
26	PSU Research Review: An International Journal	1
27	She Ji: The Journal of Design, Economics, and Innovation	1
28	Strategy & Leadership	2
29	Supply Chain Management: An International Journal	1
30	International Journal of Logistics Management	1
31	TQM Journal	1

Table 1. Journals used in the review.
Source: Own elaboration, 2018.

Discussion of results

Following the methodology of Okoli (2017), the process of obtaining results begins:

Phase I:

Corresponding to planning; for the research it was decided to use the keywords “IoT AND manufacturing AND productivity”; selected from the

topics of interest from the last five years (2014 – 2018) published papers in international journals, related to technology, information sciences and telecommunications, and with the manufacturing industry; from different countries (Figure 2):

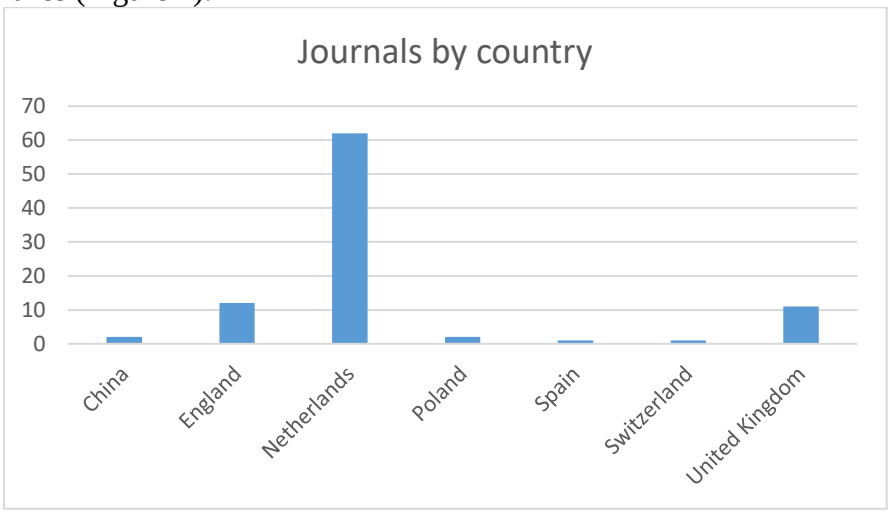

Figure 2. Journals by country used in the review.
Source: Own elaboration, 2018.

Phase II:

For the selection process, it was decided to use a total of 91 articles from 31 different journals focusing in the relation to the topic of interest, in order to have a diverse sample; valued in terms of their relevance and relationship with the issues of IoT, productivity, security, privacy, and the manufacturing industry.

Phase III:

An increasing polynomial tendency was found (Figure 3) with respect to published papers from 2014 to 2018; being that in 2014 only three articles related to the topics of interest (IoT, productivity, privacy and data security) was found in the research, while in 2018, six articles were published until March from those studied in the sample:

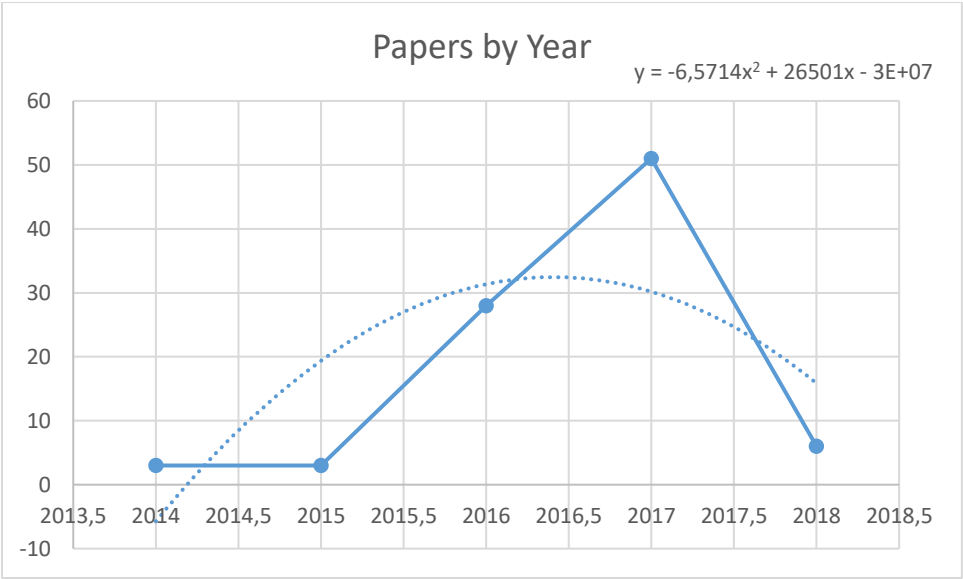

Figure 3. Papers by year use in the review.
Source: Own elaboration, 2018.

Phase IV:

In 88 of the analyzed papers, IoT was use to improve productivity in a manufacturing industry through the use of tools such as big data (9), proposed frameworks (4), industry 4.0 (5), control systems (2), cyber physical systems (3), innovation (5) and monitoring (5).

In the sample of 91 papers, some of the aspects considered in the implementation of IoT in a manufacturing industry are: additive manufacturing (4), business models (2), cloud manufacturing (2), cyber physical systems (4), digital manufacturing (5) and the supply chain (6). Only in 2 of the 91 papers the human factor is considered. By reviewing the 91 papers, the aim is to provide an objective approach that allows entrepreneurs and stakeholders to know some of the factors that should be considered when using IoT to improve productivity in a manufacturing industry.

Regarding security, in 39 of the papers it is mention, considering aspects such as: cloud security (4), cybersecurity (15), encryption (2), monitoring (5) and legal measures (3). Only in 13 of the 91 papers, privacy is mention; some of the aspects considered to protect the data privacy are: architecture, protocols, cybersecurity, guidelines, regulations and the legal system.

Conclusion:

According to the analysis, it is suggested to take into account the following aspects if when considering using IoT to improve productivity within a manufacturing industry:

1. Big data: the IoT involves the handling of large amounts of data, it is suggested to consider Big Data together with Business Analytics to store, organize, distribute and manage information for decision making.
2. Digital manufacturing: it allows to reduce the time scale and manage efficiently the entire product lifecycle, providing flexibility in designing and styling products.
3. Supply chain: it is essential to take into account the supply chain in order to improve productivity using new tools and technologies such as IoT in a manufacturing industry.
4. Cybersecurity: in order to protect the data from unauthorized access it is necessary to implement technologies, processes and practices that secure the information used in connected systems such as IoT.
5. Monitoring and control systems: it is important to monitor the devices connected to the IoT, in order to know their status, through the use of sensors; likewise, it is recommended to automate some of the tasks to take better advantage of the IoT environment.

Based on the papers analysis, it is concluded that the objective of the research was achieved, because an overview of the implications of using IoT to improve productivity within a manufacturing industry was proposed; including some of the tools and technologies that can be used to achieve it; likewise, some of the aspects to be taken into account for the handling of the information, with an special focus on the privacy and the security of the data.

References:

1. Al-Shboul, M. A. (2017). *Infrastructure framework and manufacturing supply chain agility: the role of delivery dependability and time to market*. Supply Chain Management: An International Journal, 22(2), 172–185.
2. Alkhalil, A., & Ramadan, R. A. (2017). *IoT Data Provenance Implementation Challenges.* Procedia Computer Science, 109(2014), 1134–1139.
   Avila, D. D., & Sandoval, K. V. (2017). *Theoretical and Conceptual Elements Linked to the Regional Growth of the Manufacturing Industry in Mexico* (1993-2008), 30(3), 1–17.
3. Banerjee, M., Lee, J., & Choo, K.-K. R. (2017). *A blockchain future to Internet of Things security: A position paper*. Digital Communications and Networks.
   Baragde, D., & Baporikar, N. (2017). *Business innovation in Indian software industries.* Journal of Science and Technology Policy Management, 8(1), 62–75.
   Bhattacharya, S., Wainwright, D., & Whalley, J. (2017). *Internet of*

Things (IoT) enabled assistive care services: Designing for value and trust. Procedia Computer Science, 113, 659–664.

4. Bressanelli, G., Perona, M., & Saccani, N. (2017). *Reshaping the Washing Machine Industry through Circular Economy and Product-Service System Business Models.* Procedia CIRP, 64, 43–48.
5. Campo, G., Calatrava, S., Perandones, J. M., Jie, S., & Martinez, R. (2017). *Poster : Improving Manufacturing Processes using Open-IoT BatNet Technology*, 202–203.
6. D´Outreligne, C. E. (2015). *INTERNET OF THINGS: A whole world to regulate.* ICE Economic Bulletin, 3070, 27–36.
7. Dong, X., Chang, Y., Wang, Y., & Yan, J. (2017). *Understanding usage of Internet of Things (IOT) systems in China.* Information Technology & People, 30(1), 117–138.
8. Dweekat, A. J., Hwang, G., & Park, J. (2017). *A supply chain performance measurement approach using the internet of things*. Industrial Management & Data Systems, 117(2), 267–286.
9. Graney, G. (2017). *Age of Exploration*. Quality, 12(November), 23–30.
10. Hernández, R. et al. (2010). *Research Methodology*. Mexico DF, Mexico: 5th Edition. McGraw Hill.
11. Mahdavinejad, M. S., Rezvan, M., Barekatain, M., Adibi, P., Barnaghi, P., & Sheth, A. P. (2017). *Machine learning for Internet of Things data analysis: A survey.* Digital Communications and Networks.
12. Matthew, J. (2017). *Supply Chain Management (SCM) Utilization based on SCM drivers in manufacturing industries*, 50.
13. Nolan, S. (2013). *A look at current trends and data*. Strategic HR Review, 12(5), shr.2013.37212eaa.009.
14. O'Connor, Y., Rowan, W., Lynch, L., & Heavin, C. (2017). *Privacy by Design: Informed Consent and Internet of Things for Smart Health*. Procedia Computer Science, 113, 653–658.
15. Okoli, C. (2015). *A guide to conducting a standalone systematic literature review*. Communications of the Association for Information Systems, 37.
16. Pease, S. G., Conway, P. P., & West, A. A. (2017). *Hybrid ToF and RSSI real-time semantic tracking with an adaptive industrial internet of things architecture*. Journal of Network and Computer Applications, 99(October), 98–109.
17. Rezaei, M., Akbarpour Shirazi, M., & Karimi, B. (2017). *IoT-based framework for performance measurement*. Industrial Management & Data Systems, 117(4), 688–712.

18. Riahi Sfar, A., Natalizio, E., Challal, Y., & Chtourou, Z. (2017). *A Roadmap for Security Challenges in Internet of Things.* Digital Communications and Networks, (January), 1–20.
19. Rodríguez, J., & Triana, J. (2017*). Metamodelo de Integración de Internet de las Cosas y Manufacturing Industry 4.0.* Proceedings of the 12th Iberian Conference on Information Systems and Technologies.
20. Ryu, M., Kim, J., & Yun, J. (2015*). Integrated semantics service platform for the internet of things: A case study of a smart office. Sensors (Switzerland)*, 15(1), 2137–2160.
21. Sahmim, S., & Gharsellaoui, H. (2017). *Privacy and Security in Internet-based Computing: Cloud Computing, Internet of Things, Cloud of Things: A review.* Procedia Computer Science, 112, 1516–1522.
22. Segal, M. (2015). *Planning for an IoT-enabling future. Is your digital transformation strategy prepared for IoT?*. IoT Agenda, TechTarget. pp (8-11).
23. Shea, S. (2015). *IoT in Field Services Beneficial, but not a Priority*. TechTarget, 12–16.
24. Shee, A., & Stefanou, S. E. (2016). *Bounded learning-by-doing and sources of firm level productivity growth in colombian food manufacturing industry*. Journal of Productivity Analysis, 46(2–3), 185–197.
25. Shin, D.-I. (2017). *An exploratory study of innovation strategies of the internet of things SMEs in South Korea*. Asia Pacific Journal of Innovation and Entrepreneurship, 11(2), 171–189.
26. Singla, A., Ahuja, I. S., & Sethi, A. S. (2017). *An examination of effectiveness of demand pull practices for accomplishing sustainable development in manufacturing industries*. Journal of High Technology Management Research, 28(2), 142–158.
27. Tedeschi, S., Mehnen, J., Tapoglou, N., & Roy, R. (2017). *Secure IoT Devices for the Maintenance of Machine Tools.* Procedia CIRP, 59 (TESConf 2016), 150–155.
28. Yu, X., Nguyen, B., & Chen, Y. (2016). *Internet of things capability and alliance*. Internet Research, 26(2), 402–434.
29. Zhong, R. Y., Xu, X., Klotz, E., & Newman, S. T. (2017). *Intelligent Manufacturing in the Context of Industry 4.0: A Review.* Frontiers of Mechanical Engineering, In press (5), 616–630.